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with theme

Government, Industry, Academe: Synergism for Acquisition Improvement

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and
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The 1983 Federal Acquisition Research Symposium was sponsored by the Department of Defense and Office of Federal Procurement Policy, and hosted by the Department of the Air Force at the Williamsburg Hilton and National Conference Center in Williamsburg, Virginia, 7-9 December. The theme was Government, Industry, Academe: Synergism for Acquisition Improvement. The proceedings contains 93 papers presented at the symposium on the following subjects: acquisition automation, acquisition information management, acquisition risk and uncertainty, acquisition strategy, acquisition workforce, balancing government and industry interactions, capital investment initiatives, competition, contracting methods, contracting strategy, cost applications, cost growth control, cost impact of prod rate variation, estimating and pricing analysis, industrial preparedness, integrated logistics support, management of support resources, market research and analysis, multinational applications and innovations, product assurance, program management, related aspects of productivity improvement, socio-economic considerations, and (OVER

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FOREWORD

syn·er·gism, n: the cooperative action of agents to achieve an effect of which each is individually incapable.

The cooperative undertaking of this symposium as indicated in the theme "Government, Industry, Academe: Synergism for Acquisition Improvement" is critical to the continued pursuit of a strong, vibrant, productive nation. We must work closely together in a responsible manner to reap the maximum benefits from our efforts in that pursuit. The sharing of information, concepts, concerns, and opportunities during this symposium is a valuable step in that pursuit.

However the real test of our effectiveness is yet to come, for we have to use our new awareness in order to ensure a genuine improvement in our acquisition process. And now is the best of times if we but know what to do.

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by Maurice Ecung

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by George T. Nickolas

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OFFICE AUTOMATION IN THE ACQUISITION ENVIRONMENT

Major John M. Barry, Space Division

ABSTRACT

The Defense Meteorological Satellite Program embarked on automating the office functions associated with word processing, data delivery, financial and management information in March, 1981. This paper describes some of the planning, experiences, and lessons learned involved with automating the acquisition environment within the program. This description includes specifying the hardware, software, communications and interfaces involved in tying together not only the program office, but also the contractors, and operating and supporting agencies. Finally, the paper evolves recommendations for future directions in automating the acquisition environment.

INTRODUCTION

Since March of 1980, the Defense Meteorological Satellite Program (DMSP) has been automating the contractual, technical, and financial aspects of program management using distributed processing and tailoring commercial software to specific needs. This effort was further accepted as part of the Defense Acquisition Improvement Program. The objective of this paper is to report the results and further recommendations on this project to the Acquisition Community. These results will be presented by explaining our approach, selection of hardware and software, some examples of tailoring the commercial software and future directions.

The DMSP approach to automation was based on the premise of acceptance and gradual implimentation of hardware and software. The program was sensitive to the fact that past automation failures within the government and private industry were due to "too much too soon" which resulted in poor individual and organizational acceptance. Consequently, the program began by leasing a small distributed word processing system before progressing to a larger, compatible system which integrated internal and external government and contract interfaces. The progression towards hardware and software expansion was regulated by speed and ability of personnel and manual systems to adapt to the automated environment.

The selection of the word processing system hardware was not dictated by features or preference, but rather compatibility with our major contractors existing equipment. Therefore, WANG™ word processors were selected to avoid data transfer and storage incompatibilties which have been plaguing the industry for the last decade. Software selection was based on adopting an operating system which provided the widest acceptance and offered the greatest variety of good commercial software which could be tailored to the acquisition environment. Control Programs for Microprocessors, CP/M™, the 8 bit microcomputer defacto operating system was chosen. The communications options were examined for requirements which dictated a need for high speed, error free transmission over unconditioned commercial telephone lines. Therefore, the bisynchronous, 2780 protocol was used. Experiences using these various hardware, software and communications packages will be explored in this paper.

Wordprocessing was targeted as the first priority to improve program office productivity. The experiences involved in "cultural shock," equipment placement, training and forms generation will be discussed in this paper. The next priority involved communications between the program office and supporting government agencies. Then the significant task of developing electronic delivery of contractual data was initiated. After this milestone was achieved in November 1982, the program concentrated on automating program office functions in the financial, scheduling, configuration and data management areas. Then the task of retrieving information from existing DOD data base systems with our equipment was solved. The program office is now concentrating on replacing specifically formatted Data Item Descriptions with relational data base and electronic spreadsheet information which can transmitted, stored and retrieved independent of format descriptions.

Sharing the experiences of the Defense Meteorological Program Office in applying commercial hardware and software the acquisition process should assist other programs in the development and continuation of there systems. This paper will provide an good foundation for this crossfeed.

OVERVIEW

Introducing wordprocessing into an environment of electric typewriters provided a challange in placement of the equipment, training and acceptance. Equipment placement required extra real estate since a concious decision was made that the electric typewriters would be retained for backup capability. This space included room for not only the video display terminal (VDT), but also for the disk drive, the main central processing unit, and printers. Since the manufacturer of the

equipment provided very little guidance on this subject, the program office was faced with integrating equipment into a facility which was never design with wordprocessing in mind. The placement of VDT's was fairly obvious -- with the secretaries or within a "common use" location. Due to facility limitations, some of the printers ended up being collacated in the same room as the CPU. This later proved to be a mistake since the paper dust generated from the printers subsequently contributed to a disk crash. Other printers were located in the reproduction room and a few were placed in large bay areas. These later locations proved to be more satisfactory. However, placing a VDT near printer(s) is essential in obtaining status of queued documents to the printer. Finally, both printers and VDT's were scattered throughout the organization because management determined that the "secretarial pool" concept would not be used. After locating the equipment, training became the next large obstacle.

The best laid plans for training evaporated when none of the organizations would release their secretary for formal training. Fortunately, the Wang™ system provided excellent self instructional material. Most the secretaries became proficient in basic wordprocessing in less than nine months. However, another problem surfaced for which we did not prepare. Almost all the junior officers began learning and using the word processor to type their own reports since they found that they could compose and edit faster using the word processor than paper and pencil since the program only has a limited number of steno-typists.

The last hurdle in the word processors was acceptance. Although this was initially a problem, the secretarial staff was generally very cooporative in helping each other discover "new features" and overcome their apprehension of the system.

Along with mastering the word processing came special uses to which the equipment was placed. This included using some of the special features such as fitting typed material into existing preprinted forms, establishing documentation libraries, and tricking the equipment into thinking it was a computer. This latter feat was accomplished by commanding the wordprocessing glossary into adding rows and columns of a financial matrix. These additional uses rapidly used up our on line hard disk capacity to such a degree that a manual "scrubbing" of the system was necessary on a weekly basis to purge the disk. Anything for retention had to be archieved on a floppy disk which stores about 120 pages of data before the system was purged. This situation was further complicated by the introduction of telephonic data delivery via word processors with the contractors and other Air Force activities.

The feasibility to institute electronic data delivery with our contractors was determined by examining the total spectrum of reports and paper copies delivered by 25 separate contracts and 6 contractors. The major savings were forecasted to be in contractor development and editing of reports, postage, reduction in paper copies and storage and retrieval of information. These savings amounted to be over $ 1,250,000 over a five year period. However, the additional storage requirements forced us into removeable hard 10 megabyte and fixed 80 megabyte backup hard disk. These requirements were further strained when we turned the word processors into computers.

The program office needed computerized distributed processing. However, it did not have sufficient "real estate" to house word processing and computer equipment. Recognizing this situation, the author convinced Wang to develop CP/M™ (control programs for microprocessors) for the word processing equipment. Once CP/M™ was place on the WANG™, we were able to purchase non-WANG™ software. This software included dBASEII™, and Supercalc2™ which we used to develop our management information systems. We developed a user-friendly budget system which allowed one person to do the work that was normally required of four individuals. Additionally we developed data and engineering proposal tracking sytems. Future development is planned to track internal commitment of financial data, schedule milestones, and our internal paperwork system. As with the present initiatives, commercial hardware and software will be the preferred approach with these future projects. The rationale for selecting commercial products will be examined next.

The explosion in the variety of microcomputers has provoked price competition, encourgaged the development of "mix and match" systems, and resulted in the advancement of technology. Price competetion has propelled relatively obscure companies to instant success, while destroying others. The December issue of National Geographic stated that the profit margin on personal computers was less than 10% and that they agreed with a September issue of Business Week that the survivors of the

industry would not be the computers with the greatest technological edge, but the ones with the greatest distribution and marketing base. The importance of selecting a microcomputer from one of the expected "survivors" is essential to the long range support required of a selected system. For these reasons, the program selected a commercial manufacturer was already established and provided long term support to its customers. The tendancy to select and integrate ones own hardware and software at a lower acquisition cost was extremely tempting. However, lowest life cycle cost and not acquisition cost was the major selection criteria. Downtime could not be tolerated because people would be left without the tools to work. Similiarly, future availability of spare parts was also important as well as tried and tested user documentation was important. These criteria led us to select a well known manufacturer of word processing equipment, Wang™. The selection of this paticular word processor was strongly motivated by the fact that the program's major contractors were already using this equipment. This common usage guaranteed that the interface problems between dissimilar pieces of equipment that has been plaguing the industry for the last ten years. would not occur. Finally, our selection was based on the knowledge that Wang™ equipment was based on the Zilog -80™ (Z80™) microprocessor which used CP/M™ operating system. This defacto standard operating system allows the use of thousands of commercially available business software.

SUMMARY

The experiences of automating the Defense Meteorological Program illustrate one approach to using commercial hardware and software products in automating the acquisition environment. This approach should not be construed as the best or only one. The important point is that long term supportability should be an essential criteria in the selection of equipment. The government assumes too much risk when "mixing and matching" equipment on its own or selecting a commercial sources which does not have a long term support potential or the resources to provide that support.

The internal problems in hardare selection, equipment placement, and training faced by DMSP probably are generic when adapting this new environment into a new situation. Therefore, the author hopes that these experiences can assist others in structuring their own particular application.

NOTE

Much of the information in this paper is the result of the author's personal experience while working for Space Division and should not be considered a statement of Air Force Policy. Neither the Air Force nor the author are endorsing the products mentioned in this paper.

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THE MICROCOMPUTER IN THE ACQUISITION ENVIRONMENT

Major Maurice Ecung, Hq Space Division

ABSTRACT

Headquarters Space Division in Los Angeles took the initiative in adopting the microcomputer as a viable tool to improve overall operations. After a little better than 18 months there are over 200 terminals on station. Most are split between 4 and 8 user multiprocessor systems.

Our primary goal in both microcomputer hardware and software acquisition is to stay away from proprietary products that can lock the user into a particular vendor for systems support and modification. The result of our November 1981 design decision was hardware configured around the Z80 microprocessor using the S-100 (IEEE-696) Buss. Standardized user interface was included by specifying a keyboard configuration of NASA's Jet propulsion Laboratory design with 40 programmable function keys. Eight inch single side, single density floppy disk drives (IBM format 3740) were chosen because they represent the one industry wide standard in disk formating.

Though most of this work was done in a Contracting office the conclusions are relevant to all. We feel the experience of our period of experimentation with Office Automation can aid other offices considering taking this course of action. We have had both positive and negative result with our effort, but the overall conclusion is that (1) micro-computer office automation can not be avoided and (2) we have only scratched the surface of its applications in the acquisition environment.

INTRODUCTION

Microcomputers and Office Automation have been headline news for the past year in news magazines, the Wall Street Journal and other publications oriented towards the business community. The federal acquisitions community is in a position to directly benefit from these advances in technology and office operations.

DEFINING AND ACQUIRING THE TOOLS

Before you can totally appreciate the microcomputer's benefit you must understand the structure of the tool and concept of its operation. Most of the decision making process on selection of hardware and software was facilitated by prior research by the Department of the Navy. This research was incorporated into the examination of practical applications by NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California. Space Division then utilized JPL as a consultant in the development of the Space Division "Standardized Primary Office Computer" (SPOC). The term SPOC is not a brand name nor does it refer to the equipment of one particular manufacturer. It is simply used to identify hardware generally compatible with and complying with the following guidelines.

HARDWARE

Hardware considerations for the Space Division Deputy for Contracts Resource Management Office (SD/PMA) anticipated the use of a minimum of eight work stations in a "Multi-Processor" mode. Multi-user systems (like MP/M) with a "time-shared board" technology tend to slowdown with more than three users. Therefore they were considered inadequate. The multi-processor mode allows a separate processor board for each work station user. Each user functions as if he has an independent computer with 64K random access memory (RAM) while sharing all of the expensive peripherals like modems, printers and hard disk mass storage.

The advantages of the S-100 Bus structure is that it is manufactured by more than 20 different vendors. Therefore we are not required to be locked into any one vendor for follow-on support. If at some later date we decide to upgrade to even a different operating system the S-100 Bus Configuration will allow the insertion of boards that either run Turbodos, MSdos, CP/M-86, UNIX or combinations thereof without having to junk the entire system. The choice of peripherals is virtually unlimited.

The prototype SPOC system was procured with funds originally budgeted to upgrade an old Inco microprocessor Database Management system. The "upgrade" consisted mainly of adding one new information field. The cost of converting this proprietary software and hardware design was $42,000. Instead, we purchased an 8 user multiprocessor with two NEC 7710 Spinwritter printers (with silencers), 8 SOROC 150 terminals with keyboards with 40 custom designed function keys for word processing, two Tarbell 8" floppy disk drives (SSSD, IBM 3740 format), Ades 33 megabyte hard disk and a ten megabyte tape backup. We also purchased the CP/M multi-processor operating system, scores of utility packages, and word processing, database management, and spreadsheet software. This may give you an idea of the increased capability combined with lower cost of this type of system.

Maintainability: With the procurement of "off the self" hardware the solution recommended by the navy in an early issue of Chip magazine still applies for maintenance and repair. "Buy a spare computer and send the original back for repair when it goes down." In the case of the multiprocessor spare boards can be stock piled in Base Supply along with keyboards, CRT terminals, modems and printers. The time to replace a processor board is less than 30 seconds by a user.

SOFTWARE

Word processing: The first software decision was the operating system. The CP/M operating system was adopted because it is an industry standard with "vast" libraries of low cost business software available. Software considerations are based on the assumption that the hardware will offer a CP/M operating system. This being the case most Air Force business management requirements can be met with "off the shelf" packages readily available on the local market.

In determining the software packages to procure the decision was fairly simple. It involved observing the market place. Business requirements tend to break into four basic areas: (1) word processing, (2) database management, (3) spreadsheet / analysis functions and (4) telecommunications / electronic mail. Therefore we chose "off the shelf" software packages to meet each of these primary requirements.

In general word processing represents about 70% of office automation, based on JPL figures. Most of those utilizing this function will be secretaries. Therefore it was essential that the package be both extremely efficient, comparable to the dedicated word processors, and just as easy to use. "Wordstar" (Micro Pro International), a commercial package available at your local computer store (list - $295) is considered by many to be the "Cadillac" of word processing software. Because it has so many capabilities requiring multiple keystrikes, it can be complex to the novice user. JPL already had the solution. By buying terminal keyboards with programmable function keys all of the word processing functions are now printed on the key caps giving the user the same capability as those using dedicated word processors. At the time of our market analysis (Nov. '81) the dedicated word processors cost up to three times as much per user, without computing capability. Since then competition, in part from micro computers, has resulted in dramatic price drops for dedicated word processors. Many of them now offer some computing capacity.

Data Base Manager: The data base management program is a commercial package called "dBase II" (Ashton-Tate). This program sells locally for aproximately $435.00 (list price is $700.00). It is Capable of managing 65,000 records . A Data Base Field can have up to 250 characters per field, 32 fields per file with a join capacity that allows a file to be expanded to 64 fields of information and up to 2000 characters per file record.

Electronic Spreadsheet: The third program function was the spreadsheet analysis. Those familiar with the Micro Computer Industry are aware that the Visacalc Spreadsheet program was probably responsible for selling more Apple computers to the business community than any other factor. This is the type of program format that allows you to play the "what if" game. A change in any cell within the spreaIdsheet can be made to be interactive with all others. You can then see what impact one decision in one part of an organization may have relative to the rest of the organization. SD is currently using "Supercalc." Some users are experimenting with "Supercalc II" and the Super Data Interchange (SDI) enhancements (Sorcim).

Telecommunication: A fourth element of the system was the Telecomunications Requirement. We were looking for way to transfer files and use electronic mail without the immediate requirement for a hard wire local area network (LAN). Software generated Telecommunications using the standard SPOC system was the solution. At this time we are using commercial programs called "Move-it" and "Term". The preferred Telephone Modem is the Hayes Smart Modem 1200.

The decision to go with these software packages was based on the fact that they were the top of the line on the commercial market in the fall of 1981. They are also CP/M Software Programs. They are used by a large volume of users. This results in constant product upgrading at a minimal cost. Should other, better, program become available, the CP/M operating systems would allow us to change our files to any other data base managers, spreadsheet or word processing program. The vendor currently providing multi-processor SPOC systems installs "Turbodos", a CP/M compatible operating system.

We've effectively put to work 8 users, all with full word processing and computer capacity for less than $ 5000.00 per user. This is less than the price of dedicated wordprocessors alone.

DIRECT RELATIONSHIP TO THE ACQUISITION WORLD

In the direct application of this technology to the acquisition community there are two basic areas to be examined. One is the day to day work environment. In general this is the same things that would benefit any business office. The second area is contract action tracking and the analysis of functions that would be more directly related to the actual contracting process.

First we will examine the day to day work. Generally this involves the word processing type functions. The most obvious application would be the automation of the standardized forms used in the procurement file folder. Much of this automation has been realized in our contract writting operation developed several years ago. We can now take the next step forward because of the ease of developing formated screens and form printing without advanced programer assistance. The user can identity his own needs and translate them directly to hard copy. In fact it should no longer be necessary to produce a hard copy until final signature is required. Each of the approval steps could be done electronically to floppy or hard disk. For command approvals at other locations telecommunication would allow for review on screen, and return, in almost real time.

One of the requests from the Contracts director was to provide a spelling checker which would preclude high ranking contract review personnel spending hours simply correcting spelling errors. The obvious solution was a spelling checker program which checks the words as you go along.

The movement of contract files back and forth between one office and another for either contract review and/or checking is a very time-consuming process. Files are often lost. Through a local area network many small Microcomputer systems, and in this case multiprocessor systems, can be joined together. In such a network up to 64 users can access the same database locally. Currently we are running users as far as 300 feet from the main processor using wire alone. Therefore in effect we have an electronic mail system that will allow file sharing and cross comunications with a simple touch of a button.

Interactive training is another potential use of this system. Our current "Buyer's Guide" training manual could be automated and made a part of an automated training program. Computerized contract training would allow the trainee to answer questions and study problem situations. When inaccurate responses are given to questions, this infomation is retained. Then future questions focus on the individual's areas of weakness. This would provide individually paced training not currently available.

Another use could involve accumulating data during the contract review process. You could track where errors are being encountered, and who is producing them. In fact eventually most of the contract review function will be automated. A program could be written to read through the entire file checking for the existence of required clause references for the particular type contract.

The second area involves more of the data manipulation functions. At present in the prototype system we are running a 16 bit boards in the same bus with our eight, 8 bit boards. We originally put the 16 bit board in to allow for an increased RAM capacity in order to do larger spreadsheets. This was at the request of our pricing section. In preparing for a negotiation, approximately 20 hours was being spent manually developing position spreadsheets. Using both the eight bit and sixteen bit version of "Supercalc" the time now required is four (4) hours. In time, with the development of standardized templates for particular companies, this time requirement will be cut significantly. In fact most of the raw data input can then be performed by secretarial level personnel.

In the past, when the contractor walked into negotiation with new rate schedules, or some other change, the old manual spread sheets were immediately invalidated along with most of the pricer's efforts. Now if a change is required in any part, all of the related figures are changed instantaneously. Just as important is the ability to play "What if". Several different negotiation positions can now be explored and printed out. We are now using a compatible portable computer. This allows the pricer to evaluate positions while negotiating. We have ordered extra portables because of the demand from pricers on TDY and those desiring to work evenings and weekends.

With the full adoption of this automated practice, pricers can be used to do "price analysis". They are then utilizing both their skills and their talents in an area where they are most valued based on their salary scale. Currently they are being used as number crunchers, sitting behind calculators for hours on end.

The next step, suggested by our pricers, is to develop independent cost estimating techniques based on historical pricing Databases maintained in the pricing section. The data can be used both in spreadsheet formating process and as a part of the historical pricing data base to be developed for each company. Then, using a data base managing file program it would be a simple process to develop a data base which would maintain historical information, negotiating techniques of particular companies and their negotiators, problems encountered, rate schedule data, etc.

Perhaps the most difficult process in monitoring the contracting functions is providing an accurate and current Management Information System (MIS). Currently Space Division PM has its internal management information system. Air Force Systems Command has its Acquisition Management Information System (AMIS) and are tracking contract milestones. However, at present these are being tracked on an after the fact basis. There are presently software

packages available in the low cost CP/M market place that can be used for milestone tracking, Gantt charts, Pert networks and Graphics display.

THE AMIS INTERFACE

Utilizing the AFSC AMIS database we have been able to demonstrate the local capture of current data files. The SPOC system (or any other microcomputer with a modem) can directly access the Acquisition Management Information Systems data bases located at Wright-Patterson AFB, Ohio. By using a program called Term or Move-it, to telecommunicate, we can transfer the ASCII code files, in any data format that we require, directly to our hard disk. It is later reformated from the text structure to dBase II format and then manipulated into report/ presentation format through the use of other dBase II programs. This data can then be analyzed on a spread sheet or displayed graphically.

Most of the difficulty in accessing AMIS has nothing to do with the quality of the database, the structure of the database or the hardware used to maintain them. The problem evolves out of trying to please everybody. This means that every time someone wants the buyer's name to appear after the PCO's as opposeed to the opposite (or an uncountable number of other options) a new report format must be designed, documented and maintained though it may be accessed once a year. The result is that several inches of paper is handed to a prospective new user. This microcomputer interface would free the AMIS office of the need to maintain and support the many different data format requirements of the user community for report generation.

The validity of this AMIS/SPOC interface capability was demonstrated to the AFSC AMIS Program Office on 21 April 1983. Combining this same non hardware dependent process with the Improved Data Input (IDI) project could result in a significant dollar savings. It would provide low cost, user friendly interface to the AMIS system, from any Microcomputer. Thus, there would not be a dependency on one vendor's expensive proprietary operating system, software or hardware. Most installations would not have to purchase any new hardware. Standardized user developed templates (in the form of mini-programs) could make this process even more efficient. We then have the ability to produce immediate data analysis provided with multicolored graphics displays. All of this in a low cost Microcomputer mode.

The ability to access the main data base at Wright Patterson (and have this information immediately available, manipulated in any format desired and at any time desired) does not in any way threaten the integrity of the main data base. In fact it confirms and enhances the currency of local management information. Today manually manipulated data might be stored for months, and quoted from, as opposed to having to go back and reevaluate a current printout of the current data base. What this now means is you can request current data at 9:00 a.m. in the morning and have slides prepared with all the analysis from the current database in time for a 10:00 briefing. This takes days in the manual mode.

THE MANAGER

We are spending large dollars having managers and supervisors preparing presentation slide formats from raw data. Using simple two and three hundred dollar programs we can take the imformation directly from the data base. It can then be put on to slides to be displayed in any presentation format desired. The objective is to free managers to manage and get them away from the mundane, time consuming functions that are nonproductive relative to their assignment and skills.

Rick Minicucci in his article on "Decision Support Systems" (DSS) outlines the "ultimate goal in the development of the Executive interface." Where MIS furnishes all of the data DSS analyzes it. First, realize that more data is not better data.[7]

The best executive can drown in a sea of information without the ability to digest any of it. Alternatively the basis of most MBA programs is providing the mathematical and analytical tools to reduce this data to inteligible consumable form. However, the time required to manually reduce this "database " to a digestible form may be longer than the useful life of the data.[7]. According to Walter E. Lankua, Jr., of Management Decision System, Inc., the current problem is that DP professionals see their job as providing massive printouts of data. This is in part because they do not understand the needs of management.

We are asking DP trained professionals to provide DSS that are more in line with the academic and experience preparation of the MBA. The ultimate goal then is to use an MBA with data processing experience to structure the DSS. (This is an opinion shared with Julia M. Mingledorf, Coca Cola's DSS specialist). As the user friendly nature of the Computer interface software increases the end user can structure the end product to meet his own needs. Even the analysis software modules preclude the necessity to remember applicable formulas for analysis processes. Then the DP people can concentrate on maintaining the integrity of the data base and studying the technology change that can make their operation more effective.

CURRENT APPLICATIONS

These SPOC system capabilities have given the Space Division Contracts Office of Resource Management (SD/PMA) the capability to automate the personnel locator function, training requirements, tracking of suspenses, projecting personnel departures and acquisition. We also have report generation in any desired format drawing on the data stored in the data base. In addition form letters have been created for repetitive functions. In a one-year inplace test, SD/PMA has validated the functional and practical usefulness of the SPOC concept in a multi-processor configuration. The SPOC in this configuration has become indispensable for (a) word processing, (b) tracking training progress, (c) training requirements, (d) manpower, and (e) assignment status.

Using the same hardware with word processing software, like Wordstar, word processing capability is immediately available for each system user. This has significantly reduced processing time of written documents. It allows drafts to be written directly to the system in many cases to be revised or printed as desired. "Spellstar" spelling checker, Random House Thesaurus and "The Word" grammar checker enhance writing skills.

In the future this system will provide the capability to access commercial databases and electronic mail. With minor modification, access to Space Division mainframe systems can be simplified.

With the limited secretarial resources and the competitive demand for this resource in the Los Angeles area market, word processing capability will offset some of the present personnel requirements. It also enhances job desirability. Our recruitment effort should ease when secretarial resources are aware they will have access to word processing equipment.

PEOPLE VS. COMPUTERS

If I had been asked at the start of the Space Division Microcomputer Office Automation project I would have been very optimistic about the period of time required to project completion. After almost two years of effort in this direction my view has changed drastically. As it turned out the critical time factor has consistently revolved around the factor of "people".

In Alvin Tofflers book "Future Shock", he attempted to address the stressful impact of constant change, at an ever increasing pace, on those accustomed to a more traditional pace. In office automation we see many examples of this phenomenon. Eileen Feretic (editor of Today's Office), in a recent editorial, illustrated the impact that fear of change is having on the application of OA. One hindrance is the fact computers today are keyboard oriented and most managers have never learned to type. To illustrate that change will come she points to the fact all corporate accounting was manual 40 years ago. Today even small businesses must automate to remain competitive.[4] Others used the example of the slide rule. A required engineering tool, it virtually dissappeared overnight. The options apparently are (1) overcoming this fear or (2) facing personal functional obsolescence.

TRAINING

Everything I have read on the psychology of office automation suggest that it can best be introduced at the top of the support personnel level. Logically you should take the senior individuals at this level, teach them first. They therefore wouldn't be threatened by lower ranking personnel who have developed these new skills. They then would instruct those they supervise.

It didn't work that way. The senior personnel used every excuse not to learn the system. They were too busy and didn't have time to "play with a computer". One person all but ordered me to "get that thing out of here". My solution was to instruct a person at the lowest level who didn't object. She quickly became the expert at using word processing. No pressure was put on her to instruct the other potential users, but within a short time she was the SPOC word processilg authority for Contracting. Respect for her skills led everyone else to ask her to instruct them. It was a slow and tenuous process but gradually we have reached a point where almost every secretary is demanding access to a terminal, albeit mainly for word processing.

As mass training was started much of the fears dissipaed but problems remained. We started training long before enough systems were available for each "student" to practice. By the time they were delivered much of the training had been lost. This led to some user frustration that was interpreted by them as hardware and software unfriendliness.

THE ADPE PROCUREMENT PROCESS

There are bureaucratic delays inherent in the implementation of procurement practices that weren't designed for this type purchase. For example, I can buy a typewriter off the GSA schedule very easily. As a manager I would much rather buy a portable computer for the aforementioned reasons. The purchase price would be less than a quality typewriter but the paperwork requirements would be comparatively enormous to satisfy the Data Authorization Request (DAR) requirements for the purchase of Automated Data Processing Equipment (ADPE).

Software procurement is hampered by much of the traditional attitudes developed in the mainframe environment. Clauses relevant to proprietary data rights don't apply when you are buying software "off the self" from your local software store.

A reexamination of the entire procurement process is essential to facilitate addressing the projected DOD micro-computer demand. According to the Federal Contracts Report (June 6, 1983) the Federal Government's 19,000 computers are twice as old as those used by corporations, with an average age of 6.7 years in 1980. The changes in computer technology from that period of time to the present have been significant. The President's Private Sector Survey on Cost Controls recommended the "upgrading and replacement of uneconomic and obsolete systems."[2] In evaluating the replacement of these "dinosaurs" I'm sure many of the functions currently allocated to remote terminals on mainframes can now be allocated to micro-multiprocessors.

In a recent article, Government Executive magazine pointed out that "previous ADP acquisition approaches seldom are able to capitalize on private sector gains - either in technology or in productivity." According to GSA, the Federal Government can expect to have between "500,000 and one million personal computers" by the end of the decade.[1] This presents a warning and a challenge at the same time. It is incumbent upon those of us in the acquisition community to analyze our current procedures and expertise.

COST VS. QUALITY

One negative response to utlization of microcomputers to replace some mainframe functions is directly related to the low cost of microcomputing business applications software. Understand the concept of price (economies of scale) as a factor of demand and size of market. It isn't hard to understand that a database software designed for a specialized system or one with even a few hundred potential users must be expensive ($70,000 - $150,000) to recover the developmental cost. Whereas a product like "dBase II," which is currently retailed at approximately $400.00, has sold thousands of copies. The fact that so many copies have been sold speaks for the quality in several ways. One, it is getting tested on a grand scale. The volume of use insures that any shortcomings of the package will be encountered early and adjusted. Also, user groups contribute to product enhancements which the manufacturer is then happy to incorporate. An example of this is the development of a multiuser dBase II with record locking capability to meet a need defined by the Air Force. The fact the Air Force will not have to pay the cost of this adjustment is indicative of its commercial appeal. Instead of software being deadended once, put into use it now is living and growing with a rationale for continuing support on the part of the manufacturer.

"Computers and the resources to operate them consume about ten percent of the Air Force budget. The big cost is software, which eats up eighty cents of every computer dollar."[6] Disregarding weapon system imbedded computers, the need to avoid recreating the wheel is obvious. Significant dollar savings will be the results of using off the shelf software for business management applications.

CONTROLING OFFICE AUTOMATION

The Federal Office Automation Conference, referencing their report called "Organization", recommends consolidating key information policy and information resource management functions in a single top-level staff organization reporting directly to the senior 'single agency official.' Line functions would not be consolidated, but would continue to operate as separate organizations under the oversight of the integrated staff organization. This would strenghten overall information policy and management and responsibilities of each organization and the corresponding managers."[5]

The Air Force's restructuring to provide for "Information Systems" illustrates "the blurring of the distinctions between communications, automatic data processing, and office system technologies."[6] This is additional rationale for taking a second look before putting emerging office automation efforts in the hands of accounting and finance people.

Creation of the USAF Assistant Chief of Staff, Information Systems, effective 1 Jun 83 ACS/Information Systems (AF/SI) "providing USAF policy, guidance, planning, programming, budgeting, and oversight for information systems," should give greater direction to the office automation effort.[4] The first head is Maj. Gen. Gerald L. Prather. Referencing his projected $12 Billion budget the General says, "the major share of future expenditures will go into modernizing logistics information systems," making "them interoperable".[2]

A "three-way battle among the office automation, telecommunication, and data processing departments has erupted at many companies over control of the personal computer influx." "Most corporations have automated the clerical worker, not the manager." However, "85% of the desktop computers were bought by users, either individuals or departments, outside the data processing establishment."[3]

The variety of options on the market can actually hinder the decision process in deciding which sytem to procure, Business Week magazine

calls this "paralysis by analysis". As opposed to making a commitment to one integrated system many companies are "letting the wild flowers grow", letting each department experiment.

Personal computer tears down the distinction between"data processing , word processing and telecommunications". " The personal computer has become the defacto workstation" [3] I am recommending that this liberal attitude prevail in the Air Force in both systems procured and access to those systems.

I am currently reviewing a Source Selection package "invented" by Major John Barry of Space Division. It is written in Supercalc and dbase II. In my opinion this package is the equivalent of and of the type quality of software we would have paid hundreds of thousands of dollars for a few years ago. The fact it was written on his "personal" IBM PC in his spare time is indicative of things to come.

PRODUCTIVITY

Traditional commercial goals of business management like efficiency of operation and the "bottom line" seem to be less motivating to the manager in a government bureaucracy. Interest generally seem to be centered on not rocking the boat by upsetting personnel with a change in their daily routine. There is no incentive for senior leadership to introduce these new tools when efficient opperations can not be translated into "profit" by the manager making the decision for change. Yet we in government are constantly being asked to do more with less.

The lack of a competitive environment internally is another reason the government managers fail to look at the commercial business community to see what innovations in management tools are being adopted. The market for business oriented microcomputer is the result of a need being addressed. Small businessmen particularly have a need for immediate access to decision influencing information (commercial/subsription and private databases.) Basic accounting functions along with scheduling requirements are simply too labor intensive and therefore too expensive. Profit is the incentive to innovative and efficient operation, and profit has become dependent on productivity. By following the lead of the business community we can increase our productivity.

SUMMARY

Office automation is not a panacea. There are still many problems to be worked out relative to its effective use, particularly at the level where it can do the most good (management). However, the door is now open for those aggressive minds that desire to explore the potential of this concept. Its direct application to the acquisition community is little different from its benefit to other organizations.

The most important factor of the Office Automation effort is that this mode of operation allows the user to be master of his fate. The user friendly nature of the software packages and the low cost of both soft and hardware will allow the acqusition professional to accommodate various needs. He will no longer be a captive of a data processing system insensitive to the intricacies of his profession. This moves from the current rigid structure of management information to a more flexible one.

An analogy to the situation in the acquisition office today might be the example of a carpenter building a house with "power tools" versus the "hand tools" of a generation ago. Both methods work but few people would accept the time, cost, and non standardization inherent in the old way. Now we are trying to issue power tools to our MBA and Acquisition professionals so they may better use their knowledge and skills.

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NOTE:

MUCH OF THE INFORMATION IN THIS PAPER IS THE RESULT OF THE AUTHOR'S PERSONAL EXPERIENCE WHILE WORKING AS DEPUTY DIRECTOR OF RESOURCE MANAGEMENT, DEPUTY FOR CONTRACTING, SPACE DIVISION AND SHOULD NOT BE CONSIDERED A STATEMENT OF AIR FORCE POLICY.

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AD P002749

PAPERLESS SOLICITATION AND CONTRACTING

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ABSTRACT

This paper examines the contract simplification effort currently undergoing prototype development in the services under the Defense Acquisition Improvement Program. This effort has led the author to explore the state of the art of contracting and what changes will have to be made to methods of contracting to keep pace with the commercial marketplace in the next decade.

Further, the computer is becoming as common as the telephone in every office. The use of the computer seems to be unlimited, ranging from games to sending electronic mail. This paper provides what the author perceives as a step by step advancement needed by the Government in the use of computers to transition from formal paper contracts transported by mail to paperless contracting transmitted via telephone lines or satellite to contractors and between contractor and Government agencies. This paper explains the author's concept of the various elements of paperless contract evolution which must be achieved to allow the release of solicitations via computers, contractor submission of bids via computers, and the eventual award of contracts via computers.

DISCLAIMER

The views expressed in this paper are those of the author and do not necessarily reflect the official policy or position of the Department of the Army or Department of Defense.

BACKGROUND

There are those in the computer service business who say "someday" is "today." (1) They offer the service that would allow, with the push of just a few buttons, knowledge of the latest advances in home management and nutrition; recent business mergers; high school sports scores; information on 9,000 securities which is updated each day and throughout each trading day; and the ability to scan the pages of the ultimate electronic catalog and pick and choose from over 30,000 items--from cookware to clothing--available at discounted prices. Companies are sending messages electronically to their various offices using electronic mail, which is a person-to-person message delivery system allowing individuals to privately communicate with other people cheaper than the cost of a telephone call and faster than the postal or other express delivery services.

One computer service advertises that almost any brand of personal computer or terminal and many communicating word processors will connect with their computer service. This system is available now in over 300 cities in the United States and Canada and is connected with and through a local phone call.

We are living in an age when so many things are governed, operated, and maintained by computers. General Motors and other automobile manufacturers have installed computers in their cars that monitor and regulate the amount of unused fuel that is being exhausted out the tail pipe. The computer adjusts the fuel mixture by a signal sent by the sensor to the carburetor or the fuel injection system. This is one of the ways in which fuel savings is being accomplished in each new model year as required by the Federal Government. The computers of the future, many of which are available now, will change the temperature in the room at a set time or by the addition or subtraction of a person from that room. There will be heat sensing devices in the room which will calculate the necessary amount of heat that will be produced and required or the amount of cooling required to maintain a temperature level that has been established by the homeowner. The level will be fed into a central computer which controls the entire heating and cooling system of the house.

Computers are expected to change the way we receive our news in the next 5 to 10 years. In fact, American Telephone and Telegraph is preparing for this electronic newspaper era. The amount of news and backup material which will be available would boggle the average person's mind. (2) We can already hook up to a computer than can access research banks of data for just a few dollars per hour. The British Post Office System has been experimenting with an electronic information system since 1970 that is capable of providing its subscribers with 150,000 pages of information. This system allows the subscribers to get their daily news, check train schedules, look at readings from several libraries, take televised university courses, see a list of Guinness records, look at a guide to recommended restaurants, and shop. There is a similar system operated by Dow Jones which has been started in Dallas, Texas that plans to operate throughout the country. This background is provided to show that the extent of the use of computers is truly unlimited, and that planning is needed now to transition smoothly from one stage to the next so that we are not always reacting in a panic.

In the business world there will be other great strides; computers will sense and perform tasks to insure that society is comfortable, business is conducted efficiently, and profits are maintained at required levels. What I plan to discuss in this paper, is the direction in which Government procurement is evolving and the plans which must be made to permit an orderly evolution into a paperless society.

CONTRACT SIMPLIFICATION

The size of the Government contract has grown over the years. Many of the things causing this growth have stemmed from socioeconomic considerations and pronouncements of Congress and the White House. For years, contractors have complained about the complexity of Government solicitations, contracts, and purchase orders. The Government should make a concentrated effort to simplify this situation as it has become a major complaint of industry. When Frank Carlucci became the Deputy Secretary of Defense, he immediately initiated directives to make meaningful changes. One of the changes was to develop a contract which would satisfy the desire of industry for simple contracts. The first aim was to reduce the size of the contracts. Many of the problems, which were cited by industry, emerged from the fact that potential offerors had to read through many pages of the solicitation before they could determine what items the Government wanted to purchase and when the Government wanted those items delivered.

The small businessmen were most concerned because they did not have the large staffs of experts to help in proposal preparation who were available to their big business competitors. Government contractors in the large business community also complained about the size of the contracts, but if they were substantially involved with the Government, the cost of reading and processing these contracts was always recovered in the cost which they billed the Government. The small businessmen did not always have this luxury. Also, they were most often stuck in the fixed price contract arena. Some of the small businessmen who did not have many dealings with the Government were scared away from Government business by the sheer size of the solicitation, let alone the complexity of the solicitation, purchase order, etc.

CONTRACT SIMPLIFICATION $25,000 to $500,000

The management effort initiated by Deputy Secretary Frank Carlucci covered a host of areas. One of these areas is the simplification of the Government's method of issuing fixed price contracts up to $500,000. This was considered the area of the largest volume of business and where the most savings might accrue.

Mr. Carlucci decided to establish a steering committee to take the necessary action to review this area of contracting effort. Millions of contracts have grown into administrative monsters. The committee was to develop and test some simplified contract forms and to refine them during the prototype testing period. The results of the prototype development and testing would then be reviewed and the forms further refined. Refined test forms would then be widely tested in DOD for a year or they might be adopted without further testing. This decision would be made by the Deputy Under Secretary of Defense, Research and Engineering (Acquisition Management). Mr. Carlucci provided a waiver to all regulations during the testing period, and advised the development group that they should take risks which might even lead to litigation if they could make an improvement. The only limitation was to develop forms and supporting provisions which were not prohibited by law. Later, if the need was justified and the elimination of the restricitve law would permit simplification of solicitations and contracts, an effort to change the law would be made. It was planned to change the Defense Acquisition Regulation based upon the results of the study and the prototype tests.

Early in the planning on this project, many areas were uncovered which would allow for the elimination of great quantities of paper, resulting in the savings of thousands of dollars, in postage alone, for each Government contracting activity. Added to this postage savings would be the greater costs of the paper, printing, storage, and handling which would be saved with the elimination of pages in each contract document. The real and immediate savings will be substantial, but the indirect savings of fewer personnel needed to process these deleted pages will have to be determined after the test and the documents are developed.

Another idea which holds great promise is the deletion of the certifications and representations which are required of the contractors bidding on Government procurement. The concept is to have the contractor complete these representations and certifications once a year when the company updates the Bidders Mailing List Applications. With the removal of these additional items from the bids/proposals, another page or two may be deleted from the solicitations, which also contributes to the total cost savings realized by both the Government and the Contractor. During the planning phase of this idea and during the discussions at the Department of Defense working group meeting, the idea was proposed that perhaps contractors could submit this type of data once a year to a central place in the Government instead of to each purchasing office. The bidder would then notify each procurement office of the fact that his regis-

tration had been submitted. This could be validated as needed on some form of computer network or by telephone. The auther then got the idea that maybe the time had come to plan for the future of contracting with respect to computers. The charter for the working committee should have addressed long range planning for the progression from current contract methods to the use of paperless computer contracting. Paperless contracting should be the next formal stage of contract simplification.

THE ARMY HAS PADDS

The US Army readiness commands have moved to automation in the development of documents. The system is called the Procurement Automated Data and Document System (PADDS). PADDS is a procurement designed and distributed processing system that utilizes remote terminals placed in the user's business area (functional procurement working area) and a mini-computer to generate printed solicitations, contract instruments, amendments to solicitations, and contract modifications. This system will also generate Individual Procurement Action Reports (IPARs), DD Form 350's, and other management reports. It also provides solicitations, delivery orders, and contracts upon command. These documents are developed by the contracting personnel who identify the type of contract or solicitation which will be issued and any special clauses and provisions which may be required. Most of the clerical work is eliminated, simply because all the necessary clauses and provisions have been loaded into the system in advance, and with a few commands the proper contract/solicitation is printed. These printed documents are then reviewed and issued by the purchasing office. When an offer has been determined to be the "low, responsive and responsible offer," a few additional commands along with the contractor's identification are fed into the system and a contract is issued for execution by the contracting officer. This automated system can be adapted, with some modification, to the issuance of paperless contracts and solicitations in the system that is envisioned in this paper.

FIRST STEP

The first step that must be taken is the development of a file of bidders, in a centralized location, with all the mailing list applications and the representations and certifications stored in a computer memory bank which is accessible to all purchasing offices in the Department of Defense. This data could be located at some Defense Activity identified for the purpose of maintaining these files. This would reduce the number of places to which contractors have to submit their Bidders Mailing List Applications (SF 129). The contractors therein identify the type of item(s) which they are interested in supplying the Government Agencies, and this SF 129 would be placed in the central bidders mailing list files. These files could be queried by Government Agencies utilizing Standard Industrial Codes (SIC) for the purpose of identifying the products needed. When developing a bidders list, the Agencies would be able to obtain an up-to-date list of bidders on command. Of course, this would eventually be eliminated, we hope, when the contractors would be able to identify what the Government was purchasing on their computers each day.

COMPUTER ACCESSED COMMERCE BUSINESS DAILY

What is envisioned next is that all notices, issued by Government contracting offices, to the Commerce Business Daily would be available to contractors on terminals located in their sales offices and business offices. The contractors would be able to call to his screen the items which are being purchased by the Government on any given day. He would be able to see all the many items for which the Government is soliciting, or for which they were awarding contracts. He may direct his inquiry to the items which he could make as identified by the SICs. The contractor would enter the desired SIC into his terminal, and then, upon his screen would appear the types of items which are being solicited by the various agencies. As was noted in the opening statement, people can already shop by computers, so this is not a far-fetched concept. With the proliferation of computers that is expected within the next 2 to 3 years, and with the easy access to computer information via telephone lines and data centers, even the smallest of contractors will be able to utilize computers in his facilities. Many computers are available on the market for around $1,000, which could accomplish all of what will be discussed in this paper. The administrator of the Small Business Fifth Region, located in Chicago, Illinois, has indicated that he would promote the concept with local Chamber of Commerces in his district when the concept comes close to reality. He would propose that the Chamber of Commerce purchase computer equipment for use by contractors unable to afford all of the necessary elements to allow contracting and soliciting by computers.

SOLICITATION AND CONTRACTS ON COMPUTER SCREENS

The next logical step for the contractor, after identifying the solicitation on which he has an interest, is to direct a copy of that solicitation be shown on his computers screen. Today's computer technology will permit this immediately. The PADDS system, with some modification, might be able to transmit this information from its data base, or the PADDS system could relay the data to a central

solicitation data base in the purchasing office which could be accessed from a hookup with the Commerce Business Daily. The contractor could then view all the printed requirements of the contract/solicitation on call. This would include the description of the item, delivery schedule, quality assurance provisions, and some of the technical requirements, special provisions, and clauses applicable to the solicitation/contract.

To compliment this movement toward paperless contracting, the next phase must be for the Government engineering community to acquire drawings of items in Research and Development stages which are suitable for entry into computers for storage and future revisions. This is not a Buck Rogers in the 25th century concept, but a realistic view of what DOD contracting must evolve toward very soon. Contractors are already designing and making computer drawings. These drawings are digitized drawings which can be transmitted via telephone lines to a terminal capable of receiving them and projecting them on a screen. They can even be printed on the computer printing systems for the contractor to view in paper form. There are machines capable of scanning existing drawings and converting them to digits and storing them in computers.

Then, when interested contractors call upon their screen, a solicitation from the HQ, US Army Armament, Munitions and Chemical Command for, e.g., a machine gun bolt, the entire solicitation would appear on his screen page by page, including the necessary drawings and the entire text of any specification or quality assurance special provisions. The contractor could, if he had the necessary printing equipment, print in hard copy the entire solicitation, drawings, and specifications, for his use in obtaining subcontract bids. He could also record the appropriate drawings and specifications on a disc for transmission to his subcontractors by computer. Again, no paper would have to flow, just computer generated data transmitted between the parties of the eventual contractual arrangement, the Government, a prime and the prime's subcontractors, and suppliers network. The next logical step of this great process is the bidding process.

PAPERLESS BIDS

After the contractor has obtained all the necessary quotations from his subcontractor and supplier network he will develop a price for this item which the Government is soliciting. The contractor will then notify the Government by the use of his computer to submit his proposal to the Government data base. Adequate security will have been developed in the system to preclude any contractor from knowing what any other contractor has proposed. A form of sealed bid process will exist. The contracting officer will, on the date on which the bids are to be opened, interrogate the computer and print or display the proposals that have been submitted by contractors. These proposals may be ranked based on price, if that is the method of selection, and the low offeror will be identified. The contracting officer can then enter that contractor's identification information into the computer to determine if the Government has identified this contractor as a prior supplier. The data in the system will specify if the contractor currently has contracts with any Government Agencies, the delivery status of those contracts, information as to the production capacity and capability of the contractor, financial data based upon input into the system from Dun and Bradstreet, unliquidated progress payments, etc. The data base should be adequate in most cases for the contracting officer to determine if the contractor is a viable contractor without requiring the Defense Contract Administration Services (DCAS) office to perform a Preaward Survey. If all the data on the contractor is positive, a quick award could be made by the contracting officer. The contracting officer would key into his computer the award notification to the contractor and the appropriate accounting data for the obligation of funds on the contract, and the contract would be awarded. From the time that the bids were reviewed by the contracting officer to the actual instant of award, the duration of time could be less than 15 minutes.

It would take longer for those contractors who had not done business with the Government. In those cases, the contracting officer would immediately contact the necessary DCAS Office in the contractor's area and ask for a survey of his facility. This could take several days depending on information on hand at the DCAS Office and the scope of review requested. The data would then be transmitted back to the purchasing office and the contracting officer would be in a position to make a timely award on the computer to the contractor. This would be much in the same fashion as electronic mail is used today between company offices and between Government offices.

ADVANCED PLANNING MUST BEGIN NOW

As our society moves toward more and more electronic mail, there will be increased pressure to convert to computer generated and transmitted solicitations and contracts. Planning must begin now, and it will have to be throughout the entire Department of Defense. If this system is to be in place and functioning by the year 1990, the necessary programming and budgeting for this system must be initiated this year. Computer generated solicitations and contracts and the issuing of these documents will require comprehensive planning. This concept may not be practical

for all procurements in the Government, but it is practical and possible for repair parts, supplies, and some services, which comprise the largest number of DOD contracting actions. For research, development, and test procurements, a modified system would be used. The ADP equipment which will be used for the repair parts, supplies, and services will, I am sure, be useable for research and development procurements.

RECOMMENDATIONS

The Secretary of Defense should appoint a special task group to develop the paperless contracting concept. Subcommittees of this task group should explore all the necessary requirements that could be developed into this concept, and also, coordinate with industry, Small Business Administration, and the General Services Administration to insure that this system would be totally compatible for all Government procurements. This does not mean that the individual agencies will utilize the same type of equipment, but rather, that the systems which they possess or will purchase will interface with one another. Further, the systems which are available in the private sector can be interfaced with the Government equipment to preclude any complaint by industry that it cannot participate fully and indiscriminantly in the procurements being made by the Government via computers.

This is not a concept that is pushing the state of the art in computer technology. In fact, with the recent changes in computer hardware and programs, this concept could have been in place and working by the year 1985 if the Government had more advanced planning, to include more inter- and intra- service planning for this type of change.

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ACQUISITION INFORMATION MANAGEMENT

Panel Moderator: Dr. Neil Lamb
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General Services Administration

Papers:

Mechanized Contract Document Preparation and Abstract System
by Thomas L. Bono

The Acquisition Management Information System--Friend or Foe?
by Curtis R. Cook

Consolidation of DOD Bidder's Mailing List Application
by Elizabeth Parsons

MECHANIZED CONTRACT DOCUMENT PREPARATION AND ABSTRACT SYSTEM

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AD P002750

ABSTRACT

We have developed a system that revolutionizes contract document preparation by taking advantage of "state-of-the-art" technology in combining the functions of word processing (WP) and data processing (DP). This system has been proven effective in reducing document preparation time, in producing a better quality document, and in reducing document errors. The system simultaneously captures data to be abstracted and fed into a Management Information System (MIS) ensuring that the contract document and abstracted data in the MIS are identical. Since contract documents are mostly text, the WP capability was most important, yet the abstract of specific information could not be accurately and efficiently captured in WP mode. To streamline the data capture portion of the system for abstracting, DP was needed. Finally, to produce a finished product containing both the text and abstracted data, WP and DP had to be efficiently integrated. Through complex software development, we supplemented the vendor software to build a successful prototype system that is undergoing acceptance testing. The system is still in its infancy, but it has taken great strides in increasing the efficiency of contractual document preparation and abstracting. Yet to come is distributed processing of edit and validation routines currently being accomplished on the mainframe computer.

INTRODUCTION

This paper describes a project designed to significantly increase the productivity of contract document preparation and automatic abstraction of data for inclusion in a Management Information System (MIS). The system utilizies a microcomputer containing both word processing (WP) and data processing (DP) software capabilities and the ability to pass data from one to the other. The system also has sophisticated communications and letter quality printing capability. The system is totally menu driven which simplifies procedures and minimizes keystrokes, and is the foundation for a self help/self teaching system in the future. The DP capability is used to capture data that must be precise and needs to be abstracted to the MIS such as line item number, unit price and quantity. The WP capability is used to capture large blocks of text such as contract clauses which are entered into the system only once and stored in such a way that they can be updated when necessary and recalled for inclusion in a contract document with a few simple keystrokes. The data captured in the the DP mode is stored in a data base where it can be extracted for abstracting or for inclusion with the contract clauses for printing of the entire contractual document, ready for distribution, including automatic headers, footers and page numbering. Current programming efforts are being directed at including edits and validations in the distributed system to give the buying office more independence from the current host system that restricts most editing to an overnight turnaround. Edits that cannot be distributed will be accomplished in a near real time mode on the host computer during regular work hours.

BACKGROUND

Since the innovation of Source Data Automation (SDA) there has been a technology explosion in the methodologies of capturing data for abstracting to an MIS. Early SDA efforts required the use of preprinted forms as a means of input and output and the use of Communicating Magnetic Card Typewriters (CMCT's) for storing and transmitting data to the MIS. This method often did not include the entire document, but only the data that had to be abstracted. The contract clauses portion of the document was sometimes prepared on a different device and then the two parts manually merged and page numbered after printing was completed. Problems encountered with early SDA methodologies included form alignment problems for printing purposes, data input alignment problems on forms, slow print speed, long communications connect time with host computer for editing, overnight turnaround for complete editing on document prior to distribution, and a contractual document containing numerous forms which were difficult to read and increased the physical size of the contract.

THE SYSTEM CONCEPT

The bulk (Approx. 80%) of the contractual document consists of standardized contract clauses, statement of work, and descriptive data. This portion of the contractual document is most efficiently prepared by use of vendor provided word processing capabilities. The remaining portion of the document includes line item identification, quantities, pricing, delivery schedules and accounting data. This data is important to contract management as well as to the contractor. Therefore it must be mechanically abstracted into a centralized data base where

it is accessible by the contract management personnel in such functional areas as administration and disbursements which are usually geographically scattered throughout the country. In order to do both these functions (hard copy and abstracting) in an accurate and efficient manner and as transparent as possible to the user, DP, with user provided programming is required. Word processing cannot capture precise data and properly edit it for accuracy as can be done by programming in DP.

Why not do it all in DP? Essentially, for us to program a WP system as sophisticated and adaptable to general use as can be obtained from the open market would not be cost effective and doesn't make sense to expend the resources. On the other hand to capture precise data and edit it exactly as we require for abstracting is a very unique program that would not be available commercially.

Since data has now been captured in two different manners and we desire to produce the printed document as a single integrated package we need a system that will convert our data file created in the DP mode into a WP file that can be properly inserted into various places within the contract created in WP mode. The merging of WP and DP is a relatively new concept in office automation that is essential to our system. The system must also produce a file of the abstracted data that can be communicated to a host computer and do such communications in a user friendly manner.

WHAT THE SYSTEM CAN DO FOR THE BUYING OFFICE

Building and maintaining a standardized set of contract clauses is a cumbersome and labor intensive job even on a diskette based WP system. On the other hand, using a hard disk based system and a simple document manipulation instruction language (that can be learned in one day), "this task takes a fraction of the effort previously required", to quote an experienced user of the system. The instruction language is essentially a method for storing a set of predefined keystrokes that can then be recalled with a single keystroke. Such methods can be used to collect individual contract clauses into a single document that then can become a model contract. Decisions can be built into the set of instructions that allow the contract writer to choose different clauses based on variables such as dollar value or type of contractor. He can virtually tailor a document to his specific needs. Additionally, if multiple systems exist within an activity, the cost of maintaining the clauses can be reduced even more by maintaining them on only one system and disseminated them to all other systems through telecommunications or other magnetic media.

Capturing the contractual data that must be abstracted and fed to an MIS for management, administration, and disbursements has always been looked upon by the buying community as an extra burden with little reward. SDA was a step towards automation designed to insure that the hard copy contractual document and the abstracted data fed to the MIS were identical. Such methods are currently outmoded but were the best available at the time. Unfortunately they are still being widely used in an era when technology has generated equipment that provides a tremendous increase in the efficiency of document preparation and abstracting. Thus, through the use of state-of-the-art equipment, we have designed the dual mode system which employs WP to capture the bulk text and DP to capture data that must be precise and is required by the MIS, and then merge the two into a single complete document. This is an attempt to make the previously burdensome portions of contract document preparation more transparent to the buying office through the use of modern technology which gives us user friendly methods of getting the work done. Studies done by experienced system users have shown as much as a 50% reduction in document preparation time.

The hard copy document itself shows significant improvement in readability, size, accuracy, and general overall appearance. All the previously used SDA forms (except for face pages) have been replaced with plain bond paper which resembles, in structure, the old Standard Form (SF) 36 continuation sheet. For the most part, data titles are not printed unless there is data to be printed. Also, descriptive data can be as long or short as necessary. There is no wasted space like there is when description blocks are fixed length. These features are responsible for a 20% reduction in the overall size of contractual documents. Our users also show a reduction of 20% in print time for a document due to the absence of having to handle forms. The overall appearance is improved because the document is totally printed on the same device without intermittent forms and every page has exactly the same header (insures the correct PIIN/SPIIN is on each and every page) and/or footer with automatic page numbering to reduce errors. See figure 1 for a sample hard copy page.

The DP programs that have been written to capture the portion of the data required for abstracting are designed to minimize the keystrokes needed to prepare a contractual

F12345-99-C-9999
Page 3

70B - PART I, SECTION B OF THE SCHEDULE

Item No	Supplies/Services	Quantity Purch Unit	Unit Price / Total Item Amount
0001	CLIN sec class: U	11,000	$ 65.01
		EH	$ 715,110.00

noun: Factory/Field Support
acrn: AA nsn: N
site codes pqa: S acp: S fob: S
pr/mipr data: FY7616-82-01007
type contract: J

descriptive data: The Contractor shall provide the number of equivalent hours as defined in SECTION H.52 for Factory/Field Suport in accordance with SECTION C(1). (3400 Funds)

Figure 1

document and increase the user friendliness of doing so. Some of the features that do this are as follows:

The DAR Appendix N Code need only be entered once at system implementation time. This sample Video Display Terminal (VDT) screen shows the Appendix N Code already prefixed in the PIIN field as it was previously defined at system implementation time. It can be overridden if need be on an exception basis. Note the prompts (which are highlighted on the screen) to instruct the user in what to enter and how to proceed.

Sample VDT Screen (not to scale)

BUILD CONTRACT INSTRUMENT

PIIN F12345-__-_-____ SPIIN _____

Enter PIIN/SPIIN and press EXECUTE,
or press CANCEL to exit Edit routine.

- The contract and modification number need only be entered once for each document created. All data subsequently created for that document is logically related to this single entry.

Sample VDT Screen (not to scale)

BUILD CONTRACT INSTRUMENT

PIIN F12345-99-C-9999 SPIIN _____

PIIN/SPIIN not found

Create PIIN/SPIIN Y/N? Y

Certain fields can be pre-set to values, called default values, that are common for the majority of the line items that are being created for a particular document. The user has the option of entering or not entering default values.

Sample VDT Screen (not to scale)

BUILD CONTRACT INSTRUMENT
S E C T I O N S B & F

PIIN F12345-99-C-9999 SPIIN _____

Set Default Item Field Y/N? Y

Press EXECUTE to Select Indicated Choice

_ Edit CLIN Item Entry
x Create CLIN Item Entry
_ Create Service CLIN Item Entry
_ Remove CLIN Item Entry

The values entered on this screen will be preset on each screen that uses one of these fields. The value may be changed on a later screen if so desired.

Sample VDT Screen (not to scale)

```
BUILD CONTRACT INSTRUMENT
S E C T I O N S  B & F

PIIN F12345-99-C-9999 SPIIN _____ITEM ____

Use RETURN or TAB to change data fields.
Press EXECUTE to record data.

ACRN
Site codes   PQA ___   ACP ___   FOB ___
PR/MIPR Data _____
Purch Unit   ___
Type Contract ___
```

The PR/MIPR default carries over into the section G preparation of accounting data.

The system will, in the near future, provide the ability to reuse contract documents and line items in a follow-on document such as a definitization of an unpriced order. When an unpriced order or change order is awarded the line item prices and delivery schedules are either estimated or excluded. A definitizing document is required to establish firm prices and delivery schedules. All other information on the unpriced order is essentially identical to the definitizing order, therefore the unpriced order is renamed to the definitized order, the proper pricing and delivery schedules are added and the order is complete.

The ability to maintain a contractor, administration and pay office name and address to DODAAD/H4/H8 code cross reference data base locally is being added in early 1984. This means that any name and address required on a contractual document only needs to be typed in once. Thereafter it can be recalled simply by entering the reference code in the appropriate block in the data capture system. Additionally, the contractor code will be cross referenced to the administration and pay office(s) such that when the contractor code is input, the administration and pay office(s) codes, names and addresses will automatically be placed on the document.

This is only the beginning of what is planned in the next couple of years for this project. Some of the other planned features are:

Distributed edits and validations are being developed that would insure the validity of each field that was to be transmitted to the central MIS prior to its transmission. Some examples are as follows:

All codes must conform to DAR and MILSCAP.

All codes on a individual document are compatible.

All math is correct.

No duplication of Line Items or ACRNs

The sum of the quantities scheduled for delivery for an individual line item equals the line item quantity.

Plans are being formulated to build a self help system directly into the contractual document preparation procedures. This help system will be directed toward contract writers and buyers who could be preparing their own document on the system. Suppose, while filling out the face page of a mod, the user cannot remember the "Kind of Mod Code" required for this particular document. The user simply presses a special key "HELP KEY" and the DAR clause pertaining to "Kind of Mod Code" plus each code value and its meaning will be displayed. Once the user has decided what the correct code is, he returns to the formatted input screen, enters the code and continues with the face page preparation.

A self teaching (Computer Aided Instruction) system is planned as an expansion of the self help system which will serve as its basis. The majority of the teaching aids will have already been built into the system with the "Help Key". By adding the instructions on how, when, where, and why to go from menu to menu and formatted input screen to formatted input screen, the system would be complete.

Printing the face pages is another goal we have. We currently do not have the printing capability to do this and be in compliance with DAR. We intend to experiment very soon with new technology in printing to

satisfy this goal.

CONCLUSION

The world of contract document preparation is being revolutionized by automation and it not only affects the clerk/typist but also affects the contract writer, the buyer, the contracting officer, the review committee, the contractor and essentially everyone involved with contracting. We envision buyers filling out formatted input screens rather than forms which then need to be input by a clerk. We envision review committees receiving documents electronically with the option of reviewing it on the VDT or printing a quick draft copy for review. We envision electronic transmission of voluminous unpriced provisioning documents from the contractor to the buyer's system where it can be transformed into a contractual document. The system as it is today is a tremendous productivity saver but is only in its infancy in capability to support the contracting community. We look forward to its expansion and development into areas of contracting that will improve all aspects of contracting.

DEFINITIONS

Word Processing (WP): The capture, storage, and manipulation and output of large repetitiously used groups of textual information, e.g., contract clauses, using electronic, and electromechanical devices. The software to accomplish these functions contains control characteristics such as carriage returns, tabs and end of page indicators that are unique to WP.

Data Processing (DP): The capture, storage, manipulation of selected groups of data values, e.g., contract line item detail, schedule data, and accounting information using electronic and electromechanical devices. The software to accomplish these functions stores specific data values in specific locations in tightly controlled formats for validation, computation, transmission and reporting.

Source Data Automation (SDA): Capturing data on magnetic media in computer processable format at the same time the hard copy contractual document is prepared.

Default: A pre-programmed data value that is inserted into a particular field or location in the computer or on a display screen unless the operator takes specific action to override the value with a different data value.

Video Display Terminal (VDT): A cathode ray tube or gas plasma tube display screen terminal that allows keyed or stored text (or data) to be viewed for information, manipulation, or edit.

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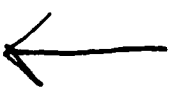

AD P002751

THE ACQUISITION MANAGEMENT INFORMATION SYSTEM--FRIEND OR FOE?

Capt Curtis R. Cook, Hq Air Force Systems Command

ABSTRACT

AFSC's Acquisition Management Information System (AMIS) is a complex, extensive computer system containing detailed information on over 61,000 contracts. This paper describes the history and development of AMIS, plus recent actions taken by the Directorate of Contract Data Systems to improve system user-friendliness. A survey of field activities revealed several unsatisfied user needs, especially in data input/output. The Distributed Processing for Contractual Input (DPCI) system was designed and programmed to fill some of these needs. The genesis and growth of DPCI is treated, including software design and hardware acquisition. The paper also covers a fundamental change in management philosophy--expanded participation of system users in establishing and prioritizing system development and change. A new AMIS Users Group was established to advance the effective use of AMIS through the interchange of information concerning system design, use, operation and maintenance. More emphasis is also being placed on improving data base accuracy and completeness. Management education has been stressed. The paper explains steps taken in these and other areas and comments on future system changes to further enhance user-friendliness.

INTRODUCTION

In the Air Force Systems Command (AFSC) contracting community, the need for increased productivity is imperative. Short term problems have plagued the contracting executive, but productivity is now the key issue as contracting workload continues to increase, yet manning levels do not. There has never been a greater need for automating the contracting process and for understanding how automated systems can, indeed, lead to significant productivity gains. As important as productivity is, however, another equally important need in the Armed Forces is information--timely, accurate information. Basic Air Force doctrine states:

> The very large quantity of data acquired by our command and control systems demands many forms of data processing, so that the right information will be given to the right commander at the right time. (1)

The right commander, for the purpose of this paper, is the acquisition manager and his command and control system AFSC's computer-based Acquisition Management Information System (AMIS).

To appreciate the value of AMIS, the mission of AFSC must first be examined:

- Advance aerospace science and technology;
- Apply it to aerospace systems development and improvement;
- Acquire qualitatively superior, cost effective and supportable aerospace systems and equipment needed to accomplish the Air Force mission.(2)

The third element--the acquisition process--must be supported by proper buying procedures, effective administration of contracts, timely delivery of items, and correct methods of payment. (3) These contracting functions are normally accomplished by geographically separated offices yet, because they are involved with the same end product, the offices must often make simultaneous decisions. Whether these decisions combine to achieve a coherent result depends on timely communication throughout the contracting network.

AMIS is an automated contract data repository, contract preparation, payment and communication system designed to meet the needs of this network, whether a contract is being prepared, a summary activity report generated, a one-time inquiry made from a program office or an on-going dialogue with other contracting functions is involved. The system is available to all AFSC organizations for input of new contracts, for update of contracts already stored, and for management use to answer any of the myriad questions that can be asked about a contract during the performance period. The basic concept of AMIS, seen in figure 1, is simple:

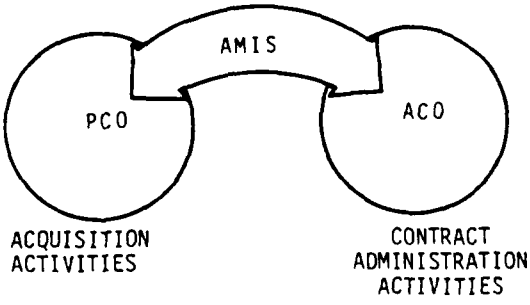

Figure 1. AMIS Provides Real-Time Interchange of Information Between Procuring Contracting Office and Contract Administration Office.

This exchange is not limited to internal AFSC organizations. Information concerning AFSC-written or administered contracts is exchanged, either directly or by AUTODIN, with Air Force Logistics Command, Air Force Accounting & Finance Center, the Army and Defense Logistics Agency. How the system was developed to implement this basic concept, how AMIS operates today and what improvements are being implemented are the topics that will now be explored.

HISTORY

In the early days of AMIS, the question was not one of being "Friend or Foe" to system users but one of existence and compliance with DOD direction. DOD Directive 4105.63M, Military Standard Contract Administration Procedures (MILSCAP), first published in 1967, required the services to develop standard procedures for exchanging data between purchasing offices and field contract administration offices within DOD. The technology in computers and communications was not then available to implement the MILSCAP concept efficiently. Starting in 1974, however, when the AMIS System Program Office (SPO) was established, the AFSC contracting community has had an automated system that accomplishes three basic things:

- Complies with DOD MILSCAP instructions--the only such system among the services, all of whom are developing automated MILSCAP systems.
- Automates the AFSC invoice-payment function, speeding up bill payments and giving program offices, executive management and others with a need-to-know the cash flow picture in real time both on individual weapon system developments and also on AFSC systems collectively.
- Gives management at all levels immediate, automated access to program status information. (4)

By 1974 the basic concept in figure 1 had been developed to that shown in figure 2.

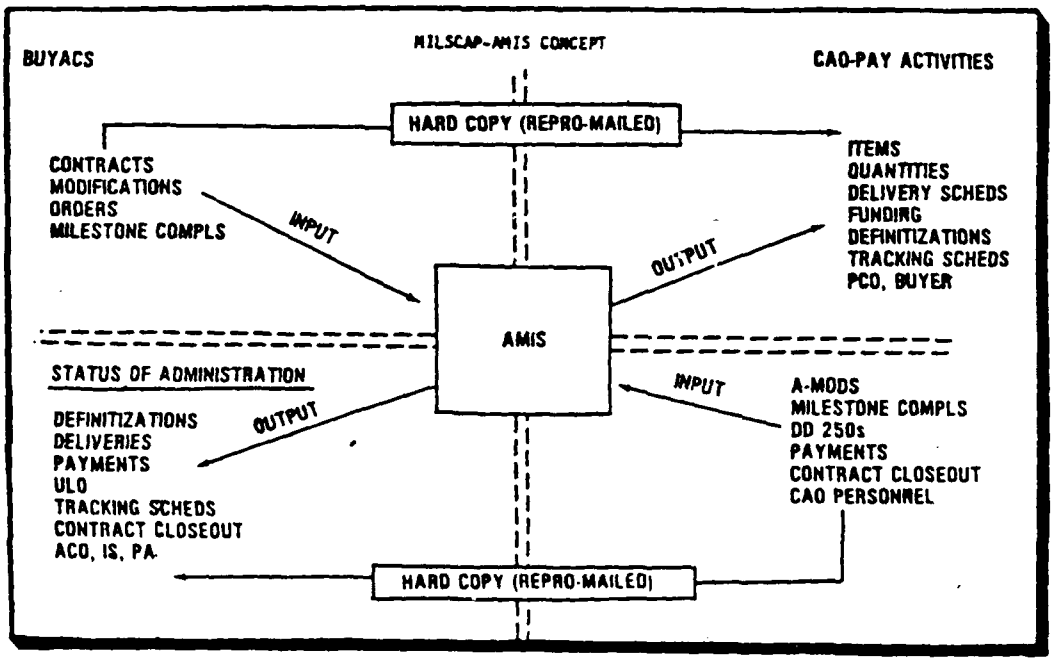

FIGURE 2 MILSCAP-AMIS Concept

Contracts, modifications, etc. executed at Buying Activities (BUYACS) are mailed to various Contract Administration Offices (CAOs) throughout the country. Simultaneously, the AMIS central computer at Wright-Patterson AFB, OH is updated. The CAO instantaneously has information on line items, quantities, prices, etc., which can be used to manage contractor activity or make payment while the hard copy is still in distribution (a process that may take up to 30 days!). The same process occurs when the CAO executes modifications, submits receiving reports or the paying office makes payment. The BUYAC is informed immediately while the hardcopy document is in the mail. Current, accurate data is promptly reported to decision makers throughout the system.

Despite the advantages of AMIS, the system made some enemies initially. Cyberphobia--the irrational fear of computers--played a big part in early resistance to the system, but real problems did exist. For example, 1974 data entry equipment was archaic by today's standards. Cumbersome magnetic card typewriters, coupled with cramped, bureaucratic contract forms, made data input difficult. Contracting officers sometimes bypassed AMIS or failed to correct errors. Naturally GIGO--Garbage In, Garbage Out--resulted to some extent. Output products were suspect, management use of the system declined and the future existence of AMIS was debated. Immediate improvement was essential.

SHEDDING THE YOKE OF MEDIOCRITY

The perception existed in the field that AMIS was not responsive. All-out "war" was declared against the real and perceived problems in 1982. A strategic plan was written; the AMIS program management plan was updated; new people were added to the staff who had field experience using AMIS. A program director with both contracting and computer experience took command. A compaign was initiated that had three objectives:

- Upgrade system hardware and software.
- Expand user involvement in system management.
- Educate acquisition and program managers on AMIS capabilities.

SYSTEM ENHANCEMENTS

The single, most important improvement to AMIS made since its inception was an improved data input project, Distributed Processing For Contractual Input (DPCI). As shown in figures 3 and 4 below, system use had increased continuously since 1978.

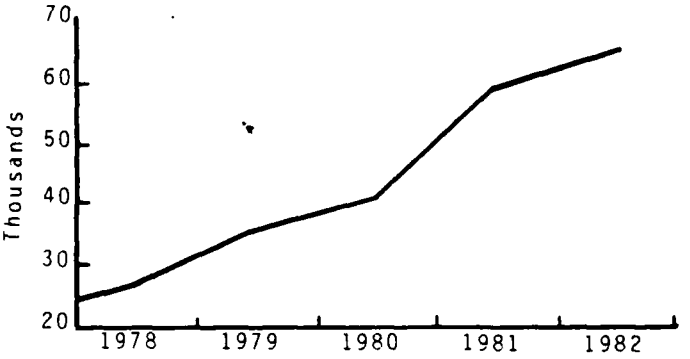

Figure 3. Number of Contracts in AMIS.

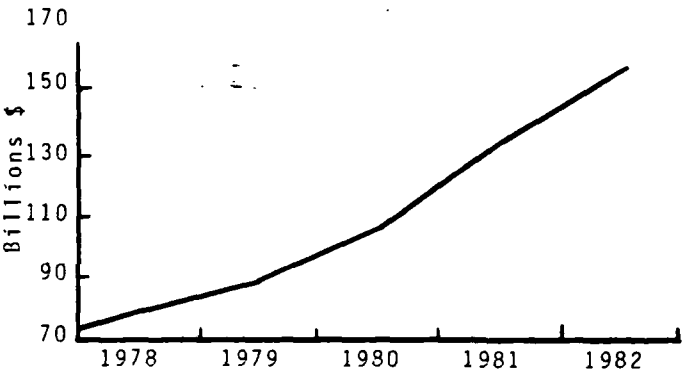

Figure 4. Dollar Value of Contracts in AMIS.

Despite these and projected increases in workload manning remained steady, thus demanding greater productivity from the work force. DPCI was developed to meet this need. It had three basic goals:

- Improve productivity of the contract preparation process.
- Eliminate difficult-to-read contract forms and replace with free-form (bond paper) documents.
- Make capture of data simpler, easier and more transparent to the user.

The project involved replacing outmoded magnetic card typewriters with state-of-the-art desk-top computers, linked to local central processor units (CPUs). User-friendly software was developed that employed prompted inputs, menu-driven routines and on-line edits. The objective was to allow as much processing locally, off-line from the AMIS mainframe computer as

possible, thus increasing response times and allowing greater flexibility. After initial testing at AFSC's Space Division, Los Angeles, in 1982, DPCI installations commenced throughout the command. Today virtually every buying activity is using the new system. The initial phase has reduced the time needed for contract preparation, produced better quality, more readable contracts and reduced errors, effectively eliminating costly administrative contract modifications. Reports from field activities project significant savings in both time and materials. Increases in productivity range from 20% at locations previously using word processors to 60% where essentially none had existed.

EXPANDED USER INVOLVEMENT

"The driving Force of AMIS is user needs", according to Colonel John Voss, Director of the AMIS Program. (5) This simple statement articulates a fundamental principle that has guided all AMIS activities for the past 18 months. To become a 'friend' to users and managers, a system must yield a return on their investment of time, energy, and money. While technically excellent in design, AMIS was sometimes too complicated for functional contracting officers in the field to use. Several actions were undertaken simultaneously to improve AMIS user-friendliness:

- DPCI was developed.
- A Users Group was chartered.
- AMIS manuals were improved.
- Training was emphasized.

DPCI. No real progress could be made until hardware and software were improved. DPCI uses prompted input, modern desk-top computers and simplified output, all user-oriented features.

AMIS Users Group. Beginning in October 1983, the AMIS Users Group began meeting on a quarterly basis. This group, made up of representatives from organizations using AMIS, was established to advance the effective use of the system and to involve the using community in shaping its future. The Users Group has specific objectives:

- Solicit user needs.
- Resolve data base problems.
- Prioritize AMIS modification requests.
- Review written AMIS documentation.
- Provide channels of communication to facilitate exchange of AMIS information among users.
- Provide feedback to the AMIS office and to the DOD MILSCAP administrator concerning system modification.
- Assist the Director of Contract Data Systems in resolving AMIS problems.

Never before in its history had AMIS users from across the country met in one place to pursue these objectives. The enthusiasm, positive feedback and, most importantly, the concrete recommendations to improve AMIS that have come from group meetings have already guaranteed its future success and benefit to the system.

AMIS Manuals. AMIS is a large, complex system with many interfaces. The AMIS manuals governing system use contain hundreds of pages and cover thousands of operations. A decision was made to commercially contract for a complete rewrite and publication of the manuals in user-friendly format and language. A contract was awarded in July 1983 and the end product--numbered AFSC manuals--will be available in early 1984. The AMIS Users Group will review the manuals and provide feedback to the contractor.

Training. A system is worthless unless its users know how to use it. Considering the changes to hardware, software, manuals and procedures that were in process to improve AMIS, training became a critical factor. A major effort was begun in mid-1982 to educate users and to "train the trainers." A team from the AMIS office visited buying activities, Air Force Plant Representative Offices (AFPROs) and other organizations using AMIS to introduce the changes and give hands-on training in new procedures. At each location an AMIS data base manager was given additional training and materials to conduct follow-on classes. These specialists were also brought together at Wright-Patterson AFB for an annual conference and refresher training. Instructors from Air Training Command's Lowry Technical Training Center received intensive training at the AMIS office, then rewrote basic contracting course materials to include AMIS in the curriculum. This last step, institutionalizing AMIS training in the Air Force's primary "pipeline" school for contracting, was one of the most significant steps taken to ensure AMIS will be used efficiently and accepted as part of the normal contracting process in the future.

MANAGEMENT EDUCATION

The ultimate success or failure of a computer system is "the extent to which managers can use the system to increase their effectiveness within their organizations." (6) AMIS output data and the ways to obtain it were designed with the knowledge that contracting people, not computer scientists, would be using the information. For that reason, most of it is in "clear text", which means plain English. Codes that are used are common to the contracting community. Add to that the current hardware being installed for DPCI and the result is very similar to subscriber services available to home-computer owners--information at the touch of a button. The problem was in convincing AFSC contracting and program managers that AMIS could, in fact, help them manage more effectively. And without top management support and reliance on AMIS information, subordinate managers would be less likely to embrace the system. To solve this problem a series of AMIS Executive Seminars was held at key locations across the country (Los Angeles, Boston, Eglin AFB, Dayton). Seminar participants consisted of top managers from contracting organizations and program offices. These "movers and shakers" were given tailored briefings and live demonstrations showing how effectively AMIS could be used as a management tool. As a result of these seminars, management use of AMIS increased substantially. New terminals installed as part of the DPCI project were ideally suited for easy access to information in the system. Pre-formatted "canned" query programs, previously developed, were emphasized for executive use. Follow-up seminars are now underway to inform new managers of the many benefits of AMIS and to update others on progress being made in the key areas discussed here.

SUMMARY

AMIS--Friend or Foe? The answer is a resounding "FRIEND"! Begun as a system to comply with DOD direction, AMIS has grown into its current role as an effective, modern management tool and operating system. It has helped increase productivity in the contracting community at a time when workload is increasing while manning remains level. System improvements, most notably Distributed Processing for Contractual Input (DPCI), have brought state-of-the-art computer hardware and user-friendly software to AFSC buying activities. Expanded user involvement--through a new AMIS Users Group--has facilitated user acceptance of the system and resulted in numerous concrete system improvements. Management education--through AMIS Executive Seminars--has increased management awareness and system use, both as a tool for more effective decision making and as an operational system for better contract formulation and administration. Future AMIS improvements, such as additional distributed processing to on-site minicomputers, better local system interfaces, training programs built into the system (learning at the terminal), easier-to-use output programs and "help" features programmed into the system will continue to increase AMIS' user-friendliness. And since AMIS leadership firmly believes that "the driving force of AMIS is user needs", system users--contracting officers, negotiators, administrators, clerks, program managers, contracting managers, and all other team members--will have an increasing role in improving AMIS, thereby improving the efficiency of the weapons acquisition process.

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ADP002752

CONSOLIDATION OF DoD BIDDER'S MAILING LIST APPLICATION

Elizabeth Parsons, Defense Logistics Agency

INTRODUCTION

This paper describes a need to streamline the processing of Bidder's Mailing List (BML) Applications, Standard Form 129, as supplemented, and at the same time, takes the first step toward modernizing an important element in our acquisition process. History has shown us that wars are lost because of the lack of supplies in the right place at the right time. With today's modern weapons systems, flight faster than sound, capability to land on the moon and return to earth and numerous other spectacular accomplishments, it would be negligent not to concentrate also on our ability to support these systems with rapidity and effectiveness.

The consolidation of the BML applications to one or more locations would be cost-effective for Government and industry. To have industry submit applications to each buying activity is time-consuming and costly. It is also expensive to have each buying activity maintain, usually in a different automated system, vast amounts of data on firms. Many of the firms included on different bidder's mailing list are the same. This occurs because the weapons systems used by the military are produced by many of the same manufacturers. Thus continuing support of these systems is obtained from the same firms. In other instances, firms sell their products to many military installations because their products are not assigned to one buying activity. As a result of the innovative efforts of our American society new items are created; however, in order for them to be introduced into the military acquisition systems, these products must be made known to each potential military user. This is both time-consuming for the firm and the Government. This paper will support the need to consolidate the bidder's mailing list applications. It will also point out that the need to consolidate could well be the first step in streamlining the acquisition process.

TEXT OF PAPER

A Need Exists to Reduce Costs of Contracting: During the past 20 years the costs for contracting have risen enormously, none the least of which is the cost associated with maintaining bidder's lists at numerous activities. Some Departments or Agencies have separate lists for small purchases and large purchases. Some of these lists are different for automated acquisitions and manually produced solicitations. In some instances, this requires the same firm to be included on three or four lists. Thus, it can be seen that even before reaching the contracting state the Government spends a sizeable sum merely on maintaining a bidders' list. Consider, how much it costs the Government to keep the firm on the bidders list. Some firms may never make an offer, or they may only provide one product which is required only occasionally. An example of costs to industry is having to be listed with each individual activity that may purchase their product. Each of the Services has a different procedure for including a firm on its vendors' list. This causes the firm much frustration and costs in submitting applications that many times are returned by the activity with instructions to complete other form(s) and/or supply additional information. Not only do the Services have different procedures, but their subordinate commands generally have other procedures as do the different procurement offices under them.

Some small purchasing activities accept applications from all firms which complete the Standard Form 129, as supplemented by DoD, whether they purchase the items or not. This means that some firms feel they have made application with that activity and should receive solicitations from all activities. When they do not, they become discouraged. Sometimes they write their Congressional representatives who contact the DoD or one of the Services which, in turn, causes numerous exchanges of correspondence concerning "What the Government activity buys my constituent's product?" If the bidder's list for all DoD activities was consolidated these exchanges would not be necessary or, at least, they would be minimal.

Many items are not sufficiently defined; thus solicitations are sent to firms which have no capability to provide the required item. The expense of mailing the solicitations, usually three copies, is a definite cost to the Government. In order to stay on the bidder's list for the one or more items that the firm can supply, the firm must negatively respond to those solicitations for which it cannot supply the item. Should the acquisition be a small purchase under an automated solicitation and no acceptable offers are received, then it must be resolicited if the first solicitation was a small business, small purchase set-aside. If it is over $5,000, or if the set-aside is dissolved, it must be coordinated with the Small and Disadvantaged Business Specialist. There may be a sufficient number of small businesses which can provide the item on the bidder's

list, however, the set-aside is dissolved. Further, to produce a solicitation that is not fruitful not only places a cost burden on the Government, but it also means that the item will not reach the military activity in a timely manner. For example, in the case of a weapons system repair, this could cause a considerable delay in making it operable. Generally if there are numerous firms on the vendor's list, the list will be rotated so that should there be as many as 40 vendors included on the list that can supply electrical harnesses, only a portion of them will be solicited each time the part is required. Further, the list is rotated so that approximately three or four firms will be solicited for small purchases and perhaps half the list would be used for large purchases. In addition, if the procurement is over $10,000 it will be synopsized in the Commerce Business Daily. This could result in additional resources requesting the solicitation, whether they are on the vendor's list or not. When the solicitation is under $10,000 only three or four of the firms are solicited. Though most automated systems are programmed to solicit the previous awardee and two or three others on the list, they have been known to rotate and solicit three firms who have never held a Government contract. In some cases the firms do not respond. Since the categories of items purchased are identified in such broad terms, many of the listed firms are unable to respond to solicitations. When no responses are received another solicitation must then be prepared and reissued.

Each solicitation issued by the Government is ladened with representations and/or certifications that each responding firm must complete. In some instances when they are not properly completed even though the offer may be low, they cannot be accepted. This has been very costly. In some instances on omission; e.g., small business set-asides when the offeror forgets to check the appropriate block indicating it to be a small business renders the bid to be nonresponsive. Many times a bid is low, however, the Comptroller General has held that the bid cannot be considered. If the size of the small business were included on the firm's application this certification would not have to be included, thus the Government would be able to take advantage of the low offer. The bidder's mailing list application can be expanded to require this information. This will be included with information concerning the firm so that input of the firm's vendor code will alert contracting personnel of its status. Thus, solicitations could be simplified and the administrative cost associated with the bidder's list could be reduced, while making them more responsive to our needs.

A Need for Change: With our modern technology it appears that acquisitioners are still trying to support our modern military forces with antiquated procedures. It is a foregone conclusion that the best supported and equipped fighting force has long been the victor. History has repeatedly told us that ill-equipped and ill-supported military forces have suffered defeat. We can put men on the moon but have great difficulty in a peacetime environment in providing timely support to our Military Services. To preclude criticism for not providing supplies provided in emergencies, often times purchases are made at prices higher than they should be. We must design procedures that will permit communication of our needs to industry by the fastest possible method. This will insure a strong, stable military force capable of responding to any aggressive act.

Our methods of supporting weapons systems must be reviewed to determine whether we can respond to supply requests expeditiously and economically. We must also review our methods of inventory control, stock and financial management, maintenance planning, distribution and transportation analysis and other operations closely associated with the total acquisition and distribution of military supplies. In the mid-60's, the Air Force attempted to develop the Advanced Logistics System (ALS). This system was conceived as a very powerful computerized data system with capacity sufficient to handle each transaction immediately as it was received. The ALS concept became bogged down and was subsequently abandoned. One of the problems was the size of the effort: the bringing together of a vast amount of data used by the Military Services and the Defense Logistics Agency (DLA). The various fragmented computer programs used by each DoD component overwhelmed the system. The Air Force was unable to purchase the hardware it felt was required to support this herculean effort. Finally, the software was taken up with basic housekeeping requirements within the system leaving an insufficiency in support of the required functions of it.

To build an acquisition system that can provide support to the DoD components, we must first establish a method to consolidate the bidder's mailing list application. It follows that a central method of controlling inventory, maintenance, distribution and other logistics ingredients is also necessary. A centralized system would permit positive acquisition of supplies/services in a timely manner. The control of supplies, as well as distribution, would be controlled by a unified system.

One of the biggest benefits of consolidating the vendor's list will be the inclusion of all known sources used by the various services for repair parts. This cross-feeding of sources should result in creating competition. All of us know that competition usually results in lower cost to the Government. A potential savings to the Government.

Prior to the consolidation of the BML applications, a determination must be made concerning which type of system will be used to input the data on firms to be included. At present, the Air Force employs a system called Central Integrated Automated Procurement Systems (CIAPS). This system is used for base, central, and systems contracting and for both supplies and services. It is also used for acquisitions over and under $10,000. Businesses are assigned five digit vendor codes based on whether they are large, small, small disadvantaged, or women-owned. They are provided a list of the types of items purchased by the various Air Force activities. The vendor's code is established at each location, and vendors must make application at each installation. For instance, ABC Supply Co., may be assigned a vendor's code of CBAJS at Newark Air Force Station, Ohio, and may have a code of ZYA3S at Wright Patterson Air Force Base, Ohio. The various categories of items for which they wish to market are identified by the Federal Supply Classification (FSC) code and a suffix assigned to each item under the FSC. That is, the code 254015 is the same throughout the CIAPS. The product supplied to both installations will be the same and is coded that way. The firm must then remember which code it must use to respond to solicitations from Newark as well as Wright-Patterson or any other Air Force activity for which they are listed for the item. This is another item of cost to both the Government and the vendor.

The Defense Logistics Agency operates under Standard Automated Materiel Management System (SAMMS). SAMMS is a bit more complicated in that it only provides for supplies, no services. Vendor lists are different for over and under $10,000. A firm listed for over $10,000 would not necessarily be on the under $10,000. An additional form is needed to be placed on the Phase II Systems - automated purchases under $10,000. By completing one of the Defense Service Centers' locally produced applications, the firm is included on the manual purchases under $10,000. To be included in the Phase I - automated purchases under $1,000 - a firm must hold a Blanket Purchase Agreement. Basically, identification of the various categories is the same; that is the first four digits are the FSC and the last two are a locally assigned suffix. The vendor codes are assigned by the Defense Logistics Service Center (DLSC) in Battle Creek, MI. These are known by the terms Federal Supply Codes for Manufacturers (FSCM) or Commercial and Government Code (CAGE) codes. DLSC is also responsible for assigning National Stock Numbers (NSNs). These NSNs are widely used throughout the acquisition system to identify supplies and equipment used by the Government. They are also used in inventory control, identification of items maintained, and acquisition of parts. The FSCM or CAGE codes identify the firm as a manufacturer or dealer. However, they do not identify whether the firm is large, small, disadvantaged, or women-owned. One can only determine this by researching the vendors' list which set forth only the number of employees the firm has. This is done by the use of an alphabetical code. The buyer/contracting officer must know the small business size standard to determine whether there are sufficient firms to make a set-aside.

The Army and Navy have no automated systems comparable to those of the Air Force and DLA. At present, each buying activity is responsible for establishing and maintaining its bidder's list. The Army is contemplating establishing a system similar to CIAPS. It can be expected that the Army will realize some benefits from this system. However, prior to expending much time in satisfying just the Army's needs, it is felt that a system is necessary for all DoD activities.

CONCLUSION

The System: To preclude having another failure similar to the ALS, DoD Acquisition and Management should appoint a committee of representatives from the Army, Navy, Air Force and DLA to study the feasibility of establishing codes for the various supplies and services we purchased. The reasons for the failure of the ALS system should be studied in great depth. A clear understanding of these reasons should be instilled in all members of the Committee. Further, members appointed should be for the duration of the study. There should be no instances in which the chairperson, or any member, is replaced in mid-stream. They should be able to tap other available resources to make their decisions.

It can be assumed that in the next few years we will see great changes in telecommunications. We must consider this when we start to combine and restructure programs that must reply on high-technology telecommunications. Thus, the panels appointed by the Committee must be very familiar with not only what is presently available on the market, but must have a good understanding of future technology. The lessons learned by NASA in their communications with their space ships in flight/orbit are certainly a "giant step forward for mankind".

Another problem will be the adoption of a single system of codifying the various items purchased by the DoD components. However, since the present systems are based on the Federal Supply Classification (FSC) code, as are National Stock Numbers (NSNs), it may not. It is recognized there are some items which are purchased by only one Service or activity, and this could be considered on an "exception basis". DoD has already assigned procurement responsibility for certain purchase items to specific Military Services and DLA. Thus, the assigning of a code to identify these items should be relatively easy. The items that are not assigned could be reviewed and some agreement made on the coding system.

In developing the system, consideration should be given to whether it can be expanded. After the system is established, civilian agencies could be included with little difficulty. This is especially true now that the contracting regulations for all Federal activities will soon be combined into one - the Federal Acquisition Regulation.

The present CIAPS and SAMMS systems need improvements but they offer a beginning. They could be reviewed with the idea of extrapolating the best of both and developing a system acceptable to all concerned. With the accomplishment of this step, a system can be designed to support it. This could lead the way for the design of the system envisioned by the ALS. It should also assure that the acquisition support required by the Military Services will be available under any conditions. It is realized that this change cannot be accomplished overnight, however, it should be placed high on the list for accomplishment within the next few years. The money saved on administrative costs, the more that can be used for our sophisticated defense weapons systems.

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ACQUISITION RISK AND UNCERTAINTY

Panel Moderator: Mr. Truman W. Howard, III
Chief, Cost Analysis Division
US Army Missile Command

Panel Members:

Dr. Robert M. Stark
Department of Mathematical Sciences
University of Delaware

Mr. John M. Cockerham
President, John M. Cockerham
and Associates, Inc.

Papers:

Cost Risk Trade-Offs in Timing the Production Decision
by John M. Cockerham

Managing Program Risk: One Way to Reduce Cost Growth
by Lee Cooper

Decision Technology the Catalyst for Acquisition Improvement
by Roland P. Swank and Henry M. Wales

Designing the Equitable Risk Contract
by Robert F. Williams

ADP002753

COST RISK TRADE-OFFS IN TIMING THE PRODUCTION DECISION

John M. Cockerham, John M. Cockerham & Associates, Inc.

ABSTRACT

The question before every development and acquisition program is when should production resources be committed. The actual decision to enter production is normally assumed to be the same point in time where the expenditure of production monies is authorized or initiated. This assumption is challenged through the analysis of the total cost risk of the combined RDT&E and production programs versus time. Consideration is given to technical risk, program termination liabilities, RDT&E spending rates, production spend rates, cost of program stretchout, production leadtimes and return on investment. The purpose is to present and explore the primary financial factors and interrelationships to determine the optimum time to expend production monies independent of the final production decision. The methods and principals are demonstrated by an example derived from an actual application on a major weapon system.

INTRODUCTION

This paper addresses the evaluation of the risk of early funding of long lead materials and facilities.

INCREMENTAL FUNDING ANALYSIS

Many development programs logically and economically call for early funding of long lead materials and tooling. The task of the contractor in proposing such an approach is to mitigate the Government's perception of the risk associated with such a decision. The Government's perception of risk is based upon past experience that has appeared costly as a result of entering into production prior to sufficient system maturity. This is a qualitative perception that to a great extent is based upon isolated but well known cases of mismanagement. The economics of early acquisition funding are seldom quantified but rather assumed to be unacceptable.

APPROACH

The following discussion and analysis is directed at quantifying the cost risk tradeoff to determine, for an example missile program, the optimum time to begin expenditures for Low Rate Initial Production (LRIP). The approach is to quantify the risk associated with the following decision options:

Option 1 - To expend procurement monies with full knowledge

Option 2 - To expend procurement monies prior to full knowledge

Definitions:

Procurement Monies - Any funding committed to LRIP and/or Rate Production to include manpower, facilities, tooling, equipment and materials.

Full Knowledge - That point in the program where there is sufficient system knowledge to make a production decision with minimal or no technical risks.

"Full Knowledge" is defined for this example program at the completion of the ninth development test flight (33 months) (see Exhibit 1, Program Spend Plan).

To spend procurement monies prior to this time is money "at risk." To spend money at this time is to risk program delay and the sustaining monies to gain more perfect information. In other words, there is a risk for making a decision prior to full knowledge and a risk for making a decision with full knowledge. In the latter, the probability of a cost and schedule impact is certain; whereas in the former, the cost and schedule implication is probabilistic. That is, there is a chance to profit at the risk of a loss. The profit is the avoidance of the certain cost and schedule impact associated with making a decision with full knowledge. The loss is the investment loss that occurs due to (a) the program being cancelled or (b) technical design changes that impact the investment in facilities, equipment, tooling, materials, or manpower that is nonrecoverable.

DECISION RISK WITH FULL KNOWLEDGE (THIRTY-THREE MONTHS INTO THE PROGRAM) - OPTION 1

Delaying the LRIP funding commitments until the defined state of "full knowledge" results in a delay in the IOC of approximately twenty-four (24) months. The sustaining support cost during the delay is estimated at $.5M per month or $12M ($C_1$ = $12M). The cost ($C_2$) of not realizing any utility from the system is calculated as an equivalent loss of profit at 10% of the investment per year. This loss is to our Government and is a valid assertion in

that a defense system must have a profit to our society through its defense utility that is at least equivalent to a comparable return on investment for a commercial venture.

The risk of Option 1 is calculated as an expected value where the magnitude of each cost impact is multiplied by the probability of the impact occurring. In this option, the probabilities of incurring the sustaining program cost and the loss of return on investment is certain. Therefore,

$P(C_1) = 1.0 \qquad C_1 = \$\ 12M$

$P(C_2) = 1.0 \qquad C_2 = \$147M$

The risk for Option 1 is calculated as follows:

$$\text{(Option 1) Risk} = P(C_1)\ C_1 + P(C_2)\ C_2$$

$$= (10)\ (12) + (1.0)\ (147)$$

$$= \$159M$$

DECISION RISK PRIOR TO FULL KNOWLEDGE - OPTION 2

The risk of Option 2 is calculated using costs and probabilities of the following events:

Events: (a) The program is cancelled

(b) Technical design changes cause non-recoverable losses in facilities, equipment, tooling, materials, and/or manpower.

Exhibit 2 shows the probability of Event (a) and Event (b) with respect to time. This is a subjective but reasonable assessment of the probabilities based upon the design maturity and the Government's decision making process.

The cost associated with Event (a), program termination, is calculated as a contract liability at 1.33 times the cumulative investment in the production cost only. The cost of Event (b) is calculated at 10% of the cumulative investment in the production cost. This represents the non-recoverable cost of technical problems or design changes to production equipment, tooling, materials and/or manpower. The 10% estimate reflects few technical uncertains that would actually cause non-recoverable cost impacts to the production investment. The cumulative investment in production is the sum of production money expenditures to that point in time, $41M at 11 quarters. At the end of eleven (11) quarters the risk is:

$$\text{(Option 2) Risk} = P(a)\ C_a + P(b)\ C_b$$

$$= (.08)(1.33)(41) + (.05)(.10)(41)$$

$$= 4.36 + .2$$

$$= \$4.56M$$

The risk (expected value) of selecting Option 2 is $4.56M as compared to selected Option 1 with a risk of $159M. The return on investment cost (C_2) is obviously the most sensitive element of this anslysis; however, if there is no return on the investment ($C_2 = 0$) the risk for Option 1 is still $12M. Therefore, the P(b) could be as high as .75 before Option 1 and 2 are equal.

CONCLUSIONS

For the proposed program it is better to commit production monies prior to the point in the program where there is full knowledge. Considering a return on investment from 10-20% indicates that a production decision should occur well in advance of the flight test program. The assumption that limits this conclusion is that each option assumes the same state of knowledge concerning production quantities, rates, and unit costs. If the knowledge concerning these factors is accurate and relatively constant, then, in general, production decisions for incremented funding could occur when the technical risk of meeting critical mission requirements is low in regard to avoiding program cancellation. This analysis measured the technical risk against functional requirements in lieu of firm system specification or mission requirements. However, the technical risks were minimal which supported the conclusion that the decision to incrementally spend production money should be made well in advance of the flight test program. How far in advance is the subject of the following discussion.

OPTIMUM TIME TO INITIATE EXPENDITURES OF PRODUCTION MONIES

This analysis uses the spend rates shown in Exhibit 1, and the same risk (Expected Value) calculations previously discussed. The first risk values for Option 1 and 2 correspond to the beginning of the 11th quarter. The risk values can be calculated for each preceding calendar quarter and compared in the same manner. Recall:

Option 1 - To expend procurement monies with full knowledge

Option 2 - To expend procurement monies prior to full knowledge

Exhibit 3 shows this data plotted for Option 2 as Curve (A); Option 1 as Curve (B); and Curve (C) as the combination of both options (i.e., the inherent total risk with making the decision to initiate production expenditures).

NOTE: Curve (B) does not include any cost risk due to return on the investment or operational savings. Curve (D) shows the effect of adding only $5M for return on investment. To use the $159M previously calculated would cause the risk of delaying production to totally dominate any other risk in this analysis. In order to demonstrate the method of analysis the actual estimated return on the investment and/or operational savings was not used.

With consideration to the above note, Curve (A) shows the risk of committing production monies to steadily decrease from the 1st Quarter to the 8th Quarter, where Curve (B), to delay the decision, steadily increases. The lowest risk point is at the vertex which occurs between the 2nd and 3rd Quarters. Curve (C), the total risk of making the production decision, indicates very little difference in total risk taking between the 1st and 5th Quarters. The vertex of Curve (D) and Curve (A) shows the relative sensitivity of the production decision to the schedule when a return on investment is considered.

NOTE: This production cost risk analysis appears to be logically sound. However, the methodology is not supported with rigorous mathematical proof and should be viewed in light of this consideration. However, analysis of the cost risk in the decision process, using this methodology is revealing and promising.

APPENDIX

Exhibit 1 - Planned Program Quarterly Spend Plan

Exhibit 2 - Event Probabilities vs Calendar Quarter

Exhibit 3 - Decision Risk Contours

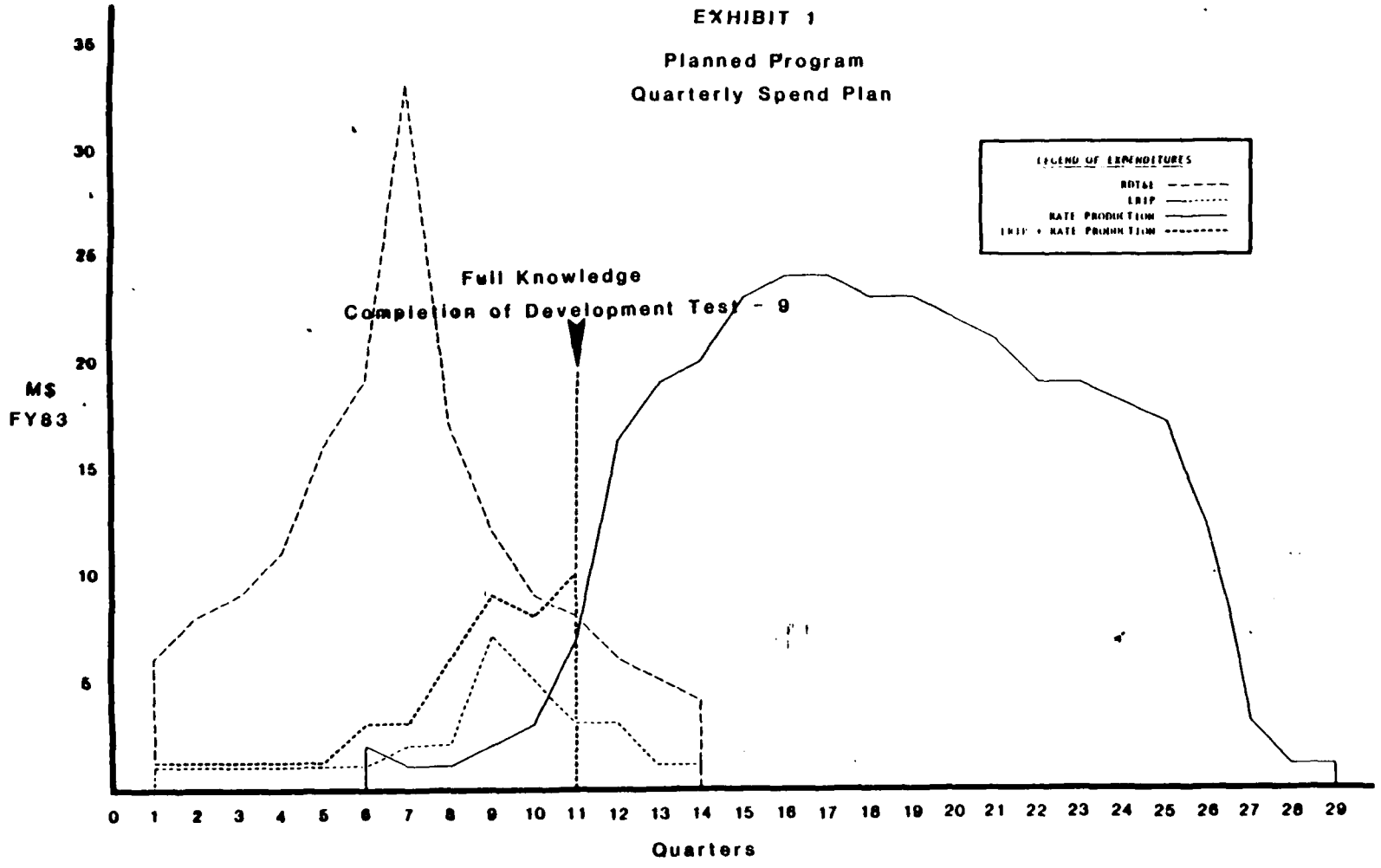


EXHIBIT 1
Planned Program
Quarterly Spend Plan
LEGEND OF EXPENDITURES
RDT&E
LRIP
RATE PRODUCTION
LRIP + RATE PRODUCTION
Full Knowledge
Completion of Development Test - 9
M$
FY83
35
30
25
20
15
10
5
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
Quarters

EXHIBIT 2 - EVENT PROBABILITIES vs. CALENDAR QUARTER

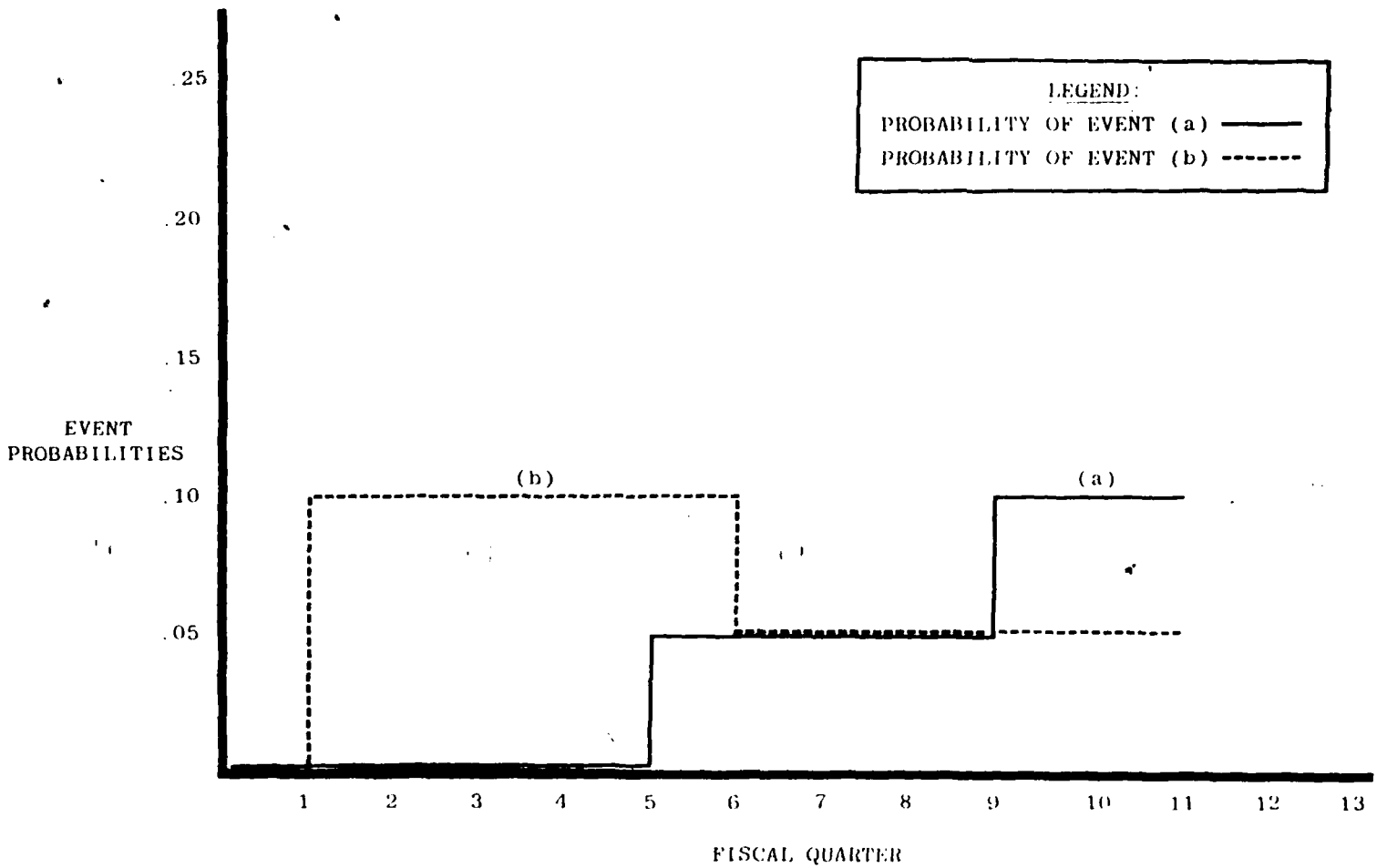
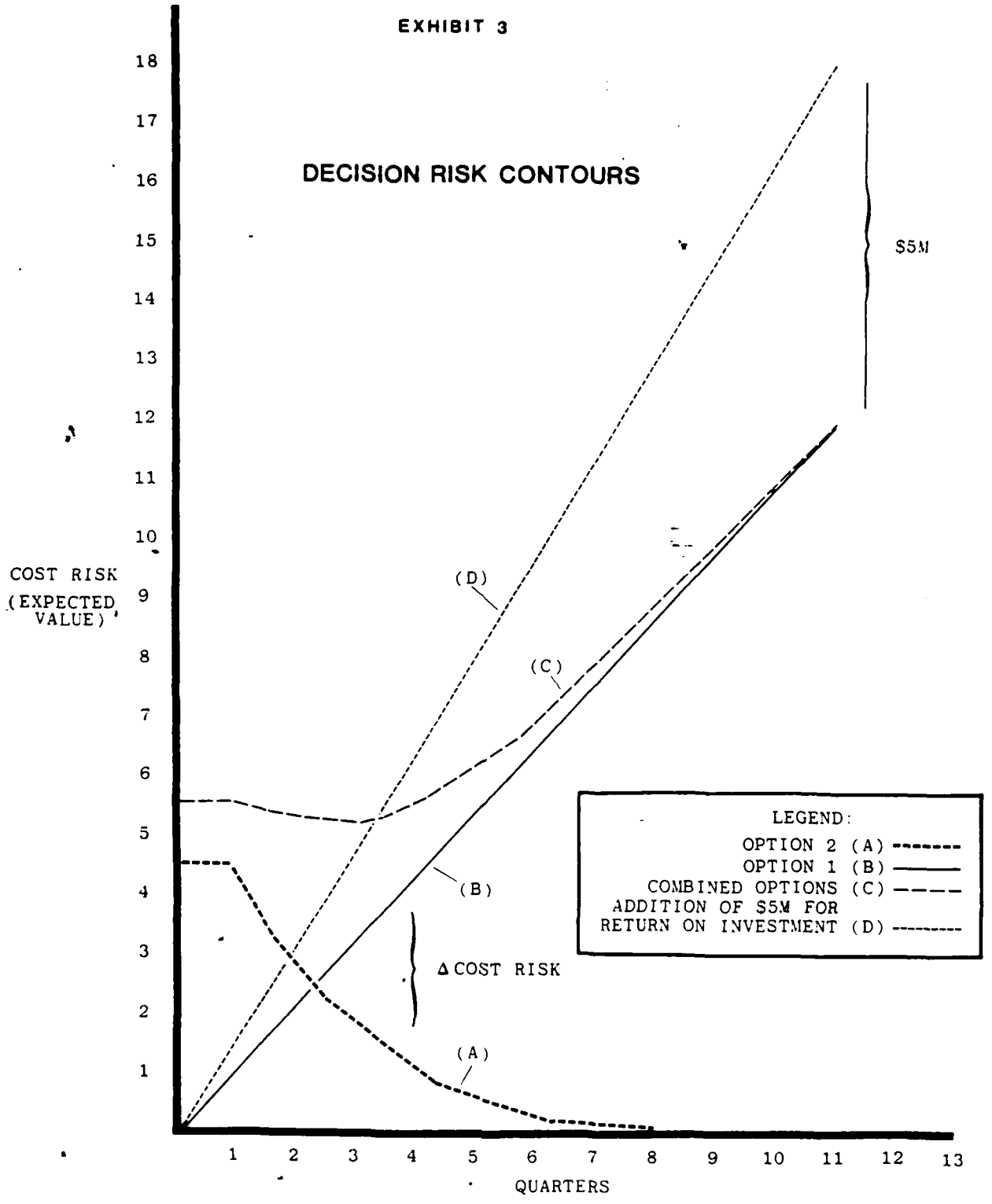


EXHIBIT 3


DECISION RISK CONTOURS
COST RISK
(EXPECTED VALUE)
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
(D)
(C)
(B)
(A)
$5M
Δ COST RISK
LEGEND:
OPTION 2 (A)
OPTION 1 (B)
COMBINED OPTIONS (C)
ADDITION OF $5M FOR RETURN ON INVESTMENT (D)
1 2 3 4 5 6 7 8 9 10 11 12 13
QUARTERS

ADP002754

MANAGING PROGRAM RISK: ONE WAY TO REDUCE COST GROWTH

Captain Lee Cooper, HQ Air Force Systems Command

ABSTRACT

Former Deputy Secretary of Defense, Frank C. Carlucci, in his 30 April 1981 memorandum on "Improving the Acquisition Process" recognized that the key to reducing program costs is to establish and maintain a stable program. One of his initiatives requires the Services to "budget to most likely or expected costs, including predictable cost increases due to risk"; and to "provide incentives for acquisition officers and industry to make and use realistic cost estimates."

This paper focuses on how the program manager can reduce cost growth through a Risk Management Program that provides a more complete assessment of program risks. The essential elements of a risk management program, a proposed approach to implementing the program, and the advantages associated with successful implementation on major weapon systems acquisitions are outlined.

In summary, OSD has demonstrated a commitment to reducing cost growth. Success, however, will require the program managers to establish a risk management program that forces consideration of all program risks before they occur.

INTRODUCTION

> "Even the most ardent supporters of greatly increased spending to strengthen the nation's defenses are turning their guns on massive waste, fraud, and mismanagement that send billions of taxpayer's dollars down the military drain every year.....The challenges are coming from both the conservatives and the liberals. Senators Barry Goldwater (R-Arizona) and Howard Metzenbaum (D-Ohio), in a joint letter to Secretary of Defense Caspar Weinberger, complained that waste and inefficiency have, over the years, become a way of life for too many in the (Defense) department. The nation cannot afford to permit this situation to perpetuate itself any longer." (2)

This perception is probably more widely held at this time than at any other time in our nation's history. Many of the Department of Defense (DOD) acquisition programs that are experiencing large cost growth are offered as evidence to support this perception. To combat this problem, Former Deputy Secretary of Defense, Frank C. Carlucci, issued his April 30, 1981 memorandum on "Improving the Acquisition Process." (1) This memorandum recognized that the key to reducing program costs is to establish and maintain a stable program.

To address the need to establish a stable program, Secretary Carlucci identified three specific initiatives, which, when implemented together, will improve our ability to make more realistic cost estimates. In other words, the objective is to control cost growth before it happens, for after it occurs, we can only measure the impact and try to prevent its recurrence. One of these initiatives, Budget to Most Likely Costs, requires the services to "budget to most likely or expected costs, including predictable cost increases due to risk;" and to "provide incentives for acquisition officers and industry to make and use realistic cost estimates." Successful implementation of this initiative, difficult as it may be, is essential to reducing cost growth on weapon systems acquisition programs. An illustration of the benefits of accurate cost estimates can be found in the 30 Jun 81 Selected Acquisition Report (SAR) to Congress. The Office of the Secretary of Defense (OSD) concluded that inaccurate cost estimates contributed over 20% of the cost growth reported on 47 SAR programs.

Some of the reasons traditionally given for unrealistic cost estimates are optimism on the part of the contractor and the program manager, intentional "buy-ins" by the contractor and/or the service, use of unrealistic inflation indices, and inadequate assessment of the program risks. This paper will focus on how the program manager can reduce cost growth through a Risk Management Program that provides a more complete assessment of program risks.

RISK FACTORS

There are many aspects of a weapon systems acquisition program that have significant cost, schedule, and performance risks. They include, but are not limited to:

Technical Problems. Even though the rate of occurrence has declined over the past two decades, our love affair with high technology often results in advancing the state-of-the-art at a high cost and over lengthy schedule delays. Similarily, a program that includes complicated software development, complex interfaces, combined development testing and evaluation (DT&E) and operational test and

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evaluation (OT&E) testing, and a significant amount of government-furnished equipment often encounters significant technical problems, cost overruns, and schedule delays.

Requirements Stability. Users traditionally have great difficulty in clearly establishing a firm set of requirements. As a result, costly engineering change proposals are generated to modify the system design. This is particularly true in large command, control, communications, and intelligence programs where the requirements are continually changing due to changes in the threat, operational tactics, and in the needs of the decision makers.

Acquisition Strategy. Modifications to the originally planned acquisition strategy can result in significant cost and schedule impacts. For example, receiving fewer proposals than needed for competition, falling into a sole source situation when one of the competing contractors is eliminated at the end of the demonstration/validation phase due to nonperformance, being required to use the leader-follower concept for national or political reasons, and other similar deviations from the original acquisition strategy increase the level of cost and schedule risk.

Political Redirection/Delays. Political pressure is often exerted by personnel in organizations beyond the control of the program manager. For example, members of congress have, through their positions of power, directed that production lines remain open even though the services didn't want the system, large computer service centers be established when there was no requirement, second best sources be selected in order to keep the company afloat or to assist in the recovery of an economically depressed area, etc. Similarily, programs are often delayed or redirected by the Services and/or OSD for political reasons. All of these actions adversely affect the program mangers's cost and schedule baseline.

Inflation Rate Accuracy. Traditionally, the Office of Management and Budget (OMB) and OSD have required program managers to use inflation indices that were significantly lower than the inflation rate economists were predicting. As a result, most programs experienced cost growth that was beyond the control of the program manager when the actual inflation was higher than OMB's indices. However, as the national economy continues to improve and the inflation rate continues to decline, the amount of cost growth attributable to this factor will decline.

Budget Cuts. Any budget cut can have devastating impacts on a program's cost and schedule since the standard approach to absorbing a budget cut is to de-scope the contract, reduce the production quantity or stretch-out the program. The probability of a budget cut on a specific program can be determined by assessing the priority of the program, size of the program, and congressional interests in the program.

Socio-Economic Impacts. This broad category includes many risk factors that occasionally result in extensive cost and schedule delays. For example, directed small and disadvantaged business set-asides, labor problems such as strikes, environmental impact statements, etc., may drain off resources that were planned for other tasks. As a result, the program cost grows and the schedule often slips.

Contractor Motivation. Although it is sometimes difficult to determine how motivated the contractor is toward your program, experience tells us that this is an important area to include in any risk assessment. For example, a contractor that is involved in a competitive, full-scale development and desperately needs to win a production contract will behave differently than one that is in a sole source position or does not expect to win the production contract due to technical or political reasons. In this example, the contractor that needs to win has historically kept personnel turnover to a minimum, been more willing to compromise during negotiations, solved technical problems quicker and cheaper, maintained strict cost control, and stayed on schedule.

RISK MANAGEMENT PROGRAM

The first of these areas, Technical Problems, was specifically addressed by Secretary Carlucci in his inititative, Budget for Technological Risk. The remainder of the risk areas are collectively included in the Budget to Most Likely Costs initiative. To implement these two initiatives, and thereby reduce the cost growth on DOD's mission-critical programs, a program manager needs to establish a Risk Management Program as an essential element of his Decision Support System. The purpose of this program is to establish an overall risk profile for the acquisition program based on combining the risk assessments for the individual factors, to assign budget dollars to the risks, and to investigate alternatives for reducing the risks. Since most major DOD acquisition programs are spread over many years, the Risk Management Program would have to be operative for the initial budget and all other budgets prepared during the acquisition cycle.

The Risk Management Program must, at a minimum, include the following steps:

- identification of the risk areas and the risk factors in each area on the program.

- assessment of the risks identified including the probability of occurrence and the potential damage.
- assignment of budget dollars to the risk factor.
- identification of the alternatives available for reducing the risks.
- analyses of the alternatives.
- selection of the most promising alternative.
- plans for implementation of the selected alternative.
- feedback to determine the success of the risk reducing action.

This program should be implemented by a Risk Review Working Group made up of representatives from each of the functional areas in the Program Management Office and chaired by the business manager. The participating commands, particularly the using and supporting organizations, should be invited to be members of the working group. The specific responsibilities of the group, including performance of the risk assessment/management tasks and relationships with other organizations evaluating the program cost and schedule, should be included in the appropriate DOD or service regulation/instruction/ pamphlet.

To identify the risk areas/factors, the working group needs to look for activities on the critical path, review lessons learned on similar programs, analyze current problems, discuss the program characteristics with functional experts, request the contractor(s) to identify the risk areas/factors, use statistical projections, identify areas where the state-of-the-art is being advanced and look for areas outside the program manager's control. Once the risk factors are identified, the committee should assess the probability of occurrence for each factor, and then determine the consequence of that occurrence in terms of its impact on the acquisition cost, life cycle cost, technical performance, schedule, and supportability of the system. This assessment should be accomplished using statistical analyses, analogies, sensitivity analyses, cost/benefit analyses, validated models, and judgement (based on education, training, and experience). Budget dollars should then be assigned to each risk area on the basis of the degree of probability of ocurrence and the potential damage for each factor in that area. Identification of the alternatives available to the program manager could be accomplished through brainstorming, trade-off studies, reviewing historical cases, etc. Analyses of the alternatives, selection of the best alternative, and implementation should be completed in the same manner as other programmatic decisions are made and implemented.

CURRENT SERVICE PRACTICES

At this time, the military services are taking different approaches to budgeting for risk. Army Regulation 1000-1 (5) requires that major programs use the TRACE Concept in developing cost estimates. This concept establishes deferral funds for the R&D Phase of the program through the use of statistical techniques which only address the "known-unknown." The funds are retained at the DARCOM headquarters until a need is satisfactorily demonstrated by the Program Manager. The Navy's approach is to direct program managers to include risk assessment and the means for dealing with that risk in their acquisition strategy. This includes "a financial strategy which describes realistic funding necessary to achieve the acquisition objective." (4) The Air Force program managers use a variety of means to assess risks for both RDT&E and production programs. They range from the subjective "percent of contract price" technique to the RISK model which requires that a cost distribution be defined for each work breakdown structure (WBS) element. In this approach, the median value of the cost distribution is considered to be the best estimate of the program cost. (3) The services have experienced some success with these approaches. However, we still have significant cost growths on most of our major programs.

CONCLUSION

It is my contention that a significant portion, and maybe even the majcrity, of the cost growth attributed to estimating errors (i.e., over 20% of the cost growth reported on 47 SAR programs in Jun 81) could be eliminated through the use of a risk management program that systematically addresses all of the risk areas identified above. There are many advantages that result from identifying and budgeting for these risks. "First, and most important, it ensures an open discussion and recognition of the risks involved in the program. That discussion, in turn facilitates adequate planning to deal with the risks identified. Second, if program funding is based on more realistic cost estimates that account for risk, those programs will be more stable in the long run." (3) Third, programmatic decisions would be made on the basis of more realistic cost impacts. Finally, there would probably be fewer unaffordable new starts.

On the other hand, there are some real and preceived disadvantages to budgeting for these risks. First, more program funds would be required "up-front"; and this equates to an early commitment to the program which OSD and Congress may not be willing to do. Secondly, if the risk management funds are openly identified, they will become targets for reprogramming actions. Third, realistic cost

estimating would seriously curtail Service buy-ins that traditionally occur in the competition for funds among the services at the OSD and Congressional budget reviews. Fourth, program managers, cost estimators, and other program office personnel, may need additional training in the techniques of assessing and budgeting for risk. Fifth, additional risk models need to be developed in order to more accurately quantify the risk and its impacts. Finally, to achieve the most realistic budget estimate for the program, techniques for incentinizing the contractor to make accurate cost estimates will have to be developed. These last three disadvantages will become advantages once the training programs, risk models and contractor incentives are established.

An indirect advantage of the formation of a Risk Review Working Group will be improved communications among the program participants. For example, program office engineers and user personnel will be able to recognize when the program manager shifts to managing to risk (in order to achieve some demonstrated capability) vice managing to performance (as specified in the specification). This subtle change, which occurs when cost and schedule baselines are exceeded, is seldom communicated to program participants. As a result, frustration sets in, teamwork is lost, and organizations start keeping "black books" on each other.

SUMMARY

In summary, OSD has demonstrated a commitment to reduce the costs experienced on most major acquisitions through policy initiatives and support for program budgets that include funds for risk. It is now up to the program managers to identify all of the risks on his program (not just the technical risks), assess those risks and budget for the cost and schedule impacts to the program if the risk factor becomes a reality. One way of doing that is to establish a Risk Management Program which forces systematic thinking about program risks before they occur.

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ADP002755

DECISION TECHNOLOGY THE CATALYST FOR ACQUISITION IMPROVEMENT

Roland P. Swank, Applied Common Sense, Inc.
Henry M. Wales, Value Management Systems, Inc.

ABSTRACT

It is possible to manage all activities in a weapon acquisition with a system that predicts and achieves desired results.

DECISION TECHNOLOGY provides the Program Manager with the exact information he needs to synthesize all program elements to accurately predict performance probability without compromising management style or objectives. It embraces a basic language that simplifies understanding and communication and applies a fundamental logic that clarifies the implications of each management action. It presents the RISK and CONSEQUENCE visibility in a format that enables the Program Manager to make necessary decisions and confidently defend them knowing they will achieve the results expected. Therefore, all the weapon system expectations are precisely known at all times.

DECISION TECHNOLOGY applied in over seventy applications has resulted in significant savings in cost and time along with achievement of predictable outcomes.

INTRODUCTION

It is imperative that Government, Industry and Academia experts and leaders continue to coordinate their efforts to develop the guidelines, data and mechanisms to achieve a proficient acquisition process. In consideration of the breadth, depth and complexities of such a process, these pioneers have developed sophisticated management systems for this purpose that are far more effective than one might expect. Unfortunately, however, disappointing results have made apparent the urgency to improve the system still further. The vast number of influencing factors, multiplicity of objectives, limits on resources and the constraints imposed by past practices require a language and a mechanism to sort out, determine and implement specific approaches that will achieve the results expected at an acceptable expense.

Meeting the challenge of improving the acquisition process will require changes in certain aspects in order for Program Managers to apply the DECISION TECHNOLOGY necessary to:

Provide expanded performance capabilities.

2. Control the probability of failures and their consequences.

3. Minimize the cost without compromising performance.

If each of the functional contributors to an acquisition are doing a superior job of applying conventional practices, and they invariably are, then why do the output products often fall short of performance expectations, become plagued with faults and anomalies, and require excessive costs to produce and maintain?

As with all endeavors, the increase in breadth and depth of knowledge, the accumulation of experience and the complexities of the interrelationships of all contributing functions severely tax man's ability to manage effectively through intuitive means. DECISION TECHNOLOGY offers a quantum jump in the ability to understand and manage these increasingly complex situations to achieve desired results.

-COMMUNICATIONS PROBLEM

> "I know you believe I understand what I think you said, but I am not sure you realize that what I heard is not what you meant"

This proverbial problem becomes even more complex when explaining DECISION TECHNOLOGY because conventional wisdom often misguides the understanding of the actual significance of the words, the terms, and the phrases employed in its application. The difficulty stems from the fact that the ideas and concepts discussed directly relate to something everyone does all the time, every day - make decisions. So, not only are the various definitions of words a problem, there has generally been an immediate mis-conception of the concepts. In the absence of a precise language for addressing the substance of decisions, an entire circumventing culture of habitual practices has been created to determine and justify them. DECISION TECHNOLOGY identifies, names, defines, and explains the discrete elements of decisions and provides a mechanism for working with them specifically and/or quantitatively.

CHANGING ENVIRONMENT

The making of decisions has been going on throughout all time. Why, then, are they so difficult today than they were, say, five, ten, or even twenty years ago? Well, the decision environment and the expectations have changed. First, as explained earlier, the com-

plexity of things we plan and work with has increased. This growth in complexity can be appreciated when considering the typical items shown in Figure 1. A simple radio with a possible turntable has given way to stereophonic sound centers. A single adjustment camera that you could point and snap now is a multi-setting computer controlled system many times using special films and lighting. A tank used to carry a protected gun now is a battlefield control center with computer controlled target search and fire control. A plane, once used to carry an airborne gun or bomb now contains systems for battle tactics and uses air and ground target rocketry. And note that costs have increased right along with complexities

THEN	NOW
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BOX CAMERA $19	COMPUTER FOCUS, EXPOSURE, FLASH; MULTI-LENS AND FILTER CAMERA SYSTEM $450
BASIC TANK $275,000	COMPUTERIZED FIRE-CONTROL, STABILIZATION, IMAGING, RANGEFINDER WITH MULTI-MUNITIONS MOBILE FIELD SYSTEM $3,000,000
FIGHTER PLANE $400,000	HIGH POWERED, NAVIGATION-AND-ATTACK, RADAR WARNING, ECM, ROCKET LAUNCHING AIRBORNE SYSTEM $23,000,000

FIGURE 1 INCREASING COMPLEXITY

A second change affecting decisions is vulnerability. Figure 2 shows that advances in technology have made resulting products and services more vulnerable to unacceptable consequences. With sturdy cars, it was difficult to get into much trouble at 30 mph, but everyone knows what happens today at 80 mph. Planes carried 35 passengers, and that was bad enough if a problem occurred, but now planes carry 420 passengers. Power plants were controlling 1,800 degree coal but now must control 12,000 degree radioactive elements. Plants dumped 4 gallons per hour of waste water into the environment but now it is 1,000 gallons per hour. The power companies have had to put out special warnings of electrical dangers because of the increased chances of being killed by the higher voltages being used. Similarly, in weapon system exotic materials, unique structures and concentrated energies make it increasingly important that no problems or failures occur.

CARS	30 MPH	80 MPH
PLANES	35 PASSENGERS	420 PASSENGERS
POWER PLANTS	1800° COAL	12000° ELEMENTS
WASTE WATER	4 GAL/HOUR	1000 GAL/HOUR
POWER	110 VOLTS	220/440 VOLTS

FIGURE 2 INCREASING VULNERABILITY

COPING WITH THE NEW ENVIRONMENT

To cope with this new environment, controls have been introduced to assure that the desired results are achieved. These controls are costing a great deal and yet the results still appear to be unsatisfactory. But if each control activity and each decision was reviewed, it would be found that in almost all cases everyone is doing a good job, actually superb. So one might ask: "If everybody is right, what's wrong?"

It is interesting to note what is occurring in the area of artificial intelligence ("AI"). A vast base of knowledge including facts and heuristics is being assembled that is similar to the information a human expert would use to perform a task. But herein lies the stumbling block - "What does an expert (human) do?" (1) In other words, how is a valid decision formed?

Some fundamental consideration involved in decision making is not being considered! Every inadequate decision can be traced to a cause and effect. The cause is a lack of assurance control. This is resulting in the generally recognized effects of high cost, extended schedules and unacceptable performance.

DEFINITIONS OF THE ELEMENTS

The elements that determine the consequences of a decision have been isolated and synthesized. They are the UNCERTAINTIES that exist, the MARGINS available, and the EXPERIENCE that determines how well the uncertainties and margins are known and how they are handled. UNCERTAINTIES and MARGINS together determine the degree of successful mission performance. or the degree of RISK of substandard mission performance. EXPERIENCE is the number of times the UNCERTAINTIES and MARGINS have been measured, providing the degree of confidence in the assurance determined to exist.

APPROACH

Each decision ultimately deals with RISK VALUE, defined as the probability of not achieving an expected result and the consequences if it is not achieved. When making a decision where the probability of not achieving an expected result is low and the consequences are insignificant, the decision is easy: DO IT! When the probability of not achieving an expected result is high and the consequences extreme, the decision is equally easy: DON'T DO IT! There are, though, some decisions that are not so obvious. In today's complex world of advanced technologies, many times key decisions fall somewhere in between these two extremes so their outcome is not predictable with the desired precision. In these vexing instances, help is available to deal more precisely with these RISK VALUES through DECISION TECHNOLOGY.

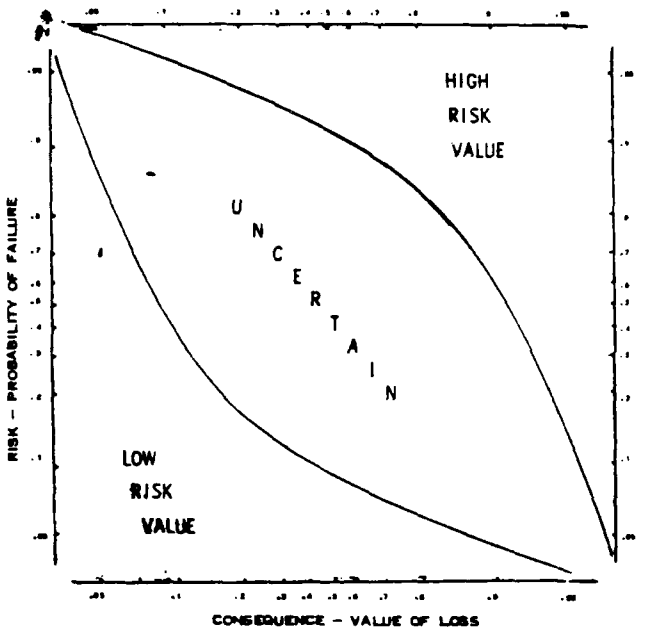


FIGURE 3 RISK VALUE CHART

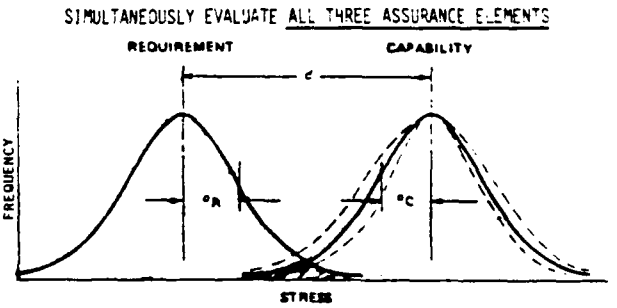
Figure 3 is a chart covering all possible RISK VALUES. The ordinate shows the probability of failure increasing vertically and the abscissa shows the consequences of failure increasing horizontally. Now if there is a low probability of failure and a low value of loss, there is a low RISK VALUE and the decision is accepted. If there is a high probability of failure and a high value of loss, there is a high RISK VALUE and the decision is rejected. The difficulty develops when decisions must be made in the zone in between, where the RISK VALUE is uncertain.

Since it is difficult to work without a limit or a baseline, it is natural to work near a condition that is known which is either at the low or high RISK VALUE boundaries and this results in a wide band of uncertainty as portrayed in Figure 3. We know when control is not good enough when we experience failures or sense high risk. Also, confidence is high when margins are extreme and an overly conservative approach is taken. The separation between these two known conditions can vary greatly. Most endeavors have conditions at both boundaries and therefore are simultaneously faced with the high cost of too much margin and/or malfunctions from not having enough.

Since initial acquisition costs are too high and frequently plagued with overruns and schedule slippages, and still have many problems associated with them, more and more controls are being applied. This results in increasing costs and schedules and often in more malfunctions! This is to be expected when the basic concern, ASSURANCE, is not quantified, and therefore must be intuitively handled. When ASSURANCE is formally addressed and quantified, the width of the band of uncertainty of RISK VALUES is very dramatically reduced. It is therefore necessary to have a mechanism to determine the status between the two extremes of RISK VALUE uncertainty. This will lead to reducing costs from the overly conservative low risk side and achieving a controlled level of system success from the high risk side.

PRINCIPLES

Levels of ASSURANCE are determined through the simultaneous analysis of the three elements of ASSURANCE: 1. UNCERTAINTY, 2. MARGIN, and 3. EXPERIENCE. A representation of these elements and the basic principle is shown in Figure 4. The requirement distribution indi-



THREE ELEMENTS

d = DESIGN MARGIN σ_T = UNCERTAINTY N = NO. OF TESTS

ASSURANCE

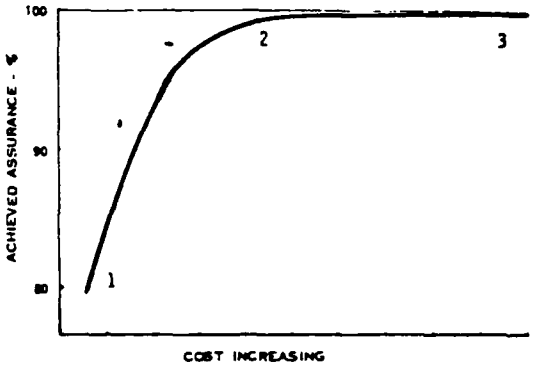
P = PROBABILITY OF SUCCESS C = CONFIDENCE

FIGURE 4 BASIC PRINCIPLE

cates the effects of all UNCERTAINTIES derived from the requirements of the mission. The capability distribution indicates the effects of all activities used to develop the capability of the system to perform the mission. The dashed curves indicate the effects of EXPERIENCE, the wider curve results with less experience and the narrower curve results from more experience.

These two curves cover all considerations. The REQUIREMENT distribution includes the environment, operations, user discretion, life, maintenance, etc.. The CAPABILITY distribution includes application of technology, produceability, quality control, reliability, operator control, test, etc.

Analysis of the overlap provides the level of ASSURANCE existing by determining the chance that on any particular operation the level of the load from the REQUIREMENT exceeds the level of CAPABILITY available at that specific time. The positions and shapes of these curves can be directly linked to cost. Therefore, as they change, success assurance versus cost can be obtained as shown in Figure 5.



1- INADEQUATE ASSURANCE 2- REFINED DESIGN
3- UNWARRANTED EXPENSE

FIGURE 5 ACHIEVED ASSURANCE vs COST

Space limitation does not permit a detailed discussion of the many considerations involved in working with this principle. To facilitate continued intelligent discussion, the concept has been reduced to a "simplified" equation, Figure 6, expressing the relationship between the involved disciplines. Although simplified, the results of using this equation are quite accurate when compared with intuitive reasoning. The main point here, though, is to show that the numerical values of the assurance elements (UNCERTAINTY, MARGIN, EXPERIENCE) form an exponential within an exponential of an algebraic equation. It then becomes apparent why conventional techniques cannot predict ASSURANCE with the necessary precision, thus accounting for the wide spread in the band of uncertainty for RISK VALUE shown in Figure 3.

$$A = f(K)^{\frac{U \times (c)^{1/E}}{M}}$$

A - Assurance M - Margin

U - Uncertainty E - Experience

K - Constant approx. .5

c - Constant approx. 9

For $E = \infty$ $A = f(K)^{\frac{U}{M}}$

For $M = \infty$ or $U = 0$, $A = 1.0$ (100%)

FIGURE 6 THE DECISION EQUATION

The nature of the equation may be understood better by considering limits on the three elements. If the EXPERIENCE, E, was taken to infinity, it would not affect the actual capability of the product to perform successfully, it would only allow us to know it exactly. Even though we do not have an infinite experience, when a product performs it has a specific probability of performing successfully. If the MARGIN, M, was taken to infinity and/or the UNCERTAINTY, U, was taken to zero, the probability of performing successfully would be 100% as each or either would cause the exponent in the equation to equal zero and therefore the ASSURANCE, A, would equal one or 100%.

To achieve 100% ASSURANCE would be ideal, but in the practical world, in order to approach the ideal conditions, the application of resources and resulting costs would become prohibitive. Costs increase exponentially as UNCERTAINTY is reduced, as MARGIN is increased and as EXPERIENCE is gained. Referring back to Figure 5, the conditions along the curve should now be more clearly understood. Inadequate funding can result in inadequate ASSURANCE. Adequate funding can achieve a refined design. Too much activity requires excessive funding that is unwarranted.

Since precise comprehension and control of ASSURANCE has been beyond normal mental capabilities, control has been achieved through gross adjustments of uncertainties, margins and experience. Imbalances in these decision elements between requirements, planned approaches and methods of implementation in an acquisition can result in high costs and/or unacceptable performance. Variations as small as one to five

percent can double or even triple costs in certain areas. If the luxury of making extreme adjustments to these elements is not available, a precise method such as DECISION TECHNOLOGY is needed for determining the delineation of the substance and degree of application contained in a decision.

APPLICATION

At the root of every decision is a parameter that can be used to tie all significant considerations together (time, range, power, load, thickness, rate, etc.). Once this parameter is selected, considering the requirements of the mission and the general capabilities of proposed approaches, an objective is developed in precise terms relating to the parameter. This objective considers consequences and limits and quantifies the ASSURANCE expectations relative to the parameters. Therefore, by definition, RISK is reduced and quantified, relative to the parameters. The uncertainty and level of the parametric required performance of the weapon system is then determined. Then, after the alternative weapon systems required to meet the mission have been researched and a preferred approach selected, the uncertainty and level of its performance will be determined relative to the parameters. The requirement and capability are then matched to determine the level of existing ASSURANCE (Figure 4). If the result is not satisfactory, activities and/or conditions can be modified to change one, two, or all three of the elements and/or the elements may be balanced among themselves to obtain optimum use of resources for the acquisition.

TYPICAL EXAMPLES (2)

The DECISION TECHNOLOGY methodology has been under development and in use for over twenty years. It has provided acquisition management with the means to achieve significant cost, schedule and performance accomplishments on over seventy acquisition applications. These applications have covered a complete range of acquisition maturity from concept development through field operations. The methods and techniques synthesized mission requirements, technology capabilities, project resources, design methods, producing capabilities, screening and control methods, and verification techniques. The following actual examples used the RISK information made available through a MANAGEMENT DECISION SERVICE providing management with the RISK VALUE information needed to make the necessary controlling decisions.

A. In a DEVELOPMENT phase, DECISION TECHNOLOGY determined that an insignificant change in a mission load parameter would result in gross changes in design, manufacturing and test providing a 75% reduction in cost of the subsystem for a $3M savings.

B. In a CONCEPT phase, DECISION TECHNOLOGY determined that the controlling parameter, reaction time, was biased by past practices and resulted in a 19% probability of mission success. Being provided with the parameter and the source and size of effects, an approach was selected providing a probability for success of over 99%.

C. After 5 mission failures in the OPERATIONAL phase, DECISION TECHNOLOGY was used to identify the operational assurance function leading to the failures. Parameter used was the dielectric strength. The operational sequence was modified and all subsequent missions were successful.

D. In the PRODUCTION phase, DECISION TECHNOLOGY verified that information to be obtained by a major system test was not needed. It was eliminated, saving $48M on vehicles delivered to date.

E. At the start of the DEVELOPMENT phase, DECISION TECHNOLOGY was used to analyze the status of the program approach. Twelve critical parameters were determined and analyzed. The resulting modification of program activities provided an overall development cost reduction of over 40% ($10M) and a 50% reduction of schedule time from start of development to delivery of first production unit. Visibility, facts, and logic provided high confidence in achieving a successful high performance acquisition.

F. In the CONCEPT phase, DECISION TECHNOLOGY was used to analyze the three critical acquisition parameters. The resulting control of design, manufacturing and quality provided a reduction in system testing leading to the largest cost improvement in a major corporation up to that time ($4M). This approach was

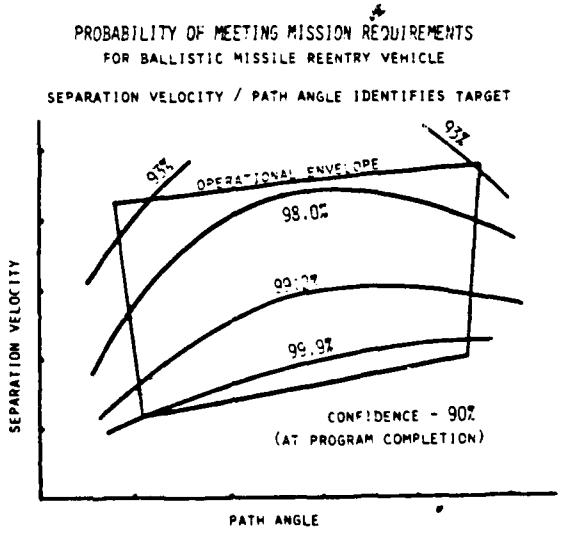


FIGURE 7 OPERATIONAL MISSION ASSURANCE

selected over another approach presented by a prime contractor which would have required an additional $210M. Also, approval was received for a plan to verify system performance effectiveness to a level of 99.76%.

G. Prior to PRODUCTION and FIELD OPERATIONS, DECISION TECHNOLOGY provided a determination of the precise demonstrated probability for success for all operational missions through an analysis of the two critical operating performance parameters. See Figure 7 for the presentation used to provide user expectations.

SUMMARY

Every manager is concerned about the ultimate outcome of his decisions. The process of managing a project, be it large or small, is intimately associated with the art of decision making. But today's complex and sensitive situations more and more are demanding a scientific approach to decision making for the necessary control of critical areas. It is becoming necessary to know and understand RISK VALUES to assure that the decisions made will indeed bring about the results expected.

DECISION TECHNOLOGY provides a method for determining the means of achieving weapon systems having high assurance of success at an acceptable cost. The definitions and common sense logic provided by DECISION TECHNOLOGY can be artfully applied for almost every decision in the acquisition process. There usually are, however, at least one or two and sometimes as many as ten or twelve decisions where the complications and sensitivities are such that even with this clarification logic, more precision is needed. For these few areas, which are usually critical, DECISION TECHNOLOGY provides the means to quantitatively assess the decision elements through THE DECISION EQUATION. Knowing how each contributor affects the outcome and by how much, it becomes possible to control and coordinate all interrelations to achieve the results desired and expected.

The substance and validity of management decisions and actions ultimately affects the quality of the acquisition. In order to obtain acquisition improvement the managers must know:

1. The quantitative chance their project has for success.

2. The critical elements and how they need to be controlled to achieve that success.

3. The insights needed to minimize cost.

Management by the DECISION TECHNOLOGY process produces desired probability of mission success that is SELECTABLE--PREDICTABLE--CONTROLLABLE--HIGH (99.9+%)--QUANTIFIED--COST EFFECTIVE.

CONCLUSIONS

When designing a bridge, it is known and accepted that knowledge, experience, facts, systems, etc. need the precision of equations to finally determine and control the critical decision elements to obtain the results known to be achievable. Similarly, managing all aspects and contributors to an acquisition requires the quantification of all factors, and their systematic integration in a structured and controlled analysis. Determining exactly what and just how much is needed from each of the contributors (mission planning, systems analysis, design engineering, manufacturing, quality control, test, storage, operations, maintainability and others) both individually and collectively requires RISK CONTROL for optimum results.

"Managing without RISK CONTROL is like designing a bridge without equations."

Knowing the ASSURANCE routine may help to understand the problems, but it will not solve them unless it is applied. DECISION TECHNOLOGY is a catalyst that can convert ASSURANCE from a Program Manager's fervent hope to a quantified, integral support of a successful acquisition process. Lack of understanding, divergent points of view, unknown effects, and a myriad of other specious reasons may no longer be valid explanations to excuse high costs, cost overruns, slipped schedules and disappointing performance.

DECISION TECHNOLOGY can be a common denominator that harmoniously integrates all management decisions involved in acquiring cost effective weapon systems.

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ADP002756

DESIGNING THE EQUITABLE RISK CONTRACT

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ABSTRACT

Department of Defense contracting faces such great uncertainty that contracts must be designed to share the resultant risk. This paper describes the steps for this risk-sharing: assessing sources of uncertainty and their probability of impact, assessing the impact of their uncertainties on both contractual partners' objectives, combining these impacts for total risk to the objectives, prioritizing the parties objectives, arraying the 2 sets of prioritized risk in order to equate them, and selecting the proper contractual devices to bring on this equity. The paper also suggests what research might be done on (1) assessing the impact of uncertainties on contractual objectives (2) developing operations research models to optimize risk sharing, (3) the impact of contractual devices on objectives, and (4) the design of experiments to effect this research.

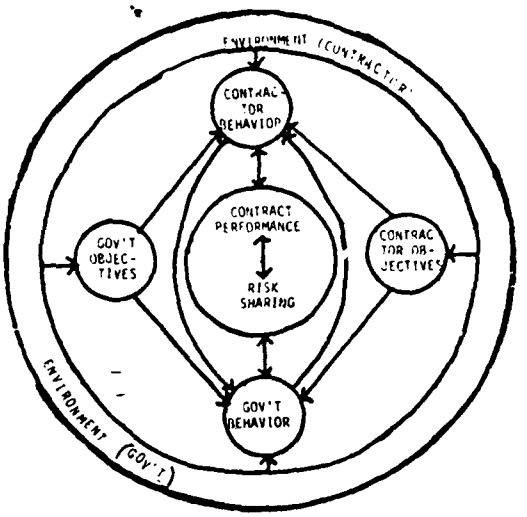
INTRODUCTION

In the capitalist society firms take risks in order to make profits; this is called entrepreneurial behavior. In the private sector the seller typically accepts most risks by putting contingency factors in his price. The Department of Defense (DOD), however, often faces such uncertainty that contingent prices from its sellers would be prohibitive, if these sellers would accept the risk in the first place.

DOD therefore must share risk with contracting firms in situations of great uncertainty. But how? The objectives of this paper are to reason out how this might be done and specifically what contract mechanisms might be used in the contract design.

CONTRACT RISK MANAGEMENT

Risk management involves the assessment, minimization and equity of contract risk. It is a responsibility of both DOD and its firm to make the contract equitable. After the government determines the cost, schedule, and performance targets for its contract, then much of the contract formulation deals with selecting those provisions which minimize risk to these targets and make risk equitable between the parties. Cost contracts tend to reduce contract profit (loss) risk; warranties tend to reduce government performance risk, and so on. As figure 1 indicates, contract performance and risk are both a function of government and contractor behavior and their influences. This figure assumes an exchange of behaviors, not necessarily cooperative, and, in effect, rejects a zero-sum game (i.e. what one wins, the other loses) as a basis for achieving risk equity. One party's behavior is influenced by: the other's behavior, its objectives, the other's objectives, its environment, the other's environment, and feedback from contract performance. The paper will elaborate on each of these factors from the government's viewpoint.



INFLUENCES ON CONTRACTOR PERFORMANCE AND RISK
Figure 1

The figure also suggests the steps to effect the sharing of risk. First, the source of risk, the uncertainty in the factors affecting behavior and performance, must be judged. Second, the risk resulting from this uncertainty must be assessed. Third, the amount of risk government must take on, its share, must be judged. And ultimately the proper contractual tools must be selected to effect this allocation of risk. There should also be some sort of risk adjustment control mechanism to equitably readjust risk when performance shows it is warranted.

Each of these steps is a challenge. As mentioned, both parties take part in risk management. This paper is from the viewpoint of the government, the initiator of the action. It speculates on the government's situation, the contractor's situation, and what activities the government might take. Further, it focuses on the most unstable (i.e., uncertain) kind of procurement, the development of a sophisticated system, so that most risk issues are surfaced. Finally, the paper deals primarily with risk sharing (and only incidentally with the issue of risk minimizing).

UNCERTAINTY ASSESSMENT

A program manager in developing a system faces a unique set of uncertainties. In a given contract he or the contracting officer must assess and measure the amount of uncertainty facing both parties so that the full contract risk impact car be found. The list suggested by the figure earlier will be the grouping used here: both behaviors, both environments (skills, attitudes, technology, economics, etc.), both sets of objectives and performance feedback. Each kind of uncertainty will be discussed in the paper.

One might describe the level of uncertainty for each factor quantitatively or qualitatively, or both. That is, one could say the likelihood of technological uncertainty (for example) having an impact on a given program (or given contract) was high, medium, or low or ranged from 0 to 1 in probabilistic terms, with perhaps a narrative statement for each kind of uncertainty. Actually one is measuring the probability that the uncertainty will have an impact on the program. The probability is one half of the risk picture.

RISK IMPACT AND MEASUREMENT

Associated with uncertainty is an amount of risk. Normally one thinks of performance risk, the risk of not meeting specifications, or cost risk, the risk of exceeding cost targets. Actually there is a risk for each objective in a program. Moveover both contractual partners have different objectives and face different risks. That is, if, for example, technological shortfall occurs in a program, the government may be concerned first with not meeting performance, and the contractor may be first concerned with profit impact. The same uncertainty can commonly have different risks for the two organizations. This obviously has implications for attempts to equalize risk between them.

Further, each kind of uncertainty will have varying impacts on a program and different objectives in that program. This risk impact is the other half of the risk picture.

A recent study of Army project and deputy project managers [1] reported the following order of factors in affecting program stability.

1. Requirements
2. Funding
3. Technology
4. Personnel
5. Scheduling

The following were not found to be significant: defense management, political, contractual and economic. More specifically the survey found funding and requirements were the most important sources of uncertainty, followed by technology, for both the cost and the schedule objectives. While requirements and technology, followed by funding, were the most important impacts on performance. Generally in the absence of other information, one might evaluate these sources of uncertainty or assume this relative order of impact. A typical scheme might have requirements and funding as high cost impact (or perhaps 8-10 out of 10); technology, personnel, and scheduling as medium cost impact (4-7 out of 10); and the remainders as low cost risk impact (0-3).

If one is able to ascertain the relative impacts of these sources of risks and quantify them, then one can combine this information with the probability of occurrence to find relative risk for each objective. This relationship can be the premise for a number of models.

One simple model to find total program risk for an objective would be multiplicative [3]:

$$RC = \sum_{i=1}^{n} (IUC_i)\, P(IUC_i)$$

where RC = Total cost risk for a particular program

IUC_i = Impact for uncertainty i (e.g., 0-10, 0-100, etc.) on cost

$P(IUC_i)$ = Probability of impact due to uncertainty i occurring

n = Number of uncertainties considered

Otherwise one could make qualitative judgements on both the impact and the probability:

Uncertainty	Probability of Impact	Impact on Cost
Technology	Medium	Medium
Funding	Medium	High
Political	Low	Low

Thenone could make judgments on the cost risk on the program. Similarly, with either approach risk on all other objectives for both parties can be found.

PRIORITY OF GOVERNMENT AND CONTRACTOR CONTRACTUAL OBJECTIVES

On a given contract either contractual partner may have any number of leading objectives. For example, the government may be most interested in gaining some technical performance at the expense of other objectives. The contractor may be most interested in meeting a certain profit or return target.

In 1981 Williams and Carr [4] did a survey on the relative priority of contractual objectives (which, it should be pointed out, are not necessarily corporate objectives). The government objectives were in the following priority over

virtually all government groups: (1) meet the specifications, (2) ensure delivery schedule met, (3) keep price at agreed upon level. (Industry respondents, however, perceived a higher government priority for price than did the government sample). Government R&D organizations had the same priority as production organizations, but at a significantly lower level; this could indicate that these personnel could be keying on objectives such as innovation and creativity.

The priority of industry objectives had somewhat more variance, but generally industry personnel expressed more interest in long-term profit first (good product, long-term relationship), then short term profit (improved cash flow, profit on sales), development of new capabilities, and a host of others (return on invested capital, development of dominant position).

In the industry sample, small firms expressed far more concern for company survival than did larger firms. Growing firms expressed a higher use for profit and ROI than did rapidly growing and mature firms. Labor intensive firms had the most regard, balanced firms the second most, and capital intensive firms the least regard for providing a good product, company survival, developing a skilled wood force, developing new capability, establishing a long-term business relationship, and improving cash flow. These industrial firms with larger Government business expressed somewhat more utility for company survival, company growth, and improved cash flow than did other firms.

Without any better information on the contract, these findings and those from other studies may give suitable guidance for inferring priorities on a given contract.

RISK SHARE JUDGMENT

The equitable sharing of risk can be only an approximating heuristic process (at this time) because of the complexity of (1) comparing two diverse sets of objectives (2) assessing the risks for these objectives, and (3) finding contractual tools to share them.

First the two parties' relative order of objective importance will somehow have to be assessed. For example, the three top objectives on a given contract might be as shown in Figure 2.

DOD	Contractor
1. Meet performance specifications	1. Meet profit target
2. Meet cost target	2. Make quality product
3. Meet Schedule	3. Generate new DOD business

Figure 2 Contractual Prioritized Objectives

It can be seen that the government (1) has a different order of risk concerns, (2) must channel the contractor's risk concerns toward its own, and (3) must calculate the tradeoffs between the different risk concerns.

In the same manner as the DOD risks, the contractor risks can be derived. Following the example above the risks might have the array of figure 3.

DOD		CONTRACTOR	
Kind of Risk	Level	Kind of Risk	Level
1. Performance Risk	Medium	1. Profit (loss) risk	High
2. Cost Risk	Medium	2. Quality risk	High
3. Schedule	High	3. Growth risk	Low

Figure 3 Contractual Prioritization Risks

As the earlier model shows, one could also have quantitative measures in the array.

Now the program manager is in the position to judge how to "share" risk. After he prioritizes both sets of objectives and assesses their risk of not being accomplished, he can pick the areas that need to be addressed to make a just contract.

In the contract under consideration he must attempt to minimize the risk to the top objectives equally. This is the essence of risk sharing. In the example the PM might consider contractual devices that reduce performance risk for DOD and quality risk for the contractor (warranties and quality programs).

Contract type has been the traditional way to share risk - a firm fixed price contract for stable environments (cost risk on contractor), a cost plus fixed fee contract for extremely unstable environments (cost risk on the government), and a cost plus incentive fee contract (with a formula to share cost risk). Actually there are many kinds of contractual provisions to accomodate cost risk - an economic price adjustment to handle inflation, a business base clause to handle loss of sales, a termination liability clause to address program termination. Moreover there are other provisions to address other kinds of risk to both parties. They are all interdependent.

Figure 4 arrays the different kinds of risk-sharing (and reducing) mechanisms. Although one has intuitive feel for the impact of these devices, rigorous study is needed to find those situations where they might be used to equalize different kinds of risk. At present the most research is on the ability of the cost plus incentive fee (CPIF) contract to reduce cost growth (i.e. reduce cost risk)[2].

CONTRACT TYPE & PRICING ARRANGEMENT

- Firm Fixed Price
- Fixed Price Incentive
- Fixed Price with Economic-Price Adjustment
- Cost Reimbursable
- Cost Plus Fixed Fee
- Cost Plus Award Fee
- Cost Plus Incentive Fee
- Etc.

CONTRACT PROVISIONS

- Warranty
- Pre-Production Evaluation
- Investment Protection
- Quantity Guarantee
- Termination Liability
- Indemnification
- Patents and Terminal Data
- Rate of Payment
- Design to Cost
- Value Engineering
- Data Rights Clause(s)
- Etc.

EXTRA-CONTRACTUAL

- Level of Contract Administration
- Should Cost
- Design of Source Selection
- Pre-Award Survey
- Post Award Conference
- Etc.

Figure 4 Contract Risk-Share Devices

SELECTION OF CONTRACTUAL DEVICES

Therefore in planning for a contract,one essentially attempts to minimize risk and share risk equally by selecting the proper contractual device. A contracting officer and/or program manager would need a spread sheet with the two parties' prioritized objectives and the level of risk assessment (from figure 3) and the array of devices that might be chosen for the contract from (figure 4). Figure 5 is one possible design with a few simple illustrative entries. The CPIF contract reduces the contractor's high profit risk, but increases DOD's cost risk in the example.

DOD OBJECTIVE	RISK LEVEL	CONTRACTOR OBJECTIVE	RISK LEVEL	CONTRACTUAL DEVICE
1				
2		PROFIT	HIGH	CPIF PR↓
3 COST MIN	LOW			CR↑
4				

Figure 5 Contract Design Spread Sheet

In this way the contract "designer" can see the cumulative impact of the different devices on both parties and if either party is left with too much risk in any area. Both parties will have new tools for negotiations.

CONCLUSIONS

A. Contract Design. One might take the following steps to attempt to design a contract that equitably shares risk.

1. Assess the sources of uncertainty that might be present in a contract. Quantitatively or qualitatively assess the probability of their having an impact on the contractual partners.

2. Assess the risk-the amount of impact of the uncertainties on the government and contract objectives. Combine the impact of the various uncertainties to find the total cost risk, schedule risk, etc.

3. Prioritize or impute the priority of the government and contractor objectives (and, in effect, the risks).

4. Array the two sets of prioritized risks and device a strategy to equate the risks between the two parties a pair at a time (top 2, second 2, etc) or by some combined strategy.

5. Select those risk-sharing devices (e.g. contract type) that satisfy the strategy. For example, a CPIF contract might be appropriate for a contract with a high priority, high risk, profit risk for the contractor and a lower priority, lower risk for cost for the government.

B. Research Agenda. This approach suggests a definite research agenda.

1. More research needs to be done to categorize and assess the impact of uncertainties on contractual objectives (after [1]) and the priorities of contractual objectives (following [4]). Possibly the most fruitful alternatives are by size of program/contract and by life cycle phase.

2. It is possible operations research models can be employed to devise stragegies for sharing risk. Goal programming, multi-objective programming and compromise programming are examples of methodologies taht can deal with multiple objectives.

3. Most importantly more research is needed to find the impact of various contract types, provisions and extra contractual activities on the different contractual objectives. One contribution would be the simple accumulation of the present literature's findings.

4. The difficulties in designing experiments to allow inferences on contractual impacts are substantial:

a. Contracting officials will normally not allow researchers to tamper with contract to isolate impacts of individual devices.

b. In any event it is difficult to isolate the impact of one variable (e.g. contract type) in the dynamic DOD contract environment.

c. It is difficult to find similar kinds of contracts to allow with and without treatments.

5. A concentrated effort by a service to take the resources to overcome these 3 difficulties in the name of future improvement would (in the author's opinion) be the greatest contribution to acquisition research today.

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ACQUISITION STRATEGY

Panel Moderator: Mr. Frank B. Ford
Director, Contracts and Business
Review Division
Headquarters Naval Material Command

Papers:

A Case History of the Cost-Benefit Analysis of the Proposed Uniform Federal Procurement System
by Kenneth H. Borchers, Joseph L. Hood, and Earl H. Langenbeck

Assumption of Risk in the R&D Environment
by James H. Gill

An Analysis of the Acquisition Strategy Decision Process Along Three Dimensions of the Acquisition Improvement Program
by Holly A. Heinz

Skunkworks 81 Revisited - An Update on Acquisition Strategy
by John E. Longhouser

Dupe

A CASE HISTORY OF THE COST-BENEFIT ANALYSIS OF THE PROPOSED UNIFORM FEDERAL PROCUREMENT SYSTEM

Kenneth H. Borchers, Booz, Allen & Hamilton
Joseph L. Hood, Federal Acquisition Institute
Earl H. Langenbeck, Naval Surface Weapons Center (1)

ABSTRACT

Public Law 96-83 directed the Office of Federal Procurement Policy to develop and propose a uniform procurement system for use by Federal agencies without regard to current barriers or statutory requirements. The proposal was to include projected costs and benefits of the proposed system. Two constraints influenced the approach to meet this statutory requirement. The methodology was an adaptation of the Analytic Hierarchy Process, which rigorously uses expert judgments of those knowledgeable of procurement systems from both the public and private sectors. A synthesis of the findings from the primary and secondary data analyses estimated net annual savings ranging from $2 billion to $9 billion.

INTRODUCTION

At the request of the U.S. Congress, the Office of Federal Procurement Policy (OFPP) of the Office of Management and Budget (OMB) proposed the establishment of a Uniform Federal Procurement System (UFPS)--a system designed to improve the efficiency and economy of government procurement and, consequently, government operations. The potential impact of the proposed system could be enormous: Federal procurement involves more than $134 billion and 18 million procurement actions each year.

When Congress asked OFPP for this proposal, it also required that the proposal include an estimate of the costs and benefits of the UPFS. The proposal and the cost-benefit analysis were submitted to Congress in February 1982. (2) Executive Order 12352 issued by President Reagan on March 17, 1982, implemented portions of the proposed system that did not require Congressional action.

The cost-benefit analysis was based on the initial draft proposal in its entirety, and references to the "proposed" system refer to this initial document.

THE PROPOSED SYSTEM

The proposed UFPS had seven basic features designed to improve upon the present system (status quo). (3) These features were:

- Improved competition
- Simplification
- Commercialization
- Uniform policy
- System standards and control
- Integrated management system
- Procurement executive supported by professional workforce

The proposal also recommended five management alternatives for the placement of the improved and enhanced Office of Federal Procurement Policy (OFPP) within the governmental organization: establishing OFPP as a separate agency, as a statutory office within OMB, as a nonstatutory office within OMB, as an office within GSA, or as an office within DOD. Additionally, three options were proposed for amending the statutory foundations of Federal procurement: maintaining the status quo; enacting a single statute for all procurement; and enacting two conforming statutes--one for the Department of Defense and one for all other procurements.

COST-BENEFIT ANALYSIS

The three main objectives of the cost-benefit analysis were to consider the investment required to incorporate the proposed new features of the UFPS; to calculate the cost savings and benefits that would result; and to assess the costs and benefits of the new system compared with the existing system. It was determined that the nature of both the existing and proposed procurement systems precluded the application of a traditional cost-benefit methodology: there were no hard data on either the performance of the existing system or the proposed system; further, there was limited time available for completing the analysis.

A two-phase study approach was chosen. A primary analysis established the relationship among the various features of the UFPS. A secondary analysis established a dollar base which could be applied to the relationships.

The methodology used in the primary analysis was an adaptation of the Analytic Hierarchy Process. (4) This process models the tangible and intangible, qualitative and quantitative, and the objective and subjective factors that bear on the costs and benefits of the proposed system. Using this technique, it was possible

to develop relationships between cost savings, investments, and benefits.

The secondary analysis was comprised of a literature search to estimate the cost savings associated with features of the proposed system and an analysis of Federal contracting practices.

PRIMARY ANALYSIS

The purposes of the primary analysis were threefold:

- Assess the expected investments and savings associated with each management and statutory alternative
- Assess the relative importance and contribution of each system feature to the overall costs and benefits of the system
- Assess the system alternatives in relation to the present system (status quo)

The primary analysis of the UFPS made several assumptions. The present system does not incorporate the features of the proposed system; the time comparison between the two systems is the present and an unknown point in time when the UFPS system is fully operational; the cost of the proposed system represents a reallocation of resources. Because of these assumptions, discounting was not incorporated.

A questionnaire was developed to gather the needed data from 150 expert sources. They represented, individually or by affiliation, organizations and agencies that receive or contract for 95 percent of the Federal procurement dollars. By comparing pairs of alternatives, these sources provided informed judgments about the relationships between features of the system; about the management and statutory alternatives; and about the status quo in relation to the investment, cost savings, and benefits associated with each feature and alternative. For example:

- What is your opinion as to which alternative will provide the greater difference in benefit? Improved competition . . . or . . . system standards, and
- What is the degree of difference?

The 120 surveys that were completed provided 20,000 judgments comparing 82 alternatives. The responses were subject to rigorous testing for consistency.

The analysis of these data (the degree of difference) resulted in the determination of the relative contribution for each of the proposed system features to the overall benefits expected to result from the proposed system. (See Table 1.)

Ratios were developed for comparing each management and statutory alternative to the present system (status quo) in terms of cost savings, benefit, investment, and savings-to-investment. (See Table 2.)

The primary analysis provided data that were used in the next stage of the analysis to translate the expected relative costs and benefits of the UFPS features into a total dollar value of the proposed program.

TABLE 1

CONTRIBUTION OF SYSTEM FEATURES TO TOTAL BENEFIT

System Feature	Percent
Improved Competition	14
Simplification	20
Commercialization	15
Uniform Policy	10
System Standards	10
Integrated Management System	9
Procurement Executive/Workforce	22
Total	100

TABLE 2

SAVINGS TO INVESTMENT RATIOS

Statutory Framework	Management Structure	Ratios
Current	Status quo	2.26
Dual	OFPP (statutory) in OMB	1.39
Conforming	OFPP (nonstatutory) in OMB	1.13
	OFPP in GSA	.23
	OFPP in DOD	.43
	OFPP as separate agency	1.58
Single	OFPP (statutory) in OMB	3.98
	OFPP (nonstatutory) in OMB	3.84
	OFPP in GSA	.77
	OFPP in DOD	1.29
	OFPP as a separate agency	.98

SECONDARY ANALYSIS

The secondary analysis included a search of literature on procurement to obtain information on the cost-savings that could be realized from incorporation of the features of the system and an analysis of Federal procurement practices.

The only feature for which sufficient data were available to perform this analysis was "*improved competition.*" *The analysis* required identifying the Federal procurement dollars awarded noncompetitively, estimating how many of those dollars could have been awarded under a competitive bidding process, and estimating the savings that could be realized as a result. (5)

A literature search revealed that a range of 20 to 30 percent of sole-source procurements could be converted to competive procurements. The cost savings of this conversion was estimated to range from a low of 7 percent of the total contract value to a high of 25 percent. (6)

A conservative estimate of total annual cost savings from improved competition was thus $1.01 billion. An optimistic estimate of annual savings was $5.4 billion. (See Table 3.)

SYNTHESIS

Because the primary analysis determined the proportion of total benefits that would be contributed by each system feature, estimating the dollar value of "improved competition" allowed a value to be estimated for each of the remaining features and, thus, the total program.

TABLE 3

RANGE OF COST SAVINGS RESULTING FROM IMPROVED COMPETITION

Noncompetitive Federal Procurement	$72 Billion	
	Conservative	Optimistic
Portion convertible to competitive procurement	20 %	30%
New competitive Federal procurement	$14.4B	$21.6B
Estimate of cost savings from improved competition		
Low - 7%	$ 1.01B	$ 1.51B
High - 25%	$ 3.60B	$ 5.40B

TABLE 4

RANGE OF GROSS SAVINGS ($B)

System Feature	Contribution To Total % Benefits	Estimated Savings Low	Estimated Savings High
Improved Competition	14	$1.01	$ 5.40
Simplification	20	1.44	7.71
Uniform Policy	10	.72	3.86
Commercialization	15	1.08	5.79
System Standards	10	.72	3.86
Integrated Management System	9	.65	3.47
Procurement Executive/Workforce	22	1.59	8.49
Total	100	-	-
Gross Savings*	-	2.87	15.36

*Root sum square was used because the features are interrelated.

FINDINGS: GROSS COST SAVINGS

The ratios developed during the primary analysis allowed the figures from the secondary analysis to be converted into a range of dollar savings possible from incorporation of the seven features and showed gross savings of between $2.87 billion and $15.36 billion. (See Table 4.)

FINDINGS: INVESTMENT AND NET SAVINGS

The ratios of savings to investment developed during the primary analysis showed a relationship of 2.26:1 between savings and investment for the status quo. To achieve cost savings, therefore, a corresponding investment of between $1.27 billion and $6.81 billion is required. This indicated that the proposed system could produce a net annual savings between $1.60 billion and $8.55 billion. (See Table 5.)

TABLE 5

RANGE OF SAVINGS RESULTING FROM INVESTMENTS IN THE UFPS

	Low/Conservative Range	High/Optimistic Range
Gross Savings	$2.87B	$15.36B
Investment Required*	$1.27B	$ 6.81B
Net Savings	$1.60B	$ 8.55B

*Savings to investment ratio: 2.26:1

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(1) The authors were employed by, and detailed to, the Office of Federal Procurement Policy to conduct this cost-benefit analysis.

(2) For further information, see "Proposal for a Uniform Federal Procurement System," and its supplementary volume, "A System Level Cost-Benefit Analysis of the Uniform Federal Procurement System" issued by OMB February 26, 1982. Also see PL 96-83.

(3) Under this system, two major pieces of legislation and approximately 4,500 other laws govern Federal procurement.

(4) (See Saty, Thomas L., The Analytic Hierarchy Process: Planning, Priority Setting, and Resource Allocation, McGraw-Hill, Inc., New York, 1980.

(5) Source: Federal Procurement Data System, 1981.

(6) The following studies were consulted:

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ADP002757

ASSUMPTION OF RISK IN THE R&D ENVIRONMENT

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INTRODUCTION/ABSTRACT

There has been a traditional philosophy regarding the use of different types of contracts to share risk during the development of a major weapon system. This philosophy would have the Government assume the burden of risk early in the life of the system through the use of Cost Type contracts. As the requirement becomes more defined, the burden of risk is gradually transferred to the contractor with a commensurate increase in potential profit.

In all too many cases we have witnessed the abuse of this concept and the resultant overrunning of scheduled targets. A residual of this practice has been the almost total lack of credibility between Congress and the Defense Department when negotiating a FY Budget. Weapon system forecasts are often not given the credibility of the paper they are written upon.

It has been an unfortunate fact that critics are all too often correct. Weapon systems are incrementally incorporated into the budget. Vested interests are most often concerned with little more than justifying their position in the bureaucratic jungle.

If we accept the premise that the Acquisition system requires improvement, what are the alternatives that may be considered to alter the process? A method that has been utilized by the Ballistic Missile Office has been to dramatically alter the traditional concept of assumption of risk by offering Contractors the opportunity to take their fate into their own hands and assume a major share of the cost risk while simultaneously reducing the risk associated with technical failure.

BACKGROUND

Two significant considerations in the acquisition of major weapon systems are affordability and acquisition time. They are often interrelated. Each has a significant impact upon the Department of Defense's capability to fulfill its mission of providing for the security of the U.S.

What is meant by affordability?

It is: a function of cost, priority, and availability of fiscal and manpower resources which shall be considered at every milestone and during the PPBS (Planning Programming and Budgeting System) process. The order of magnitude of resources and DoD Component is willing to commit, and the relative priority of the program to satisfy the need identified in the JMSNS (Justification for Major System New Starts) will be reconciled with overall capabilities, priorities, and resources in the PPBS.[1]

While affordability is indeed a major factor in weapon system acquisition, it is not the sole consideration when evaluating national security priorities. A second critical consideration relates to the time it takes to field a weapon system. This may prove to be a structural, rather than financial inability to ensure the timely implementation of that system. This problem is inherent in the acquisition system and manifests itself even with those weapons which are inimical to U.S. strategic security.

Minimizing the time it takes to acquire material and facilities to satisfy military needs shall be a primary goal in the development of an acquisition strategy. Particular emphasis shall be placed on minimizing the time from a commitment to acquire an operationally suitable, supportable, and effective system to deployment with the operating forces in sufficient quantities for full operational capability. Commensurate with risk, such approaches as developing separate alternatives in high-risk areas; early funding to design-in reliability and support characteristics, lead time reductions through concurrency; experimental prototyping of critical components; combining phases; preplanned product improvement; additional test articles; or omitting phases, should be encouraged.[2]

It is evident that risk plays an important part in the acquisition of major weapon systems. In order to expedite the process without impacting the affordability of the system a partnership in risk between Government and Private Industry is necessary. Both parties must accept an equitable share of the responsibility for producing a quality product at an affordable price in a timely manner.

The concept of risk is quite broad involving technical complexity, managerial efficiency and administrative competency. It involves a multitude of factors, many of which are beyond the control of either party - funding limitations, political restrictions, changes in the national security environment, to name but a few.

It is precisely this element of risk that can transform the acquisition process from a science to an art. The evaluation of risk ofttimes requires a crystal ball in addition to competent technical and managerial analysis.

It is an axiom of contract acquisition that the risk involved in weapon systems procurement is directly related to the phase of the acquisition process in which it currently resides. These phases have been identified as; concept exploration, demonstration and validation; full scale development (normally associated with Research and Development); and production and deployment.

All too often a contractor will assert his willingness to assume the managerial responsibility for a program in the Research and Development stage if the technical uncertainties could be resolved. Since, by definiton, the R&D phase involves some technical uncertainty, it has not appeared feasible to transfer managerial risk to the contractor in this environment.

The nature of risk is such that it can mean different things to different people. Where you stand inevitably depends upon where you sit. This is to say that the perspective of risk, much like that of beauty and obscenity, lies in the eye of the beholder.

The type of contract that is utilized by the Government when contracting for a weapon system will directly affect that burden of risk. The Government assumes the greater share of risk when it contracts with a cost-type contract. Risk is transferred to the contractor by utilization of fixed-price contracts.

The type of contract will normally relate to the certainty, or lack thereof, of the requirement. If the system is well-defined, with complete specifications, diagrams and drawings it is the policy of the Department of Defense to contract with a Firm-Fixed-Price contract. Since the majority of risk in the Production environment relates directly to managerial competence, rather than technical ingenuity, the contractor should succeed or fail based upon his capability to effectively manage a program.

If the technical requirements are not so well defined, the burden of risk should legitimately fall upon the Government. It is not reasonable to penalize the contractor for problems that are not of his making. Thus, systems that are still in the R&D environment are normally contracted with a cost type contract.

It is therefore somewhat anomalous that the Air Force Systems Command has chosen to contract for the Peacekeeper Missile Stages with fixed-price contracts while still in the Full Scale Engineering Development Phase. The utilization of this contract type represents a new approach toward Government/Contractor assumption of risk.

The Air Force Systems Command has declared war upon costs. The battle relates to a broad spectrum of cost-saving areas. One such opportunity for cost reductions involves the structuring of high risk contracts. The risk herein relates to the incentivizing of contractor performance to reward competency and penalize inefficiency. Risk may be seen to contribute to the concept of cost reduction and control.

The Affordable Acquisition Approach (A3) is now the order of the day. Two risk-related methods of reducing cost that have received significant attention recently are Award Fee Contracts and Competitive Parallel Development.

Award Fee Contracts offer the Government the capability to reward contractor excellence through the use of a set of specific criteria. The evaluation of the criteria is "based upon a subjective evaluation by the Government of the quality of the contractor's performance, judged in light of criteria set forth in the contract."[3] There is often some reluctance on the part of contractors to place their success or failure upon the Government's subjective discretion.

The competitive parallel development approach respresents an attempt by the Government to eliminate the practice of contractor buying-in. In this scenario the contractor bids unreasonably low to gain a competitive advantage for the lucrative production phase. Parallel development attempts to eliminate this advantage by attempting to ensure more than one competitor for the initial production buy.

While these techniques show much promise they do not relate to those areas in which sole-source procurement is the only manner available to the Government. Since a significant portion of Government contracting for major weapon systems involves the use of sole source contracts it is an area that requires intensive cost monitoring. Thus, risk must be controlled in an environment in which there is but a single source from which to procure the system. An ancillary consideration relates to the urgency of requirement. There are specific cases in which hindsight provides 20/20 vision as to the lack of competency of selected contractors. Time considerations related to national security do not allow for a requalification of a competitive source, nor does a budget already satiated with cost

growth provide funding for the parallel source qualification.

In cases involving sole source acquisition it is extremely important to encourage efficient management by those contractors with whom you are committed to the production of a finished product. The most practical means of encouraging this managerial skill is through the time-tested use of carrot and stick. By offering the contractor the opportunity to increase profit for cost reduction, the BMO has fallen back upon time tested tenets of capitalism.

CASE STUDY - MX/PEACEKEEPER MISSILE

BMO entered the Full Scale Engineering Development Phase in September of 1979. The propulsion contracts for system definition contained a series of options, the last of which expired in March 1979. The option for Full Scale Engineering Development was extended through December of that year with the provision for an equitable adjustment to be negotiated upon option exercise.

The failure of the Government to exercise an option that had been agreed upon by both parties was not the result of bureaucratic incompetence. It was, rather, a product of the democratic system of checks and balances. This is to say that the inability of the Air Force to exercise the option was a direct consequence of Congressional indecisiveness. The interaction between the Executive and Legislative branches of Government is often a cause for decision-making delay and "unnecessary" weapon system costs. In this instance the cost and schedule implications to the overall program proved to have significant cost impact. This lack of consistency is merely one example of the risk that a Defense Contractor must face when dealing with the Government. In some cases it is the cause of contingency costing in proposal preparation for major weapon systems. Without a measure of stability it is impractical for contractors to presume any long-term committments.

What then can be done to reduce program risk to the contractor? There are several avenues by which we may accomplish this risk reduction. One method is to fund these programs sufficently to allow for each and every contingency that might possibly arise. In a time of limited budgets this solution finds little support among the tax paying public, nor with responsible management in the DoD.

While the risk involved in Research and Development may be technical, schedule or cost, most public information relates to cost overruns without identifying the relationship between the three. This may produce a distorted view of reality, particularly on the part of the public. Too often, the underlying causes of the cost overruns are not properly identified. In some instances the Government has failed to assume responsibility for changes in technical requirements, quantities or schedule fluctuations. Many of these changes are not related to DOD mismanagement but rather to structural or systematic inequities - for example congressional funding limitations. Nonetheless, they represent a significant degree of risk to any contractor who must estimate the needs of his program. It is unusual to find a contractor who would sacrifice the profits of his company for the greater good of the nation. It is unreasonable to expect such behavior from any profit-oriented segment of society. It is apparent that a program manager would get but one chance at such behavior prior to receipt of his termination notification.

How then, does the Government propose to encourage cost-effective management by contractors while ensuring that they are not expected to assume an inequitable share of the risk? The fixed-price contracting for Full Scale Engineering Development of the Peacekeeper Missile system is an illustration of one such method for accomplishing this goal.

As we noted, traditional contracting philosophy would dictate a cost-type contract for the development of a system such as the Peacekeeper. The initial FSED procurement of the four stages was accomplished in a Cost-Plus-Incentive-Fee manner. The contract strategy for the follow-on FSED acquisition originally proposed a Cost-Plus-Incentive-Fee type contract. The Air Force Systems Command approved this strategy, albeit reluctantly.

It was only after a comprehensive re-evaluation of the acquisition strategy that the Program Manager, Contracting Officer and Project Officer developed the concept of a Fixed-Price protective type of contract. This contract provided for the contractor to work in a Fixed Price contract environment while simultaneously protecting him from situations which were beyond his control, i.e. catestrophic failure of heretofore untested flight equipment. The BMO was able to accomplish this by taking a flexible attitude toward special provisions, contract line items and overhead liabilities.

The Contractors each expressed significant concern over their specific technical responsibilities. The Stage IV Propellant Storage Assembly (PSA), the Stage III

Extendible Nozzle Exit Cone (ENEC) and the Stage II Case Fabrication were all legitimate concerns that represented potentially severe technical risk to the respective contractors.

Additional concerns associated with fixed price contracting in the R&D environment were presented to BMO during the negotiation process, included in these were: Negative cash flow, fee structure, open ended task requirements in the Statement of Work and schedule instability. These concerns were attibutable in large measure to the change from cost to fixed-price incentive contracting. They were ultimately resolved through negotiated compromise.

The incorporation of special provisions allowing for business base adjustment for program cancellation, special contract close-out cost approval, and risk of loss were instrumental in assuaging the contractor's fears of Government unreliability. The most potent factor in convincing the contractors of the Government's committment to a reasonable agreement was the "Design Provision". This provision provided for contractual relief for changes which might surface subsequent to the Government's acceptance of the First Qualification Test Unit.

Not all subsystems of the Peacekeeper were determined to be sufficiently well defined to allow for this type of contracting - guidance and control for example. These contracts were negotiated in the cost type environment. It is nonetheless important to recognize that there are specific circumstances in R&D contracting which are amenable to this fixed-price protective approach.

CONCLUSION

The attractiveness of a fixed-price contract to the Government may be attributed to two principle features: 1.) The ceiling price, wherein the contract becomes a Firm-Fixed Price type and all costs must be assumed by the contractor, and 2.) The requirement that the contractor deliver a finished end item rather than merely a best effort.

To a Contractor, the fixed-price contract requires the Government to provide firm specifications and ensures that changes are not initiated without the Government's accepting full responsibility for any increased cost. This should alleviate the prospensity to tinker with weapon system requirements. Too often such tinkering removes the weapon system from the veil of proper Congressional overview. The fixed-price contract helps to ensure visibility for these changes - both to Congress, DoD and the American public.

In a time of increasing resentment toward the large Defense budget it is essential that the perception of an incompetent and ineffectual acquisition system be eliminated. There is a willingness on the part of the American public to support a strong national security apparatus. It is imperative that the message be delivered that the Department of Defense is indeed working to increase the effectiveness of the Acquisition process and encourage cost-effective, responsible behavior from those with whom it conducts billions of dollars of business each year.

FOOTNOTES

1. Department of Defense Directive (DODD) 5000.1, dated March 29, 1982, pg 6.
2. Ibid, pg 6.
3. Defense Acquisition Regulation (DAR), Section 3-405.5, pg 3:40.

ADP002758

AN ANALYSIS OF THE ACQUISITION STRATEGY DECISION PROCESS ALONG THREE DIMENSIONS OF THE ACQUISITION IMPROVEMENT PROGRAM

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ABSTRACT

This study investigates the acquisition strategy decision process as it relates to the major themes of the Acquisition Improvement Program (AIP). Further, it examines a wide spectrum of acquisition strategy variables that draw on management, program, contracting, and industry considerations.

Data on acquisition strategies (AS), contracting techniques, and program attributes was collected across multiple programs, varying in complexity and acquisition stage. The data was correlated and experimentally manipulated by means of covariance analysis.

The study isolated variables critical to the AS decision process, defined their causal relationships, and produced a causal model.

Findings support the notion that a program's effect on the industrial base, readiness/sustainability, and cost can be pre-determined from a specific number of program factors. Further, their effects can be enhanced or otherwise altered by a few, key AS approaches/factors.

The findings also suggest that programs with limited competition at the subsystem level fare better than those predicted on the extremes of either open competition with component breakout or restricted to a sole source at the systems level; that a moderate, middle-of-the-road AS approach is more effective for most programs.

INTRODUCTION

This study attempts a systematic investigation of the acquisition strategy decision process, along with acquisition strategies, from the context of the Acquisition Improvement Program.

Many papers addressing second sourcing and the acquisition strategy decision process have recently been published as an adjunct to the Carlucci Initiatives and subsequent Acquisition Improvement Program. Many of the papers have advanced methodologies and/or functional tools for determining program specific acquisition strategies that range from flowcharts to matrices and even include computer models or programs. Though many of these methodologies are innovative, they have little or no scientific foundation, and therefore lack validity. Rather than being the product of systematic investigation, they are extensions of other non-scientific inquiries entailing nothing more than descriptive compilations of literature searches, uncontrolled observations, and jaundiced suppositions and conjectures. Very few studies go beyond the descriptive or exploratory phases; those that do, have very little external validity.

LITERATURE REVIEW

The current acquisition decision process involves the application of a judgemental methodology by the acquisition manager to various subjective and objective inputs to arrive at an inductive determination of an appropriate acquisition strategy for his/her program. The cornerstone of this process is the judgemental criteria used by the manager to select both the inputs and decision methodology. Notwithstanding the use of comprehensive inputs and sophisticated methodologies, in final analysis, the decision process is judgemental, and therefore difficult to quantify.

Based on a literature review, acquisition strategies fall into two antithetic categories, sole source and second sourcing, as illustrated by Figure 1.

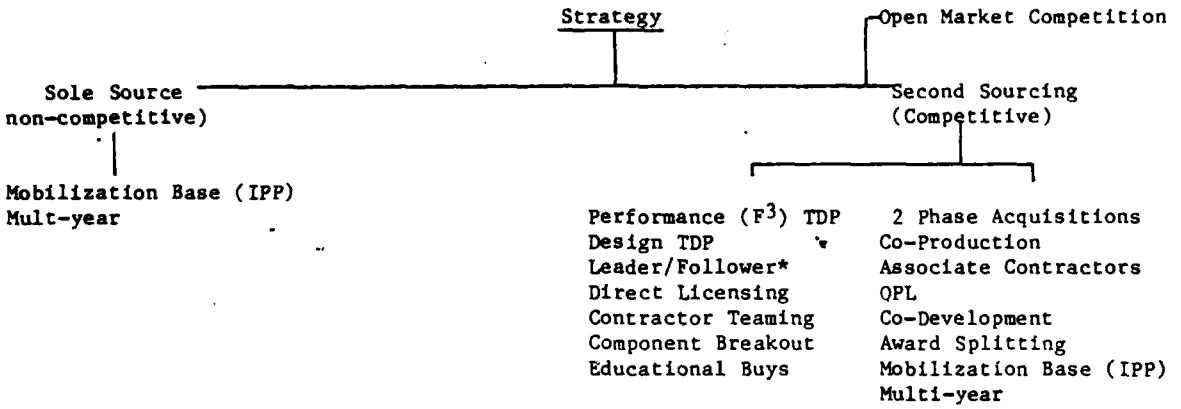
Second sourcing may be defined as a group of techniques and strategies designed to dilute a sole source, monopolistic position by introducing competition. However, not every item or system lends itself to second sourcing. The relative advantages and disadvantages of second sourcing must first be weighed by systematic analysis of all the factors/parameters affecting an item or system.

There are two excellent descriptive analyses of the second sourcing process currently available. One offers a systematic approach to assess if an item or system lends itself to second sourcing. 131. The other provides an excellent decision matrix (which is an adjusted version of a Navy model) for determining which second sourcing strategies are appropriate for a given system and situation 141.

These two studies purport a case-by-case judgemental determination of program acquisition strategies that gives consideration to program objective, system characteristics, acquisition characteristics, contractor/industry characteristics, and the advantages/disadvantages of specific second sourcing techniques or strategies. Further, because of the diversity of programs within DoD, in terms of technical complexity and state-of-the-art technology, it appears that no one acquisition strategy should be applied as a standard.

Figure 1

Acquisition Strategies



Selection of an acquisition strategy can also be viewed in the context of the Acquisition Improvement Program which may be reduced to the following three themes or dimensions: (1) strengthening the industrial base; (2) improveing readiness and sustainability; and (3) increasing cost effectiveness 111. Presently there are no systematic studies available that examine acquisition strategies in terms of the major themes of the Acquisition Improvement Program.

To fully understand the acquisition strategy decision process, there is a need for a systematic study that links acquisition strategies to the Acquisition Improvement Program through an examination of acquisition management, system/program factors, and acquisition/industrial parameters.

PURPOSE/OBJECTIVES

This study has a multifold purpose:

(i) to perform a multivariate analysis of acquisition strategies/techniques (across multiple programs and acquisition stages) and to determine their impact on the following three acquisition improvement dimensions: (1) strengthening the industrial base, (2) improving readiness and sustainability, and (3) increasing cost effectiveness;

(ii) to establish a scientific baseline (based on systematic investigation) that defines the complex causal relationships among a wide-spectrum of acquisition variables; and

(iii) to culminate the above through both the identification of effective and innovative acquisition strategies/techniques or combination thereof to be used as a basis for the development of valid and reliable acquisition strategy decision tools (e.g. matrices, flowcharts, computer programs).

- STUDY METHODOLOGY

The study methodology employed includes the following sequential research designs:

Phase I entailed an exploratory study, including preliminary analysis, of current literature, research reports, program case histories, and unstructured interviews with other commands. This phase was conducted to determine applicable study variables, their definitions, and an appropriate research instrument and design for a formal study (Phase II).

Under Phase II, acquisition managers were surveyed for data on acquisition strategies/techniques and program attributes/characteristics across multiple programs varying in complexity and acquisition stage (life cycle phase). The survey was predicated on non-probability sampling. The specifics are outlined below.

1. Research Instrument - questionnaire
2. Population - acquisition managers
3. Sampling Units - respondents with knowledge of acquisition programs, strategies
4. Sub-population - Army ordnance acquisition managers
5. Sampling Elements - project managers, development project officers, and contracting officers
6. Variables -
   a. acquisition strategies
   b. acquisition improvement program dimensions

c. ordnance programs and program objectives

d. program attributes - system, acquisition

The modes of data analysis employed included the following techniques:

1. descriptive statistics,
2. Pearson Product Moment Correlations, and
3. variance analysis.

Giving consideration to the generalization of study findings to other populations, ordnance programs (which vary in complexity from nuclear weapons, rocket and missile warheads to conventional ammunition) were selected as a cross-representation of DoD programs. To ensure inter-rater reliability, three groups of respondents were sampled. These groups were selected based on the following two assumptions: (1) they have intimate program familiarity and (2) normally participate in the acquisition strategy decision process. A questionnaire with 57 items was devised with Lickert-scaled item-response categories. The questionnaire was subjected to a limited inter-item reliability pretest, and a 90% confidence level results. Path analysis and the elaboration model were selected as modes of analysis to eliminate the problems of "directionality" and the "third variable" so frequently experienced in correlation research.

CONCEPTUALIZATIONS

For the purpose of this study, the following definitions apply:

Viability. A positive measurement of the sum of effectual relationships (if any) of an acquisition strategy along three acquisition dimensions.

Acquisition Strategies/Techniques. Includes the following list:

Scopes of Work	Qualified Products List
Performance (F^3) TPD	Co-Development
Design TDP	Award Splitting
Leader/Follower	Mobilization Base (IPP)
Direct Licensing	Multi-Year
Contractor Teaming	Warranties
Component Breakout	Economic Price Adjustment
Educational Buys	GOGO/GOCO Lap
2-Phase Acquisition	COCO Lap
Co-Production	Open Market Competition
Associate Contractors	
Pre-Production Evaluations	

Acquisition Dimensions. Based on an empirical factor analysis of the literature, interviews, and contractual case histories, the following categories were developed:

1. strengthens the industrial base,
2. improves readiness and sustainability, and
3. increases cost effectiveness.

Though program stability is an additional major dimension, it is interpreted as a consequence of congressional commitment in terms of funding which is requisite to long term planning and improved program execution, continuous economic production rates, industrial preparedness planning, and multi-year contracting considerations. Consequently, it was not addressed as part of this study.

Variables. Based on Phase I findings, each acquisition dimension was further subcategorized by its functional characteristics (measures) along with a trinomial attribute scale. The attributes were precoded in terms of their effect on the relationship between the variable and its respective dimension(s).

Research Propositions. The a priori proposition of this research was (i) that acquisition strategies must be determined on a case-by-case basis due to the wide spectrum of DoD items/systems, and (ii) that such determinations involve consideration of a multitude of factors encompassing the following:

a. program objectives,

b. item/system characteristics (e.g. technical complexity, state-of-the-art, technology transfers, capital investment requirements, etc.),

c. acquisition characteristics (e.g. competitive savings, production quantities, program stability and duration, logistics, etc.), and

d. industrial base characteristics (e.g. production capabilities, availability of skilled/experienced manpower, degree of subcontracting, etc.).

Supporting Hypotheses.

a. There is a relationship between acquisition strategies, observed effects along acquisition dimensions, and program/item characteristics.

b. One or more of the relationships are causal.

DATA ANALYSIS AND FINDINGS

Approach: Table I (Appendix A) provides the variable list, their descriptions, and data types. A data file containing 57 variables

and 75 observations/cases was created. The data was subjected to the following types of statistical analyses: descriptive statistics, Pearson Product Moment Correlation, and Covariance Analysis.

Descriptive Statistics: An ordnance program profile was devised by variable and frequency of response. Generally, ordnance programs appeared to vary in terms of type, size, and complexity. Most of the ordnance programs appeared to be in advance development or production; design TDPs were preferred; and more than half of the acquisition strategies were competitive. Only 30% of the programs employed second sourcing techniques, with a preference towards component breakout. The program that employed contractor teaming had the highest viability score. Most contracting was at the systems level (Work Breakdown Structure - Level 1). Further, ordnance acquisition strategies rarely underwent any major changes from the original strategy.

Some peculiarities were noted in the response frequencies that ran across both the subpopulations and program types. In particular, performance reliability requirements were never low; and the following variables were never "not applicable": degree of design innovation, need for specialized skills/talents, state-of-the-art, item complexity, degree of technical risk, availability of funds, and amount of subcontracting. These peculiarities suggest that either the raters (PMs, DPOs, & PCOs) were biased (in the same direction) or that these variables were applicable to all programs and represent constant program characteristics.

Correlations: Tables II A through II C (Appendix C) provide excerpts from the original correlation matrix which was too lengthy for inclusion.

As the result of correlation analysis, the a priori research proposition and supporting hypothesis, as previously stated, were reduced to the following symbols and variables:

LET:

Symbol	Description	Variables
A	Program Characteristics	2, 3, 22, 14, 24, 32, 42, 19
B	Program Stage	3
C	Acquisition Strategies	4 thru 11
V	Program Effects/Viability (which is the sum of X Y, & Z)	20, 31, 42
X	Strengthens Industrial Base	20, 19, 15, 41, 16, 18, 12, 13, 17
Y	Improves Readiness & Sustainability	31, 39, 36, 52, 34, 29, 41, 30, 20, 48, 16
Z	Increases Cost Effectiveness	52, 50, 46, 53, 44, 45, 47, 55
D	Availability of Funds	27

(Because variables 20, 31 & 52 had the highest correlations in their respective variable sets, they were used as proxy variables to represent X, Y & Z).

Symbol	*Proposition*
P_1	Acquisition strategies (C) must be determined on a case-by-case basis due to the wide spectrum of DoD systems/programs (Variable 2).
P_2	Acquisition strategies (C) involve a multitude of factors/program characteristics (A) that encompass program objectives, item/system characteristics, acquisition characteristics, and industrial base characteristics.
P_3	There is a relationship between acquisition strategies (C), observed program effects along acquisition dimensions (V), and program characteristics (A).
P_4	One or more of the relationships are causal.

The above propositions were represented by the following anticipated causal model:

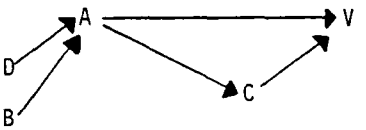


Figure 3 displays correlational support for the above propositions at a .05 significance level for a two-tailed test. (r values under .232 equal a .10 significance level).

Covariance Analysis: The data was processed by a program designed to compute analysis-of-covariance information for a one analysis-of-variance variable with multiple covariates and unequal treatment group sizes. Cases were specified as being in certain treatment groups based on each value of the treatment variables listed below:

Treatment (C Variable)	Covariates (A Variable)	Dependent (V Variable)
2-11	14, 24, 19	20
2-11	22, 24, 32, 42, 19	31
2-11	22, 32, 42, 19	52
5	55	17
5	2, 3, 55	44
5	2, 3, 55	45
6	2	31
7	39, 27	20
5	39	20

For each treatment, a control group was used that represented the population means for each attribute of the applicable dependent variable and covariate.

The program output included the variable means for each treatment group; and analysis-of-covariance table which included the degrees of freedom and the F-ratio; between group, within group and total treatment regression coefficient tables with standard errors and t-values; and a table of adjusted means and their standard errors. The statistical model employed by the program is provided below:

$$Y_{ij} = \mu + \alpha_i + \beta_1 (X_{ij1} - X_{i.1}) + \cdots + \beta_p (X_{ijp} - X_{i.p}) + e_{ij}$$

Notation:

X_{ijk} (k^{th} covariate), $YijU = X_{ij(p+1)}$ (Variate)

i = 1, 2, ..., t	(Treatment groups)
j = 1, 2, ..., n_i	(Sample size of the i^{th} treatment group)
k = 1, 2, ..., p	(Covariates)
m = 1, 2, ..., p	(Covariates)
a = 1, 2, ..., p+1	(Covariates +1 variate)
b = 1, 2, ..., p+1	(Covariates +1 variate)

The null hypothesis (H_0 = there was no difference among treatments after adjusting for covariance) was rejected when the F-ratio had a significance level of .10 or less and the t-values were at a significance level of .10 or less. Treatments that resulted in rejection of the null hypothesis are graphically represented in Appendix B.

DISCUSSION

This research explored numerous program and acquisition strategy variables and assessed their effect in terms of the major themes of the Acquisition Improvement Program. A number of program/acquisition characteristics involved in this AIP related process were statistically isolated as critical causal, intervening, and dependent factors, as summarized below:

Causal Factors:

1. Program Characteristics
   a. State-of-the-art
   b. Need for specialized skills/talents
   c. Amount of qualification testing
   d. Difficulty in achieving product quality
2. Acquisition Life Cycle/Program Stage
3. Planned Production Quantitites

Intervening Causal Factors:

1. Acquisition Strategy Characteristics
   a. Acquisition strategy category
   b. Second sourcing techniques
   c. Multi-year
2. Contracting Characteristics
   a. Type of technical data package
   b. Type of contract
   c. Level of item on contract (system, subsystem, component)
   d. Special contract provisions (PPEs, award splitting)
3. Availability of Funds

Figure 3

Correlation Support for Propositions

Proposition	Related Variables/Pearson r	
P_1	Variable 2 to C Variable = 3/.4796 & 5/.3310	
P_2	C Variable	to A Variable/Pearson r
	4	42/-.3702, 3/-.3506
	5	2/.3310, 3/.2666
	6	2/-.2083
	7	32/.2874, 22/.2606, 19/2533
	8	3/.2370
	9	3/.3689
	10	3/.3560
	11	27/-.2884, 35/-.3388
P_3	C Variable	to V Variable/Pearson r
	4	52/-.3665
	5	45/.7895, 44/.5239, 55/-3711, 16/-.2548
	6	47/.5443, 31/.2854
	7	34/.2442, 46/.2349
	8	15/.2524, 36/.2355
	9	34/.2275, 16/.3271
	10	44/-4104, 47/.3632, 55/.3309, 33/.3346, 17/.3218
	11	50/-.2702, 13/.2191, 18/.2126, 46/.2192, 16/-.3387

Dependent Factors:

1. Industrial Base Characteristics
   a. Contractor productivity
   b. Contractor capital investment
   c. Amount of Subcontracting

2. Readiness & Sustainability
   a. Length of production cycle
   b. Length of fielding and support

3. Cost Effectiveness
   a. Qualification testing cost
   b. Technical/design competition
   c. Price/cost competition
   d. Cost of ownership

(These variables should be included in any causal models/tools designed to determine program specific acquisition strategies.)

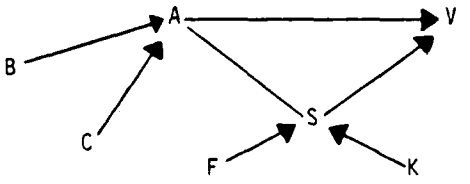
The following relationships were also statistically confirmed and experiementally defined through covariance analysis:

1. Acquisition strategies are program specific.

2. Acquisition strategies are related to numerous factors that include program characteristics, acquisition characteristics and industrial base characteristics.

3. There is a relationship between acquisition strategies, observed program effects along acquisition dimensions (AIP), and program characteristics.

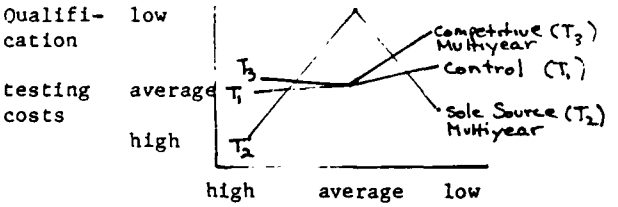
4. The relationships are causal and are represented by the following causal model:



A = Program characteristics
B = Life cycle phase
C = Planned Production Quantities
S = Acquisition strategy
K = Contracting techniques
V = Program effects/viability
F = Fund Availability

Both the research design and variable types were mixed. Mixed designs permit the researcher to simultaneously obtain both correlational and experiemental evidence as two separable main sources of variability on a given measure. Further, they permit both the generality of experiemental findings and limitations by providing error variance as a measure of the sensitivity of the test (reduced error variance increases sensitivity). 121

This study's mixed design permitted examination of program effects as a function of program characteristics and various acquisition strategies. Program characteristics served as the correlation variables while acquisition strategies were the experimentally manipulated or treatment variables. For example, in a simple case (a 2x3 factorial design), measures of program viability (such as qualification testing cost) were divided by three degrees of a particular program characteristic (such as the need for specialized/skilled talents) and then assigned to an acquisition strategy treatment variable (such as multi-year which can be either competitive or sole source). The results may be graphically displayed as follows:



Need for Specialized/Skilled Talents

From the above graph, it can be seen that the introduction of competitive multi-year reduces qualification costs only when the need for specialized/skilled talents is either high or low.

Appendix B provides the graphical representations of the significant variable interactions when various acquisition strategy factors are introduced.

The findings suggested that AS is a function of the program stage; that what is best (in terms of the AIP) for the earlier stages is incompatible with what is best for production; that at 6.3, sole sourcing is best; and that at 6.5 and on, competition is best. Based on the foregoing, the following questions are generated: Should the AS be taylored to a particular phase or the program objective (namely, production)? Can two incompatible ASs coexist, with one subordinate to the other? If competitive production is the objective, should competition be introduced early in the R&D phases and maintained through development?

Competition's positive benefits, in terms of the AIP, were demonstrated only under the following causal conditions: 1) low difficulty in achieving product quality; 2) low or high need for specialized/skilled talents; 3) minimum to average item complexity; and 4) minimum qualification testing.

Strengthening the industrial base (X_{20}) positively correlated to improved readiness/sustainability (X_{31}) and increased cost effectiveness (X_{52}). However, examination of the scales used for the above variables revealed that the

direction of the scaling attributes for X_{20} was inverse to those for X_{31} and X_{52}, creating the effect of a positive relationship when, indeed, it was inverse/negative. Further, the findings indicated that when contractor productivity was high reflecting a strong industrial base, the production cycles were long and qualification testing costs were high. But high qualification testing costs and long production cycles do not reflect increased cost effectiveness and improved readiness/sustainability, respectively. Thus, it appears that what strengthens the industrial base is not necessarily compatible with either increased cost effectiveness or improved readiness and sustainability.

The main viability score for the entire population was 64.72; the maximum score was 102 (contractor teaming); and the minimum score was 32 (sole source). The top fifteen scores are presented in Figure 4 by rank, program type, stage, and AS. It should be noted that there is a 10 point spread between the highest score and the next highest.

Cost/price Competition (X_{45} had a .0000 correlation to qualification testing costs (X_{52}) and failed to correlate any higher than -.1687 (cost growths/overruns - X_{51}) to any of the other cost measures (X_{45} - X_{53}). However, X_{45} had a .5015 correlation to technical/design competition (X_{44}) and X_{44} had its strongest correlation to contract type (X_{47}). These findings suggest that increased cost effectiveness may in fact be a process akin to contract type (or the amount of cost responsibility assumed by the contractor) rather than competition itself, with maximum cost effectiveness being realized when a FFP contract is used in conjunction with competition.

A key variable common to strengthening the industrial base (X_{20}), improved readiness/sustainability, (X_{31}), and increased cost effectiveness (X_{52}) is production quantities (X_{39}) as indicated by the following correlations:

	X_{20}	X_{31}	X_{52}
X_{39}	.3992	.3944	.3193

X_{39} also has a correlation of .4256 to contractor capital investment (X_{12}). During the experimental introduction of various AS variables, it was noted that multi-year (X_7) and mobilization base (X_8) dramatically increased X_{39} relationship to X_{20}, X_{31} and X_{52}. However, the introduction of competition had little effect on the original relationships. But, when a FFP type contract was introduced, the relationships were strengthened.

These findings suggest that ASs, such as X_7 or X_8, serve to ensure stable, long-term production quantities; that competition in itself has no effect because the quantities are not necessarily long-term; that when such second sourcing techniques as component breakout are employed, they have a tendency to reduce the quantities per contract. Whereas, under sole source-systems contracting, increased cost effectiveness is lost through the monopolistic pricing of the sole source. However, competition employed at the subsystem or system level, in conjunction with multi-year/mobilization base (& a FFP Contract) supports large, long-term, and stable production quantities which in turn, strengthens all three AIP themes Unfortunately, the group sizes for the various attribute combinations on variables X_6, X_7 & X_8 were too small to render the findings significant.

Figure 4

Score	Program Type	Program Stage	TDP	AS
102	Weapon Sys	6.3	SOW	Contractor Teaming
92	Ammunition	6.4	SOW	Sole Source
85	Weapon Sys	6.4	Design	Competitive
84	Bio/Chemical Sys	6.5	Design	Competitive Multi-year
80	Bio/Chemical Sys	6.3	SOW	Leader/follower, Multi-year, Mob-base
80	Bio/Chemical Sys	6.2	F3	Sole Source
79	Weapon Sys	6.3	SOW	Competitive
78	Bio/Chemical Sys	6.2	F3	Competitive
78	Mine	6.6	Design	Component Breakout
78	Mine	6.3	SOW	Competitive
77	Mine	6.6	Design	Component Breakout
77	Nuclear Projectile	6.5	Design	Competitive Multi-year (Two-phase)
77	Weapon System	6.5	Design	Competitive Multi-year
77	Bio/Chemical Sys	6.4	SOW	Co-development, award sp
76	Weapon System	6.6	SOW	Co-production, award splitting

It was also noted that some critical program characteristics such as design innovation or item complexity were unaffected by various AS factors. An explanation for this anomoly may be that these factors represent critical program constants, inherent to all programs, regardless of type.

Conclusions

As defined by the major themes of the AIP, a viable AS can be determined as a function of the following key variables, to be used in conjunction with their graphs provided in Appendix B.

AS	Key Variables
1. Type of TDP (X_4)	X_{19}, X_{24}, X_{42}
2. AS Category (X_5) (Sole Source Competition)	X_{19}, X_{24}, X_{39} X_{42}
3. Second Sourcing (X_6	X_2, X_3, X_{42}, X_{39}, X_{47} (X_{21} & X_{23})
4. Multi-year (X_7)	X_{19}, X_{22}, X_{39}
5. Mobilization Base (X_8)	X_{32}, X_{39}
6. Type of Contract (X_{47})	X_3, X_{22}
7. Level of Item on Contract (X_{55})	X_3, X_5

Conflicts that exist in the graphic recommendations can be resolved merely by prioritizing the desired dependent measure and/or the conflicting causal variables. Again, such program characteristics as design innovation or item complexity are not being rendered non-critical, but are merely being represented by an associated proxy variable, such as state-of-the-art, which is more subject to AS influences. Lastly, to ensure generability of the above findings and conclusions, it is desired to repeat the study using other populations such as MICOM's, CECOM's, and TECOM's.

References

[1] Deputy Secretary of Defense Memorandum

[2] Subject: Guidance on the Acquisition Improvement Program. 8 Jun 83.

[3] Shipmen, Robert, MAJ, USAF. Establishing a Second Source in Production. Army Logistics Management Center. May 81.

[4] Williams, William B. Guidelines for the Application of Competition. Army Procurement Research Office. Jun 82

Appendix A
TABLE I
RESEARCH VARIABLES

VARIABLE TYPE	IDENTIFICATION	VAR. NO.	DATA TYPE
I. Independent	Rater Subpopulation	1	Nominal
	Type of Program	2	Nominal
	Program Stage	3	Ordinal
	Type of Technical Data Package	4	Nominal
	Acquisition Strategy Category	5	Nominal
	Second Sourcing Technique	6	Nominal
	Multiyear	7	Nominal
	Surge/Industrial Preparedness Planning	8	Nominal
	Miscellaneous Procurement Techniques	9	Nominal
	LAP (GOGO/GOCO/COCO)	10	Nominal
	WBS Leval of Item on Contract	55	Nominal
	Strategy Changes	11	Ordinal
II. Dependent	Degree of Contractor Capital Investment	12	Ordinal
	Degree of Gov't Facility Investment	13	Ordinal
	Degree of Design Innovation	14	Ordinal
	Degree of Manufacturing Innovation	15	Ordinal
	Degree of Subcontracting	16	Ordinal
	Degree of Small Business Set-asides	17	Ordinal
	Degree of Skilled Manpower	18	Ordinal
	Degree of Difficulty in Achieving Product Quality	19	Ordinal
	Productivity Curve Position	20	Ordinal
	Degree of Proprietary Data	21	Ordinal
	Need for Specialized Skills/Talents	22	Ordinal

Technical Transferrability	23	Ordinal
State-of-the-Art	24	Ordinal
Degree that Industrial Base is Stregthened	25	Ordinal
Length of Production Cycle	26	Ordinal
Degree of Fund Availability	27	Ordinal
Degree of Critical/Scarce Materials	28	Ordinal
Length of Production Lead Time	29	Ordinal
Length of Acquisition Cycle	30	Ordinal
Length of Production Cycle Including Long Lead Time	31	Ordinal
Degree of Item Complexity	32	Ordinal
Degree of Item Use in the Field	34	Ordinal
Length of Fielding & Support	34	Ordinal
Degree that Item Requires Support	35	Ordinal
Cost of Gov't Ownership (operational, maintenance, & support)	36	Ordinal
Extent of Performance Reliability Requirements	37	Ordinal
Extent of Compatibility & Interchangeability	38	Ordinal
Requirements Size of Production Quantity	39	Ordinal
Extent of Gov't Surve/IPP Requirements	40	Ordinal
Degree of Contractor Surge/Mobilization Capability	41	Ordinal
Degree of Qualification Testing	42	Ordinal
Degree that Readiness & Sustainability is Improved	43	Ordinal
Extent of Technical/Design Competition	44	Ordinal
Extent of Cost/Price Competition	45	Ordinal
Degree of Technical Risk	46	Ordinal
Type of Contract	47	Nominal
Learning Curve Slope	48	Ordinal
Degee of Administrative/Contractual Costs	49	Ordinal
Extent of Direct Material Buys in Economic Lots	50	Ordinal
Extent of Cost Growths/Overruns as Compared to Contract Price	51	Ratio
Degree of Qualification Testing Costs Compared to Contract Price	52	Ratio
Degree of Post-award Administrative Expense Compared to Contract Price	53	Ratio
Degree of Cost Effectiveness	54	Ordinal
Extent that Program is Viable	57	Ordinal

Appendix A
TABLE II A
INDEPENDENT VARIABLE CORRELATION SUMMARY

VAR 2		VAR 3		VAR 4		VAR 5		VAR 6	
3	-.4796	2	-.4796	3	-.3056	2	.3310	2	-.2083
5	.3310	4	-.3056	42	-.3702	3	-.2666	7	.2888
14	.3544	16	.5398	52	-.3665	44	.5239	47	.5443
20	-.3153	24	.4753	45	.7984	46	.2584		
24	-.3360	25	.4030	55	-.3711	31	.2584		
26	-.3436	26	.5039						
31	-.3637	44	-.6048						
41	-.3068	47	-.5751						
43	-.3169								
44	.3747								
45	.3514								
47	-.3603								

TABLE II B

RANKED CORRELATION COEFFICIENTS (Pearson r) GREATER THAN ±.4 BY INDEX

X (VAR 25)				Y (VAR 43)				Z (VAR 54)		V (VAR 57)			
VAR	r	VAR	r	VAR	r	VAR	r	VAR	r	VAR	r	VAR	r
20	.6024	34	.4323	31	.7464	40	.5217	52	.5988	43	.8953	29	.6061
24	.5951	13	.4101	34	.7018	54	.5131	31	.5561	25	.7947	50	.5443
19	.5673	50	.4377	39	.6973	25	.5038	53	.5424	54	.7436	42	.5440
15	.5327	34	.4323	26	.6907	38	.4984	50	.5404	31	.7420	36	.5072
54	.5276	13	.4101	29	.6284	35	.4409	25	.5276	34	.6885	15	.4837
22	.5154	17	.4045	36	.6278	50	.4255	43	.5131	52	.6671	40	.4603
43	.5038	3	.4030	41	.6157	12	.4164	34	.4836	26	.6595	30	.4411
52	.4713			52	.5904			41	.4654	41	.6443	38	.4222
41	.4604			42	.5576			20	.4553	20	.6410	24	.4220
31	.4580			30	.5563			29	.4552	39	.6205	19	.4090
50	.4580			20	.5238			26	.4501	32	.4042		

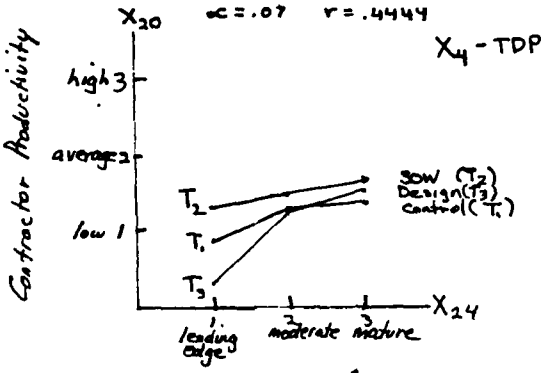
TABLE II C

DEPENDENT VARIABLE CORRELATION COEFFICIENTS (Pearson r)
GREATER THAN .4 FOR VARIABLES 12-24, 26-42 & 44-53

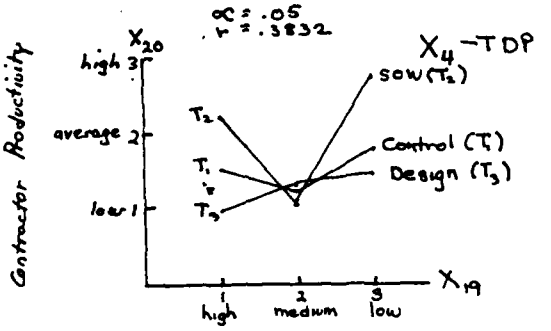
r = .7	r = .6	r = .5		r = .4	
5:45	3:44	3:16	36:52	3:24	30:42
26:31	22:32	3:26	39:41	10:44	31:36
29:31	26:29	3:47	44:45	12:39	34:36
40:41	39:40	5:44		16:47	24:39
		6:47		19:22	34:42
		14:24		20:24	34:50
		20:31		20:26	35:38
		20:34		20:41	36:42
		22:24		20:47	41:52
		22:46		20:48	42:46
		26:34		23:32	42:52
		26:52		23:49	44:55
		31:34		24:32	46:47
		31:52		24:46	46:52
		32:46		29:34	
		34:52		29:52	

Appendix B

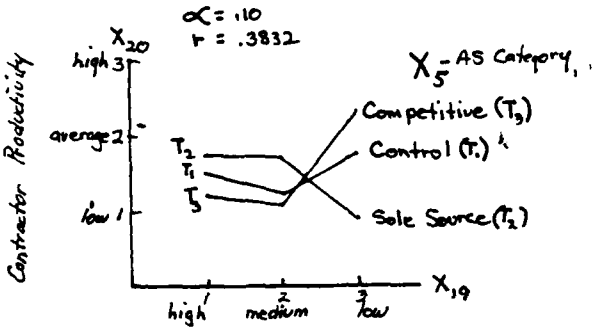
STRENGTHENING THE INDUSTRIAL BASE



State of the Art



Difficulty In Achieving Product Quality



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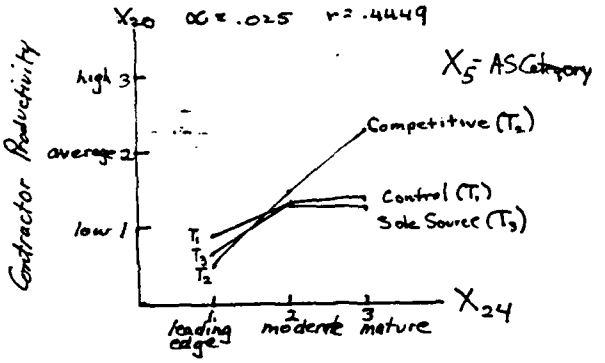

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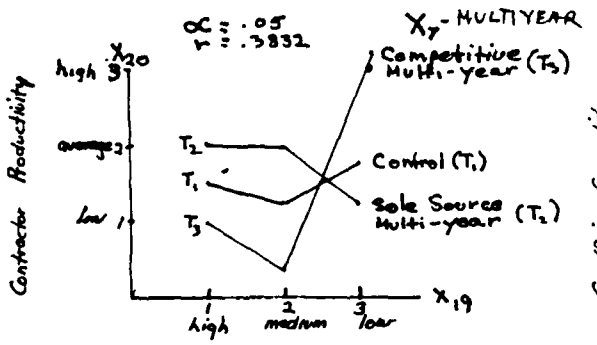

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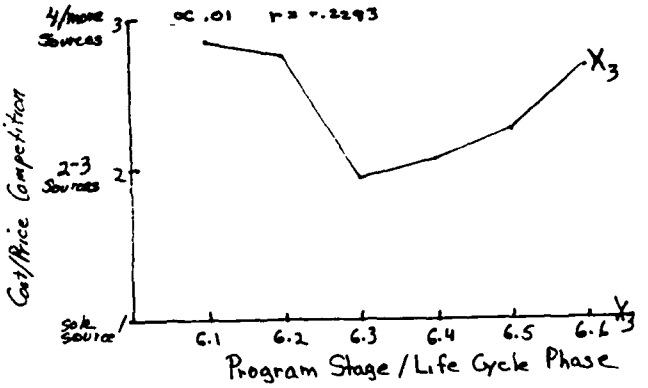
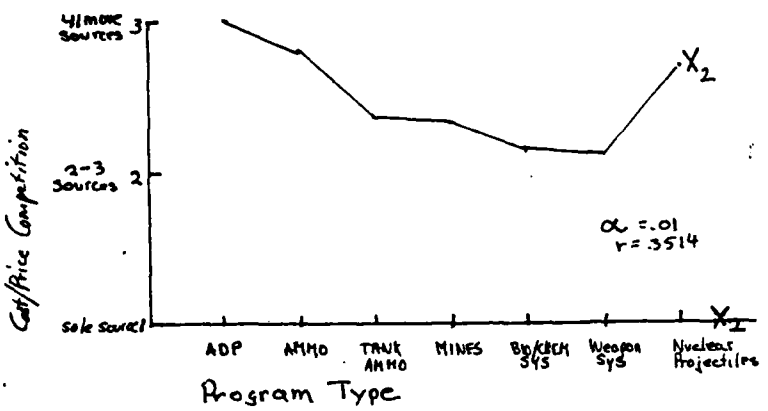


Program Stage / Life Cycle Phase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2-3 Sources 2
sole source 1
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X_1
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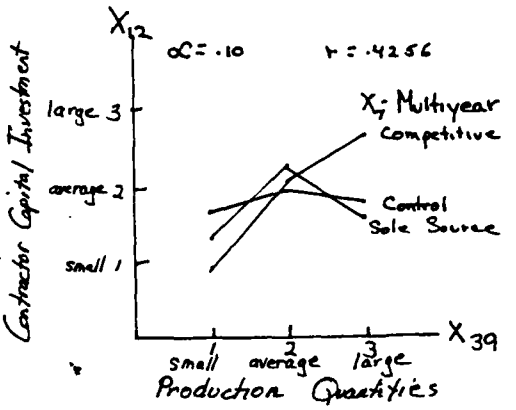
ADP
AMMO
TANK AMMO
MINES
Bg/Kech SYS
Weapon Sys
Nuclear Projectiles
Program Type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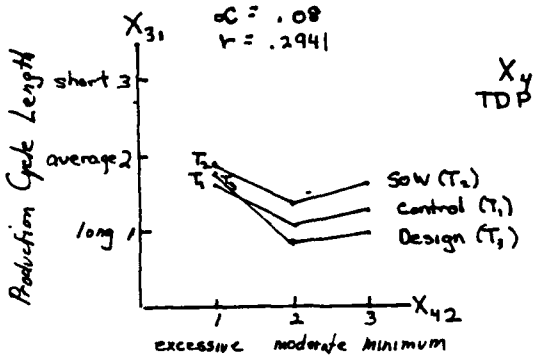
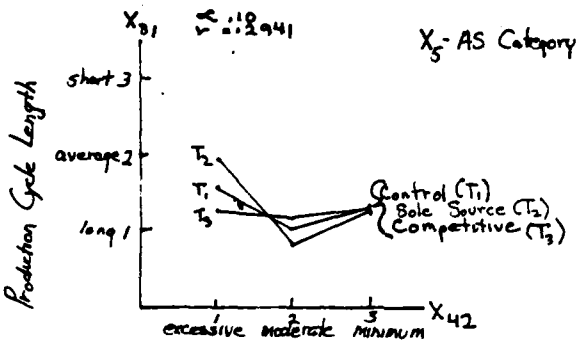
average 2
small 1
Contractor Capital Investment
X_7 Multiyear
competitive
Control
Sole Source
X_{39}
small
average
large
Production Quantities

Appendix B

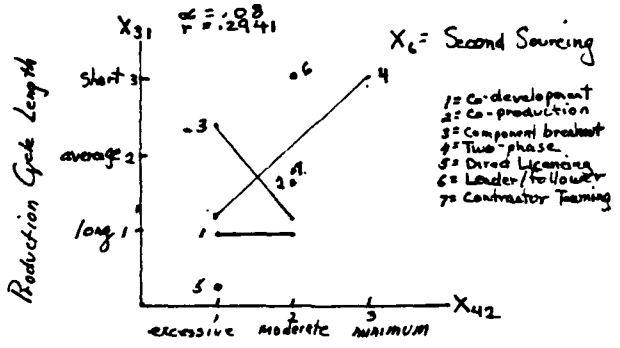
IMPROVED READINESS AND SUSTAINABILITY



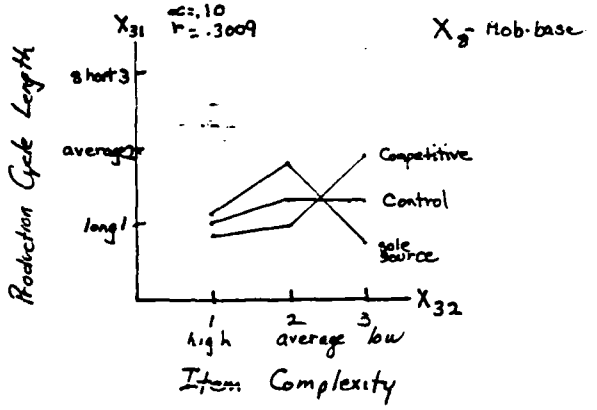
Qualification Testing



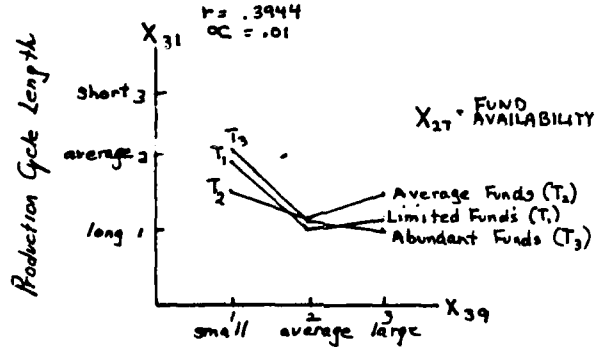
Qualification Testing



Qualification Testing



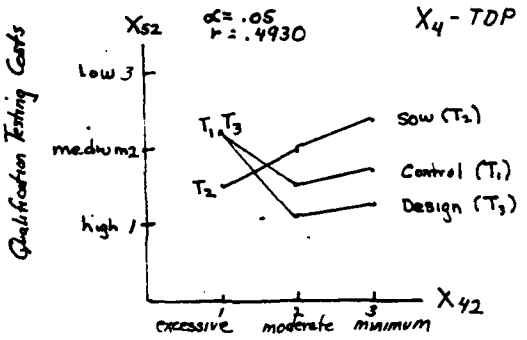
Item Complexity



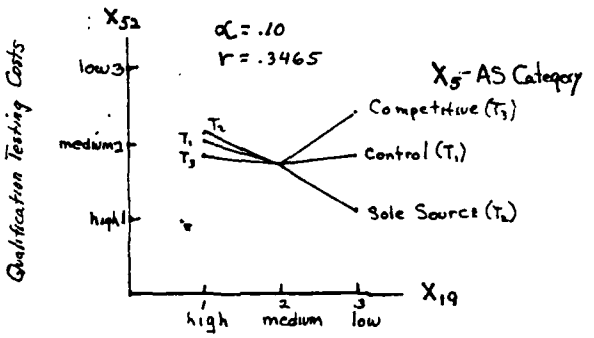
Production Quantities

Appendix B

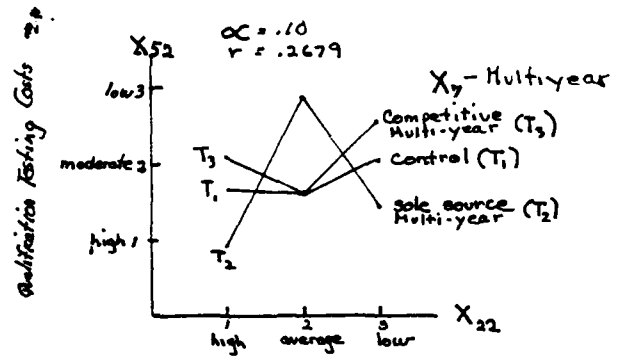
INCREASED COST EFFECTIVENESS



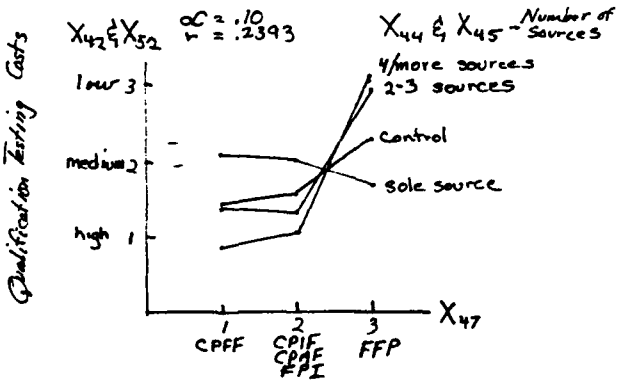
Qualification Testing



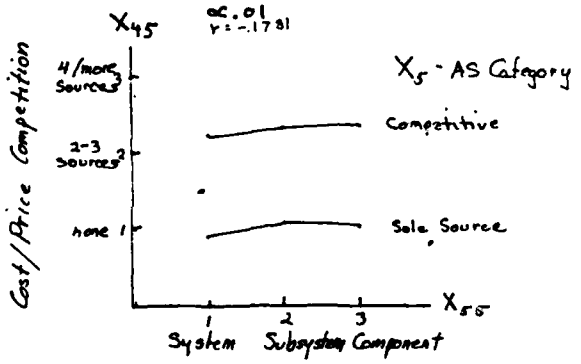
Difficulty In Achieving Product Quality



Need for Specialized / Skilled Talents



Contract Type



Level of Item On Contract

AD P002759

SKUNKWORKS 81 REVISITED - AN UPDATE ON ACQUISITION STRATEGY

Lt. Col. John E. Longhouser, Hq, United States Army

ABSTRACT

A paper on competitive prototyping was presented by Mr. William Stansberry, Deputy Product Manager for Armor Training Devices, at the Interservice Industry Conference in December 1981. That paper coined the phrase "Skunkworks 81," meaning a combination of the Skunkworks applied to earlier Air Force projects and competitive prototyping in full-scale development. The paper was well received and accurately reported the Conduct of Fire Trainer (COFT) development at that time. The promulgation of the well-trodden DOD Acquisition Initiatives and the much needed emphasis on streamlining the acquisition cycle provide reason for updating "Skunkworks 81." The author of this update, recently assigned as Product Manager for Armor Training Devices assesses the results of the COFT application of competitive prototyping and discusses the impact this acquisition strategy has had on transition from development to production for the largest procurement of a training simulator ever negotiated.

INTRODUCTION

In 1981, Mr. William Stansberry, Deputy Product Manager, Armor Training Devices, published a paper titled "Competitive Prototyping During Full Scale Development." This paper reflected upon the acquisition strategy adopted by the Armor Device Product Office to initiate competitive development for the Army's Conduct of Fire Trainer. Mr. Stansberry pointed out the key aspects of this new acquisition approach by saying:

"Competitive prototyping is, of course, not new to the acquisition process. However, it has historically taken place during validation with award of a full-scal development contract to the winning contractor, followed by delivery of a complete Tech Data Package, design disclosure and a package for solicitation of a production proposal, as was the case with the M1 Tank.

"Skunk works" contracting also is not a new initiative in acquisition since it was used as early as 1943 by the Air Force on a contract with Lockheed Aircraft Corporation for the P80, the first tactical jet fighter aircraft. It was again used for contracting for the U2 spy plane in 1955, and on the SR 71 Reconnaissance Aircraft between 1960 and 1975. It has been used a total of 18 times at Lockheed (sole source) and the procedure is considered by Lockheed to be very successful. The refinements that have been applied to the present efforts are:

1. The competitive prototyping is taking place during full-scale engineering development and is followed by a competitive test resulting in production award to the winning contractor within 3 years of the development contract award;

2. The "skunk works" is taking place during a competitive phase as opposed to the sole source environment." (1)

The dust has settled on the initial application of "Skunkworks 81," and full scale production efforts are now one year old with initial simulator deliveries only one year away. Although the concept achieved its goal to initiate production of a fully capable trainer within three years of the development contract award, there were circumstances which may require necessary refinement of the skunkworks approach. Of particuliar import was the fact that one of the contractors delivered a prototype which was unsuitable for developmental and operational testing (DT/OT), and the Government found itself in a sole source environment far earlier than it would have liked. This dilemma was unforeseen and prevented the Government from realizing the full value of the "Skunkworks 81" strategy. Nevertheless, the Government maintained its course, tested both the M1 and M2/3 prototype versions of the Conduct of Fire Trainer (COFT), negotiated a comprehensive scope of work for production and awarded a production contract to General Electric Company in September 1982. Two very fine publications have been written about the COFT and its much heralded training management package, and are offered for those with continued interest in the COFT Program. (2,3) In the following, "Skunkworks 81" is reviewed two years after its application.

UPDATE 83

Skunkworks 81 Is Not For Every Contractor

The "Skunkworks 81" approach pre-supposes that every contractor is seasoned in the transition from development to production. It envisions the delivery of a "mature" prototype ready for competitive testing and complete with an attendent plan which can be properly priced and carried into production without missing a step. All Government contractors simply do not fit this mold; nor can they be expected to arrive at the finish line with the ingredients essential for successful production in a hands-off environment. In the case of the COFT program, one contractor never made it to the wire. The other lacked large scale production maturity during development and, although equipped with

a solid winner in terms of prototype performance, had great difficulty in pricing the forthcoming effort (transition and production) and conforming to the myriad of Government data requirements in production. This immaturity cost the Government Team approximately three months during transition as the teams on both sides worked shoulder to shoulder in creating a workable contract for quantity production. In considering the application of "Skunkworks 81", one must review the contractors' business history in terms of performance and longevity, and determine that (a) the contractor is capable of converting flexibility in development into a rigid, comprehensive production plan and (b) the contractor can properly price a production program laced with the requisite data requirements. Normally, the contractors' history will provide necessary insight into refinement of the skunkworks strategy, as appropriate.

Dollars Versus Deliverables

The "skunkworks" contract was structured as a "cost plus" with a cap. Needless to say, all budgeted dollars were spent. It is noteworthy to briefly consider how the contractors prioritized the work in terms of expenditures. Given the sequence of events, one can safely conclude that both contractors gave the Government test top billing. Simply put, the top performer during Developmental and Operational Test (DT/OT) would win the production contract. Additionally, it was envisioned, that by the end of "Skunkworks 81," life cycle costs and production planning would also be criteria for source selection. Documentation and supportability would be cleaned up at a later date. In retrospect, one can hardly argue with that philosophy. Each contractor, however, approached prototype performance from different aspects. One contractor concentrated on hardware fidelity, knowing full well training transfer would be a key discriminator. On the other hand, the other contractor focused on scene content and consistency in their newly designed computer image generator. Although both were afforded liberal guidelines regarding baseline documentation, great pain was taken on the part of the contractors to conform to classical, Government required documentation for both hardware and software control. A point can be made that although industry complains vehemently about excessive data requirements - when left to their own mastery - they fall back on the Government's approach to design description and documentation. Does this perhaps indicate we have created a monster that cannot be destroyed?

The Continuing Dilemma Of Data

In the Stansberry paper, it was stated that only those data items necessary to assure Government access to appropriate information, when necessary, were required. This approach was certainly a cost and time saver for the contractor and permitted engineering to be focused on the meat rather than the dressing. Conversely, it dramatically compounded the number of data deliverables attendent to the production contract. If managed properly, these deliverables should be reviewed by a myriad of program office groups - both on the contractor and Government side - and formally accepted. This task, though not unmanageable, has required a monumental investment in resources. Moreover, it once again suggests that the data requirements on Government contracts are excessive and require overhauling. Data requirements must be made flexible for tailoring by Project Managers. Simulator production programs provide ample justification for such an undertaking.

Testing A Skunkworks Prototype

As stated previously, one competitor never made it to test. A purely subjective and incomplete assessment would suggest that on the part of the losing contractor, not nearly enough importance was placed on software baselining and integration. As a result, his hardware would not play and thus, could not train. The Army Team learned a valuable lesson from this calamity and has applied it to the preparation for the COFT First Article Test. That is, regardless of the complexity of the task, in spite of the unknown obstacles strewn along the way, and cognizant of the value of pretesting, a period of system burnin or wring-out before a major testing period must be planned and considered sacred - at almost any cost.

Test goals must be established and prioritized according to the parameters provided during development. Training transfer and effectiveness headed the list for COFT and provided the basis for operational testing. These criteria were soundly tested and verified during DT/OT. There were, however, a substantial number of system deficiencies and shortcomings as delineated by the test reports. During operation, the visual scene accommodated an unacceptable amount of flashing and streaking. Additionally, a requisite degree of detail and special effects were missing. On the hardware side, fidelity was lacking in certain areas and the RAM bogey of 100 hrs (minimum acceptable value) was not attained. Basically, a letter perfect prototype had not emerged out of the 'skunkworks' effort, and it should not be expected under the terms of the competitive development effort. Understandably, the Government Team considered a number of options. It could be short-sighted and parochial in its thinking and require the contractor to upgrade the prototype and initiate a plan for further formal testing. If so - what value was the 'skunkworks?'" Alternatively, the Government Team could take advantage of the strengths of the prototype and maintain the advantage the 'skunkworks' effort

provided in terms of time and dollars. The 'skunkworks' approach does present risk in terms of design definition and performance criteria. One must consider these risks as the acquisition strategy is shaped and never permit the risks to outweigh the value of the 'skunkworks' approach. In the case of the COFT, the risks associated with the outcome were sized as manageable.

All problem areas associated with the Government Test were categorized either as (a) low risk - thus fixable during production, or (b) moderate risk - which must be fixed and demonstrated before production. None of the deficiencies or shortcomings were considered showstoppers.

The COFT Team embarked upon a "fix and test" phase where both the Government and contractor resources would be collectively involved with and committed to correcting the moderate risk problem areas. Testing, as necessary, would be conducted on appropriate hardware fixes. A week long Fix and Test Demonstration was held in June 1982. All the governmental decisionmakers were in attendance. However, the real decision power rested with the users from Ft. Knox and Ft. Benning, to include a 14 hour free-play phase. During this free play period, those soldier experts who were participants during initial government testing were allowed to operate the COFT without restraint to verify that all hardware and software fixes were demonstratable and acceptable. The fix and test phase was a resounding success and with unanimous support from the user, the supporter and the materiel developer (US Army Training & Doctrine Command, US Army Logistic Evaluation Agency and US Army Materiel Development & Readiness Command), the COFT Team forged ahead toward production. These types of management decisions are expected with the 'skunkworks' approach and can be dealt with using logic and innovative acquisition strategy.

Plan For Competition - But Don't Ignore Sole Source

As Mr. Stansberry aptly pointed out in "Pros and Cons," a very large source selection team was required. The size, composition and planning for this source selection team was further compounded by the fact that only one contractor reported for DT/OT with a testable prototype. In accordance with the terms of "skunkworks," the deficient contractor was terminated "for the convenience of the Government." And, though the 'skunkworks' approach achieved the goal of competitively producing a technically acceptable prototype in a very short time, it left the Government with the dilemma of a sole source environment. It was therefore decided that the source selection board would convene instead as a Proposal Evaluation and Analysis Board (PEAB) and would conduct its business similar to a "should cost study." This led to an exhaustive search for experienced help from within several Army agencies. The PEAB began its effort late in 1981. When the smoke cleared in mid 1982, the PEAB, chaired by Maj Gordon M. Brown II, had consumed 17 1/2 manyears of effort at a cost of approximately $2M to the Government. However, the PEAB reduced the proposed program cost by $239M, without reducing requirements. A Project Manager must use assets available within the Government - especially in a sole source environment and remain strong during the evaluation and negotiating phase. He must argue forcefully for the requisite skill necessary in that the potential payoff is very large indeed.

Production Planning A Necessary Ingredient

Throughout the "Skunkworks" phase, production planning was conspicious by its absence (traded off completely by both contractors). This was a clear impediment to speedy transition from development to production. The initial months following DT/OT were consumed by producibility studies and creation of a viable production schedule, the last of which was and continues to be, perturbated by a dynamic distribution plan for the Abrams Tank and the Bradley Fighting Vehicles. As negotiations for production ensued, it became apparent that much more non-recurring costs would be experienced in the initial production year than originally planned for. In retrospect, it is obvious that when using the "Skunkworks 81" approach, data and production planning will lag the priorities of hardware development, reliability and, in this case, training effectiveness determination. The logical recourse is to have the production plan become a non-tradeable item in the Government list of desirable features. However, the price to the Government will be more time and dollars during competitive development. On a program-by-program basis, this issue must be weighed accordingly. Additionally, in the early phases of production (as production planning continued), both contractor and Government engineers extended quasi-development activities forward, searching for the 100 percent solution. In order to manage a production program effectively, the umbilical cord to R&D must be severed as soon as possible The necessity of having a Government/Industry team engaged in both development and production activities can be counterproductive. Most likely, the outcome is cost growth, schedule risks and a moving baseline.

The Training Device Dilemma

Although the Government goal is generally to have the training device available to train soldiers engaged in operational testing of the weapon system, this goal is seldom achieved. COFT is no exception; however, the COFT catches weapon system distribution inside three years of initial fielding. This catch-up is, to a great

extent, a result of "Skunkworks 81," and can be sustained through innovative acquisition strategy and program stability.

Emergence Of A New Support Philosophy

The COFT will be supported in the field by the contractor and requires no additional Army resources. This approach has been determined to be the most viable for simulators. The confidence of the contractor in his product is adequately represented by contract clauses. If the COFT isn't kept operational, the contractor doesn't get paid for his logistics effort. This approach across the board will provide the Army with the opportunity in future years to compete logistics support contracts on a regional basis for all fielded simulators.

SUMMARY

The first two lots of the COFT Five Lot Program were awarded in September 1982 and February 1983. The program remains on schedule and within cost. COFT was proven to be training effective - comparable with gunnery training on the vehicle. The next threshold subsequent to delivery will be to not only refine its real training effectiveness, but to measure cost savings realized in ammunition, fuel, and repair parts. An increase in the Army's readiness posture is a sure bet.

"Skunkworks 81," although a success, has had its warts, as will any innovative concept. Its precepts must be intertwined with common sense, clear goals, acquisition awareness and the willingness to take properly assessed risks. Despite the warts, "Skunkworks 81" will result in the fielding of simulators five years from program inception. It has fulfilled its objective.

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2. Jones, Donald E., and Hopkins, Richard K., "COFT - A New Concept in Tank Gunnery Training," Proceedings of The 5th Interservice Industry Training Equipment Conference, Washington, D.C., November 1983, p. 215.

3. Weaver, Michael K. and Renfrow, Richard, "Armor Training Simulators Are On The Way," Armor Magazine May-June 1983, pp. 14-18.

ABOUT THE AUTHOR

Lt. Col. John E. Longhouser is currently the Product Manager for Armor Training Devices in Orlando, Florida. He is a member of the Army Project Manager Development Program and has served as Chief of Manufacturing Engineering for the M1 Tank Program. Additionally, he has held command or training positions at all levels from platoon to brigade. His last troop assignment was with the 1st Armored Division (Old Ironsides) as 1st Brigade S-3 and Executive Officer from 1980-1982.

ACQUISITION WORKFORCE

Panel Moderator: Mr. William N. Hunter
Director, Federal Acquisition Institute
Office of Federal Procurement Policy
Office of Management and Budget

Papers:

Assessing Contracting Workforce Requirements in the Matrixed Organization
by Albert J. Goebel, Conrad W. Kipp, and Richard M. See

Closing the Gap Between R&D and Application in Academe to Better Support Government and Industry
by Yvonne F. Howerton

The Leader of the Army Acquisition Workforce
by Gerald B. Kipp

Prerequisites for the Establishment of a Professional Acquisition Work Force
by John D. Krieger

Training Requirements for Changing Times
by George T. Nickolas

A Dynamic Personnel Assignment Model in the R&D Environment
by Patrick J. Sweeney

Training Acquisition Personnel through a Local College
by Eugene R. Watters and Harley A. Main

ADP002760

ASSESSING CONTRACTING WORKFORCE REQUIREMENTS IN THE MATRIXED ORGANIZATION

Albert J. Goebel, Conrad W. Kipp, and Major Richard M. See
Hq Aeronautical Systems Division

INTRODUCTION

Aeronautical Systems Division (ASD), within the Deputy for Contracting and Manufacturing, of Air Force Systems Command, we believe our most critical resource to be people. Therefore, how we allocate this workforce becomes a primary ingredient to the success of our mission. The purpose of this paper is to explain how contracting personnel are managed and allocated within our matrix organization. We intend to show you how we started; our growing pains in developing a model for evaluating workload; the results of our efforts and finally, our plans for future improvements.

For those of you who have not had the opportunity to work in a matrix organization - matrixing can be defined as the concept of classifying and assigning skills by functional area and the collocation of personnel with these skills from a central home office to support specific program/project organizations. ASD implemented the matrixing of engineering personnel in support of their acquisition programs in 1964. The concept was expanded in 1976 to include the Deputy for Contracting and Manufacturing/Quality Assurance and the Comptroller organization. Initially, we used other organizations such as the Personnel Office and the Management Evaluation Team Office to evaluate the number of personnel and types of skills required by the user organization or program/project office. Simple time and motion studies and gross work measurment approaches were used as the basis in making their recommendations. This approach produced extremely unsatisfactory results. Our analysis led to the conclusion that the basic problem stemmed from a lack of involvement of the affected functional area. As a result, we concluded that it was imperative that active participation by functional specialists must be a central part of any assessment process.

As a result, in 1978, the Contracting Home Office within the Deputy for Contracting and Manufacturing/Quality Assurance made its first attempt at developing a workload assessment model (WAM) to ensure that the requisite quantity and mix of contracting skills were provided to each ASD program office while maintaining our total manpower ceiling. First, we requested our collocated contracting organizations in the program offices to give us their estimate on how long it took to do a specific contracting task. The categories of tasks were divided into two general areas. First, the contract actions were classified as either competitive or sole source acquisitions. Next, the contract tasks were divided into ranges depending on dollar amount. For example, the assumption was that it takes longer to award a contract valued at $5,000,000 than a contract for $500,000. The same theory regarding dollar value was also applied to contract modifications. Approximately thirty standards were developed using the average number of hours for our nine collocated organizations. Our basic assumption was that regardless of where the contracting task was being performed, the same number of hours would be required. WRONG! We found the WAM worked reasonably well in some organizations, but was grossly in error in others; however, in most cases, the model erred on the low side.

Our first revision of the WAM model in 1979 added two factors. The first recognized program complexity within the collocated contracting office and the second dealt with quantity and complexity of contract correspondence. Complexity Points were given to the organizations for such factors as contract complexity, interface with the contractor, source selections, funding problems, etc. These complexity points were estimated by the senior staff within the Deputy for Contracting and Manufacturing. Points were also earned for the quantity and complexity of correspondence. We now referred to the hours earned using the WAM, i.e., those associated with the thirty standards, as direct hours. In addition, based on the complexity and correspondence factors, the collocates now earned a percentage ranging from 0% to 40% of direct hours earned from the WAM. These hours were referred to as indirect hours. We used the direct plus the indirect rate methodology during the 1979-1981 timeframe, and it appeared to work well in approximately two thirds of our organizations.

We had made progress, but still did not have a common system for all our needs so an analysis was accomplished in 1982 to find why the existing model did not work for all of our organizations. The analysis showed that by adding the indirect rate we had taken a big step in the right direction, but additional factors had to be considered. For example, the model did not take into consideration the type of contract being negotiated, the number of repetitive contract actions being performed, (i.e., where learning would be a factor), tasks within the normal contract cycle that were not accomplished, etc. Approximately 15-20 new factors were identified. Finally, a new technique was added to the actual conduct of the workload assessment. In previous years, personal interviews were seldom conducted below the first or second level supervisors. Now, it was decided that each available individual (PCO & Contract Negotiator) and first level supervisor would be interviewed to insure the

proper standard from the WAM was used in arriving at the number of direct hours earned. The method that resulted is the system used today, and it will be the subject of the rest of this paper. In order to give a better insight into how ASD/PM's workload assessment methodology is used today, we will take you through the process step-by-step.

BACKGROUND

In a paper of this length, it is not possible to provide the reader with every detail in the workload assessment process. However, we will attempt to highlight the more important areas. As was previously stated, the WAM was developed using an average number of hours to perform a particular contract or modification. This is referred to as a standard. The standard includes time spent by the contract negotiator, PCO, clerical, first level supervisor and second level supervisor. It does not include time spent for legal reviews, actual writing of the document, program management inputs, etc. The shaded area of figure 1 depicts who is included in the WAM direct computation.

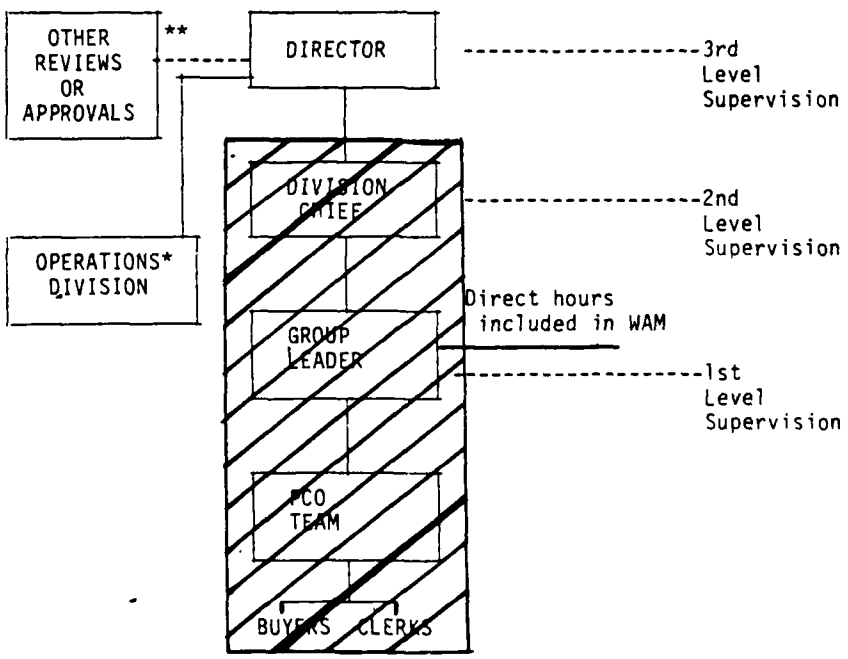
Step 1 - Administrative Arrangements: Once the workload assessment team has been identified, the Senior Collocate Director is contacted by telephone to inform him of the impending workload assessment, scheduled dates of the visit, and to establish an in-briefing time and date. This is confirmed in writing. In addition, organization personnel are to prepare worksheets depicting their current and forecast workload for a six month period. The accuracy of the worksheets are very important since they are the primary source for determining the number of direct hours earned.

Step 2 - In-Briefing: The in-briefing is used to explain the workload assessment model, how the assessment will be conducted, and stress the importance of the accuracy of the worksheets. The Director is given the option of determining who will attend the in-briefing; however, it is recommended that as a minimum, all available first, second, and third level supervisors attend. During the in-briefing, we also establish the method of obtaining correspondence files, receive current organization charts, and establish the initial interview schedule with the Division Chiefs.

Figure 1.

Typical Chain of Command

Diagram for Collocated Contracting Organization



* Internal Review Function
** External Reviews, Approvals, Signature

Step 3 - Direct Hour Worksheet Preparation: The worksheets are scheduled to be received 1-2 workdays before the start of the workload assessment. Time after receipt and before start of the WAM is used to perform an initial review of the workload and determine what computer run information will be necessary to supplement the worksheets. The worksheets contain the following information:

a. Brief description of the program and the contract number

b. Modification number (if applicable)

c. Purchase Request number or document that generated the contracting action, i.e., Engineering Change Proposals (ECP), Contract Change Proposal (CCP), Letter from the Program Manager, etc.

d. Fund Status - Whether the funds are available now or forecast to be received at a later date and dollar amount of the program

e. Contract Status Information

If the worksheets are not prepared properly, they are returned to the Division Chief or Group Leader for correction.

We mention above that additional computer based information might be required. For example, we have found that most organizations are unable to forecast their ECPs and CCPs accurately. In an organization with a large number of ECP/CCPs, this causes a gross error in their forecast. A computer run is obtained on the organization which gives us their change activity for the previous year. This information and the worksheet data are used to forecast the change activity for the next year. Other information is available such as number of contracts distributed, various types of modifications distributed in addition to ECP/CCPs, Purchase Requests received, and contracting actions. The computer base information and the individual worksheets provide a crosscheck of current and projected efforts and assure common agreement on a baseline from which to derive direct hours.

Step 4 - Indirect Rate Development: As we have previously stated, the indirect rate is composed of two elements: (1) Correspondence Index and (2) Program Characteristics Complexity. The indirect rate in point of time is actually developed prior to compilation of direct hours and for essentially two reasons. By reviewing the correspondence first, it allows the workload assessment analyst to better understand the different types of activities that are being performed within the organization. Second, the indirect rate is used to manipulate some portions of the direct rate calculations. The actual calculation will not be explained, however, until we show the methods that are used.

The correspondence is reviewed for quantity (number of letters) and complexity. Generally, a three month sample is selected. Each piece of correspondence is assigned a complexity factor, which earns points. We have three categories of complexity:

a. Routine, Non-Complex. Approval/transmittal actions or correspondence written by another organization for the contracting officer's or group leader's signature.

b. Routine, More Complex. General correspondence, requiring research of some kind and generally written within the contracting organization. Some correspondence written outside the contracting organization could be classified in this category if the contracting organization were required to research and verify the contents of the letter.

c. Unique, Complex. Involves complex contract issues requiring coordination with legal and other organizations. Letters or documents requiring high level signature or approval, numerous coordinations, etc.

The correspondence index is computed by multiplying the number of letters and documents within each category times the difficulty rating and then dividing the total by the number of people in the Contracting Division. The result is the number of points earned.

The Program Characteristics Complexity Index is determined by a survey of key contracting staff personnel within ASD. Factors such as program complexity, negotiation complexity, formal source selections, and funding impacts are used in the weighting of each organization. For example, it is easier to negotiate and issue a routine supplemental agreement to an enthusiastic cooperative contractor than to definitize a complex ECP with an uncooperative contractor. Based on this survey, each organization will be credited with a certain number of points and this number is then fixed for a period of one year.

By adding the total points earned for correspondence and the points allotted for program characteristic complexity, an individual indirect rate for each organization is determined. In summary, at this point, we have developed an indirect rate based on quantity and complexity of correspondence and program office complexity. We are now ready to develop the assessment of direct hours.

Step 5 - Direct Rate Development: The interview process starts with informal discussions with the Division Chief. Changes in workload since the last assessment are discussed. Any special topics the Division Chief would like evaluated are discussed. As an example, presently, most of our organizations are experiencing a loss in experienced working level personnel (PCOs & Contract Negotiators) because of promotion, loss to industry, and retirements. As a result, most supervisors are requesting an impact analysis of this change in mix of the workforce. Next, the worksheets are discussed with the Group Leaders. The primary purpose is again to ensure the accuracy of the data. Prior to 1982, most group leaders were not submitting worksheets, while in reality, most group leaders produce direct work of some kind. They may close out contracts, prepare D&Fs and acquisition plans, negotiate forward pricing rates, etc. This direct workload is now documented and credited.

Each person who has prepared a worksheet is now interviewed. However, if any level of supervision requests participation, he/she is included in the process. When interviewing trainees, care is exercised because errors are sometimes made due to misunderstandings of terminology. The interview is conducted near the work area since it is often necessary to review working files for a better understanding of the complexity and quantity of work being performed. It also allows the analyst to verify the validity of the requirement by reviewing the contract file as well as verifying accuracy. Each work element is assigned a standard and the definitization schedule for the contracting action is verified. Any redundancies, obvious errors, omissions and duplications are corrected. The bottom line result of the interview process is that we usually uncover 20-25% more work than is originally reported on the worksheets. The two primary reasons for this error on the low side are omissions of work and the contracting activities inability to accurately forecast change activity.

Step 6 - Direct Hour Computation: Now that the interviews are completed, the analyst is ready to compute direct hours earned. As we have previously stated, approximately 15-20 refinements were made to the model. The examples below show how the computations are made and two of the refinements to the model.

EXAMPLE 1 - Data extracted from worksheets and interview
- Contract F33657-83-C-XXXX
- Type of Contract: FFP (LOE) Labor Hour Contract
- Dollar Amount: $5.0M
- Sole Source Acquisition
- 6 month period being evaluated: 1 Apr 83-30 Sep 83
- Milestone Status on 1 Apr 83: Awaiting Field Reports
- Milestone Status on 30 Sep 83: Contract Distributed

Computation for Direct Hours Earned

450 Hrs* X (1.0** - .3*** - .2****) = 225 Hrs

* Hours earned for completing 100% of this particular standard from the WAM

** 100% of the standard

*** 30% or .3 of the work was performed outside of the evaluation period.

**** Approximately 45% of the entire standard involves the negotiation process. 20% is subtracted because FFP (LOE) Labor Hour Contracts are relatively simple to negotiate. (New refinement)

EXAMPLE 2 - Data extracted from worksheets and interview
- Contract F33657-83-C-XXXX
- Type of Contract: FFP
- Dollar Amount: $50.0M
- Sole Source Acquisition
- Period being evaluated: 1 Apr 83-30 Sep 83
- Milestone Status on 1 Apr 83: Awaiting Purchase Request
- Milestone Status on 30 Sep 83: Out for Contractor Signature

Computation for Direct Hours

575 Hrs* X (10. - .1** - .2***) = 402.5 Hrs

* Hours for completing 100% of this particular standard from the WAM

** 10% or .1 of the standard was not performed during the evaluation period

*** 20% or .2 was deleted for work not performed. In this particular case, the contracting office had a Class D&F and was not required to prepare an Acquisition Plan or D&F. (New refinement)

NOTE: The above examples are only two of approximately 15-20 interrelated factors which are refinements of the model applied to the WAM.

The results of the Direct hour assessment are used primarily in conjunction with indirect hours to develop an organizational manning number. However, the individual assessments also reflect workload imbalances between individuals, identifies top performers, and permits comparison of individual workload between organizations.

Step 7 - Computation of Personnel Earned: Next, the number of personnel earned from the WAM is calculated for each Division. Shown below is an example of this calculation:

$$\frac{\text{(Total Hours Earned Per the 6 month Evaluation Period)} + \text{Indirect Rate}}{880^*} = \text{Personnel Earned}$$

*This is an Air Force standard for a 6 month period and is adjusted for leave (Sick and Annual) and training.

As a final part of the evaluation we derive a ratio of technical to clerical personnel, direct personnel to overhead personnel, and most recently, the number of trainees assigned. These ratios are compared to the average of the total matrix complex to assure that no gross imbalance occurs in any one organization. If the clerical imbalance is on the high side, it generally results in an unproductive clerical function. While, if the imbalance is on the low side, it results in the technical personnel being unproductive since they must perform many of the clerical functions. Both situations often result in morale problems. Consideration of the direct personnel to overhead ratio, (wherein, a direct person is an employee who accomplished a workload assessment worksheet and an overhead person is generally a second level supervisor (Division Chief), first level supervisor (Group Leader), or a procurement clerk), where there is an imbalance on the high side, generally means that there are too many clerks and/or supervisors and there should be some type of reorganization. On the low side, we have found that technical people are performing clerical functions and the mix of personnel needs to be changed. In the case where an organization has an inordinate number of trainees, additional experienced personnel are assigned to that organization or the quantity and quality of contracting will degenerate. Utilizing all of the above, i.e., direct hours earned, indirect rate, additional factors and personnel mix, the analyst is now prepared to make a recommendation on the organization's manpower requirements.

Step 8 - Recommendation Briefings: This final step consists of a series of briefings. First, the tentative recommendations are given to the Home Office Director. With his concurrence, it is presented to the Contracting Organization that was evaluated. The final briefing is given to the Deputy for Contracting and Manufacturing including any exception taken by the Contracting Organization.

CONCLUSION

In conclusion, in matrixing ASD Contracting personnel, we have found the WAM to be an extremely valuable tool. In this time of diminishing resources, i.e. "do more with less", our goal simply is to apply equal "hurt" to our collocated contracting organizations. Our Workload Assessment team is able to evaluate most organizations in a 2-3 week period allowing management to respond quickly to the organizational needs, thereby reducing complaints from the project organizations. The fringe benefit of being able to determine individual and supervisory performance has proven to be a valuable tool in matrixing of people and identifying fastburners for promotion.

As to the future, we are implementing two separate efforts, the first of which involves programming the WAM into our automated data management system. There are many "bugs" to work out; however, we believe that it is only a matter of time until we will have "real time" insight in the workload and manning problems of our collocated organizations. Secondly, our standards for Source Selection need refinement. Using regression analysis techniques, we hope to develop a formula or formuli that can be used to determine an optimum number of people required for any Source Selection.

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AD P002761

CLOSING THE GAP BETWEEN R & D AND APPLICATION IN ACADEME TO BETTER SUPPORT GOVERNMENT AND INDUSTRY

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ABSTRACT

To successfully accomplish the goals implicit in defense research and development,(R&D), the interrelationship of Government, Industry, and and Academe deserves increased attention.

While the relationship between Government and Industry has been firmly established, it is in the Academic arena that a better clarity of direction regarding the pursuit of research and development is needed.

The lag between research and development and application is greater in education than in almost any other field. This is particularly unfortunate at a time of a technological resurgence.

Perhaps this vacuum can best be examined by looking at the changing trends in education. Until most recently the emphasis on scientific training was not a major priority in the secondary schools and universities. Only recently has attention been drawn to the increasing technological advances and shortage of qualified personnel. With the assistance of funds from the Government, Industry, and Private Foundations like the Alfred P. Sloan Foundation and others; an emphasis on scientific training has taken on a new emphasis.

INTRODUCTION

While Government, Industry, and Academe are all linked in the research and development effort, the motivations and perspectives are understandably different and distinct.

For the past three decades there have been fluctuating degrees of commitment and interest on the subject of defense research and development. Evidence has also shown that "development" has generally received more attention than "research". This has been true for many reasons. One notion is that "development" or applied research embodies utilizing an existing concept. In the commercial sector, the investment in a tangible innovation is immediately more feasible than investing in a potentially non-existent idea. However, for both the Government and Private Sector, the initiation of new ideas in basic research in cooperation with Academe can have long term benefits.

TEXT OF PAPER

For the Government, the ultimate goal of defense R&D is the procurement of superior innovative systems. To accomplish this objective, there is necessarily a long range development cycle encompassing conceptualization, design, contractor preparation and coordination, final testing, and evaluation of the product.

While Industry is committed to excelling in R&D, it is more oriented toward profit, volume of business, market share and return on investment. [2]

Traditionally, it has taken some 20 to 50 years for a scientific advance to work its way through to full commercial exploitation; but under the pressure of technological competition, this time has recently contracted considerably and is now sometimes no more than five to ten years. [3]

In a rapidly advancing technological field, the prizes go largely to those who can get to the market first with a new product that is fully developed and tested and that can be produced on a large scale. [4]

The lead time of large aircraft projects goes up to about seven years. The scale of R&D expenditures needed to develop a given innovation is also well known. It runs typically at about $1 Million for a scientific instrument, $5 Million for a medium computer with software, $200 Million for an aircraft engine, $500 Million for a subsonic jet aircraft, and still higher for spacecraft and supersonic transport aircraft.[5]

Understandably from Industry's viewpoint, the 'path to future prosperity is through research aimed at the development of new products and new industries'.[6]

The responsibility of Academe is to become more aware of the importance in training individuals with practical skills, as well as basic and applied research capabilities,that will be advantageous to both the Government, Industry, and ultimately the total R&D picture.

In a study conducted by the White House Conference on the Industrial World Ahead: A Look at Business in 1990, the lag between R&D and application was examined. The study noted that schools have traditionally limited themselves to the so-called 'basic and tool' subjects, and have left much of the remainder to the Employer.

Varying viewpoints abound. Some observers feel that many publicly funded institutions lack the state-of-the-art equipment. The American Electronic Association,(AEA),cited an example of a visit made by a Chief Executive Officer and Chairman of a major corporation, who upon visiting his alma mater, found equipment being used that he had been trained on 50 years previously.

This is not universal. Many private institutions, such as MIT, Rensselaer, Cal Tech, etc., have been able to regularly refurbish their labs with state-of-the-art equipment, often through the benevolence of Industry.

Another school of thought is that Academe believes in research for the sake of research, and not with user application as a primary motivation. As one educator noted, there is no plan within the academic structure whereby research and development ideas can be put into the system right away. An idea may be developed and published in a scientific journal and may sit around for years before discovered.

While the viewpoints differ regarding the lag in R&D and application within Academe, the consensus is very specific. The only viable and best alternative is for a much closer interrelationship between Industry, Government, and Education.[8]

This was echoed by Dr. Huddles in the National Materials Policy, where he states that the ability of Institutions to adapt themselves to rapid changes is essential.[9]

A number of ideas have been promulgated to close the gap. Developing special curriculum with Department of Defense and Industry input at the Universities has been considered an important facet of building the Nation's analytical work force.[10] Additionally, this would enable the transfer of information which would share different perspectives on the nature of defense R&D.

This might ensure that facilities and equipment are kept current as well as relevant. instructional process. A constant and viable personnel interchange between Academe, Government and Industry would become a mutually advantageous arrangement.

This of course is dependent on the ability of the Educational Institutions to adapt to the exploding changes of Industry.[11]

CONCLUSION

The impact of defense R&D is derived on in part from the magnitude of the investment by Government, Industry and Academe. The nature of defense R&D with its inherently long-term orientation, its intrinsically high-risk content, and its relative flexibility with regard to costs, provides the opportunity for trained personnel to reach further into the unknown, and when successful, to produce greater advancements.

Toward this end, the public servant and the professional from Government, Industry and Academe must join forces and agree upon an achievable plan of action.[12]

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ADP002762

THE LEADER OF THE ARMY ACQUISITION WORKFORCE

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Abstract

Who is the Leader in the Army Acquisition Workforce? I think most of us involved in any federal procurement process know that individual is the Contracting Officer (KO). In this article, first in the Introduction I will summarize how the Defense Acquisition Regulation (DAR) and the Army Procurement Procedure (APP), define a KO, how he is selected, his required qualifications, and major responsibilities. After the DAR and APP summaries, in the Text of the Paper I will point out a number of weaknesses I see in the present system and then make personal Recommendations for Improvement. In the Conclusions I will synopsize the benefits that can result from the overall upgrading of the KO position.

INTRODUCTION

My commentary has been drafted with two goals in mind; first, to generate "food for thought," and second, to provide a subject for discussion that has need of remedial attention. Many studies, investigations and reports concerning the qualifications and training of Government KO's have been made and it certainly is not a new subject. My treatment of the issue is based on personal observations, experience, and general guidance contained in the DAR and the APP.

The Regulation definition of the KO is, "Contracting Officer means any person who, either by virtue of his position or by appointment in accordance with procedures prescribed by this Regulation, is currently a contracting officer (See 1-400, Procurement Responsibility and Authority) with the authority to enter into and administer contracts and make determinations and findings with respect thereto, or with any part of such authority. . . ."[1] (I will comment on what I consider shortcomings in the definition itself in the text of my paper.)

In the Introduction I think it is appropos to quote DAR and APP guidance regarding selection procedures, considerations, and assignment of duties and responsibilities of KO's before entering into the general text of my dissertation.

The selection process is to be conducted as follows:

> "Selection.
>
> (a) Considerations. In selecting contracting officers, the appointing authority shall consider experience, training, education, business acumen, judgment, character, reputation and ethics.
>
> (b) Evaluation of Experience, Training, and Education. In considering experience, training, and education, the following shall be evaluated:
>
> (i) experience in a Government procurement office, commercial procurement or related fields;
>
> (ii) formal education or special training in business administration, law, accounting or related fields;
>
> (iii) completion of the Defense Procurement Management Course or other procurement courses; and
>
> (iv) knowledge of the provisions of this Regulation and of other applicable regulations."[2]

Assignment of duties to KO's is to be made in accordance with the following DAR guidance:

> "Assignment of Duties to Contracting Officers. In assignment of duties, including execution and administration of contracts, consideration shall be given to the ability, training and experience of the contracting officer. Duties, involving contracts of large dollar value and complexity, shall be given only to personnel with commensurate experience, training and ability."[3]

The APP cites the following as KO responsibilities:

> "Responsibilities of Contracting Officers. A contracting officer has primary responsibility for--
>
> (i) knowing and observing the scope and limitations of his authority and not exceeding the authority conferred upon him;
>
> (ii) safeguarding the interests of the United States in contractual relationships;
>
> (iii) determining facts relating to contracts, where necessary;
>
> (iv) maintaining vigilance to ensure that contractors fully comply with the terms of their contracts; and
>
> (v) the legal, technical and admi-

nistrative sufficiency of any contract which he executes (see 1-451)."[4]

TEXT OF PAPER
(Weaknesses in Acquisition System)

Let us face it, to be the perfect KO a person would have to be nothing short of an all knowing "Acquisition Guru." I do not believe we in the Government will ever achieve Guru status for KO's, but I do foresee by recognizing current weaknesses and by taking corrective action we can improve the image and expertise of Army KO's and KO's throughout the federal Government.

First, as I indicated before, the definition of a KO leaves something to be desired. A KO coming into being "by virtue of his position" is ridiculous, if not asinine. How many times have we in the procurement business witnessed the arrival of our new boss fresh out of Ft. Lee's basic procurement course, or maybe better yet, having received both the basic and the advanced course back to back. This figurehead appointed by virtue of his position is not necessarily a military officer; he might just as well be an individual qualified in a GM-300 series. Unfortunately, the Ft. Lee training in many cases is the sum total of this individual's acquisition background.

The DAR also provides for appointment in accordance with prescribed selection procedures. The Regulation sets out qualifications based on experience, training, education and business acumen. I cannot take exception to the DAR selection factors, but I do, in many cases, consider the qualifications of proposed appointees lacking. I not only refer to those receiving warrants by virtue of the position, but those appointed through the selection procedure. My concern lies in the reviewing officials' authority to take exception to a proposed candidate's credentials. Obviously, without a forceful reviewing capability that discloses deficiencies in qualifications, the integrity of selection process is in jeopardy. In addition, I feel the selection criteria requires further definition, i.e., how much and what type of experience and training, clarify business acumen, and the judgment, character, reputation and ethics requirements. I will later address specifically and make recommendations for revamping and improving the KO appointment review process.

In conjunction with the discussion of KO qualifications I see a shortcoming in the general assignment of procurement tasks to various KO's. I consider this a serious management problem throughout Government procurement. How many times have each of us found ourselves in a procurement situation where we were literally in "over our heads" and just didn't have a grasp of the problem at hand? Probably the best example of this nightmarish situation occurring would be during a contract negotiation. Admittedly, we all must learn, but it is a management responsibility to keep abreast of individual capabilities. I do not see the assigning of tasks beyond individual capability as an intentional act but rather as a weakness in the system that warrants our attention.

A subject briefly discussed previously is that of the military officer who is assigned to a procurement position from an unrelated field. To cite a common example, the chemical, armor, or engineering officer coming into the organization as the Chief of the Branch, or worse yet, as the Director Procurement with "zero" experience in t ield? In my opinion this is a defini weakness; although a number of brilliant m ry and business leaders will disagree a profess the logic that a good manager ca nage any type of operation. My position patible with a "total manager concept," I maintain that it does not apply until a certain management level is reached within the organization. To illustrate, a Director of Engineering should be an engineer, a Director of Procurement should be a procurement professional, etc., but once you reach the senior executive level, i.e., Chief of Staff, Deputy Commander and Commander, the "total manager concept" is applicable to those positions. Reiterating, assigning individuals unfamiliar with procurement to Acquisition positions is not in the Government's best interests.

The Government procurement concept has been structured upon the applications of a teamwork approach. At the head of this team is the KO. He has the responsibility of selecting team members as he deems necessary. Included on the team might be legal, pricing, audit and technical support of various types. It has been my experience that the team concept approach to contracting in many instances is not adhered to. On the contrary, I have observed the opposite where other Government elements are working independently of the contract function. It almost appears that a professional jealousy exists between the various offices/elements. Failure to provide the KO with required support violates all attempts to project the teamwork method of acquisition, and I see need for remedial action throughout the Army. Because of this lack of cooperation the KO is under-utilizing the talents available resulting unjustified acquisitions that are lacking in proper technical and cost reviews and analyses.

I see a two basic regulatory constraints that hinder the procurement process. Although giant strides have been taken to eliminate the

number of regulations, opportunity exists for improvement, i.e., individual Department regulations and local publications that duplicate. I consider the major regulatory constraint limiting the acquisiton process to be the higher headquarters and Secretarial approval requirements. It is my opinion that if any procurement activity has access to an agency headed by a general officer, staffed with a legal and policy office, a full staffing of technical personnel including a pricing element with audit support, a review by a higher echelon would appear to be a redundancy.

Another observation is that many KO's are heavily burdened with many administrative and personnel repsonsibilities. I refer to the non-supervisory KO's that are classified as "lead contract specialists, negotiators, or administrators" who are required to perform supervisory repsonsibilities for a group of lower graded specialists. Most of the time these individuals are the primary "movers" in the procurement operation and have the least amount of time to devote to these personnel and administrative matters. Agency management should give this situation serious attention, not only concerning the additional duties that are imposed on the KO, but to assure subordinates are receiving the quality of supervisory review to which they are entitled.

There are also instances where the Commander of an activity is the prime KO. This situation does not allow for proper attention to be focused on the acquisition process and does not permit time for adequate KO review.

Training for procurement personnel is another area within the system that takes a "beating." What is the first account to be reduced during a funding restraint? I will make recommendations that could curb training cuts in the next section of my article.

I would also like to make a comment concerning a general observation relative to what I consider a weakness in the procurement system. In my opinion the system does not emphasize the responsibility, knowledge and professionalism required to be a KO. I do not sense that other elements realize the immense undertaking involved in performing the KO duties. The system is lacking when this knowledge has not been projected.

RECOMMENDATIONS FOR IMPROVEMENT

My first recommendation which coincides with previous discussion would be to eliminate appointment of KO's by virtue of position. Individuals occupying positions necessitating a KO warrant would be required to participate in a very stringent selection procedure that would be applied to any potential candidate.

In conjunction with originating this selection criteria I would suggest establishing a "Intraservice Summit Committee" composed of both military and civilian acquisition personnel to discuss and draft detailed written criteria. I would recommend to the Summit that the selection process should include written tests for prospective KO's. The examination could test knowledge of regulations, accounting, pricing, funding, related laws and overall procurement procedures. Selection of KO's should also include a review board that could consider intangible traits like business acumen, judgment, character, reputation and ethics. I contend that with this type of procedure areas of weakness would be discovered and could be corrected by additional training. Those unable to meet requirements would not be issued warrants.

Next, acquisition managers must assure that KO's capabilities are closely reviewed at the time of performance appraisal to avoid assigning tasks that are not commensurate with ability and experience. In this same vein, the practice of assigning military personnel to specific procurement responsibilities who have not had proper training in the acquisition field should be discontinued. These assigning practices would also be a topic of discussion for the Intraservice Summit Committee.

A campaign should be initiated throughout Government to educate all elements associated with the acquisition process concerning the importance of the application of the teamwork concept in every contracting situation. Interoffice jealousies must be eliminated and independent dealings with Government contractors without KO knowledge must be discontinued. This educational campaign would enhance better utilization of the expertise available Government-wide.

I recommend that efforts continue to reduce the number of regulations with an ultimate goal of developing a single regulation such as the Federal Acquisition Regulation (FAR) that can be used by all agencies. Immediate attention could be placed on the reduction within each service of regulations, policies, operating procedures and memorandums. I would foresee the Intraservice Summit Committee requesting the DAR council to consider the elimination of a number of higher echelon procurement approval requirements.

Agency managers should review the practice of placing personnel and administrative responsibilities and duties upon KO's. These tasks should be eliminated or transferred wherever feasible. Consideration should be

given to reorganization to accomodate the performance of these supervisory tasks.

I would suggest that when funding constraints are imposed that instead of eliminating training of acquisition personnel a different approach be taken. Instead of cancelling the training I propose that whenever possible to bring the school to the individual. This has been done in the past and, in my opinion, with justifiable success. Obviously the cost would be minimal if adequate participation at the agency is obtained. As I have stated, this approach has been used before but I do not consider to the maximum extent possible.

Included in the campaign to educate the elements of the acquisition process should be an explanation and clarification of the duties of a KO. Emphasis should be placed on exemplifying the tremendous responsibility that is placed on a KO and the overall professionalism required to perform effectively in that capacity. An explanation of the qualifications required to be a KO should also be a part of this campaign.

There are various guides for KO's, but I am not aware of a formal published instruction. In addition to the DAR, the APP outlines general guidelines for KO's. Under "Requirements to be Met before Entering into Contracts," instruction is povided in the following areas: "Availability of Funds. . ."[6], "Review of Solicitations. . ."[7], "Boards of Award. . ."[8], "Contract Modifications Subject to Approval. . ."[9], "Departmental Preaward Review and Secretarial Notation. . ."[10], "Abbreviated Secretarial Review and Notation. . ."[11], and "Departmental Postaward Review and Secretarial Notation. . ."[12]. There have also been a number of checklists developed throughout the Army to assist KO's in their reviews of contracts prior to signature, but as I stated previously, I am not aware of formal, detailed published guidance. I propose that a pamphlet be written utilizing guidance and direction from the Intraservice Summit Committee. If there is an existing publication available from a service outside the Army, this can be brought forth through the exchange of communication within the committee.

For my final recommendation, I suggest that a formal training program be estalished through a combined effort of the services. Upon development of the program I would recommend that the responsibility for initiating the program be redelegated to the major subordinate command level. Proposed KO's would be required to successfully complete the formal KO training program prior to being screened through the selection process.

CONCLUSIONS

Through the overall upgrading and specialized training proposed, I maintain much of the fraud, waste and abuse formerly reported within Government ranks will, for the most part, be eliminated.

By eliminating these past undesirable practices the Government's image pertaining to Acquisition methods will be improved and possibly some of the lost faith in the system restored.

The elimination of regulatory constraints that have restricted the KO's ability to function expeditiously will reduce the contracting timeframes, partially eliminating the frustration that both industry and the general public experience in coping with the Government procurement process.

By producing more competent Government KO's, contracting errors should be appreciatively decreased. Increased cost and confusion will be eliminated from the procurement process by alleviating the number of misunderstandings. Dollar savings should be recognized in a number of acquisition-related cost categories through the efforts of this increased professionalism.

a. We should recognize monetary savings through a decrease in costly contract changes. More precise scope definition, better coordination with team elements and clarification during negotiation should nullify many of the necessities for contract changes.

b. More qualified KO's will asure contracts are awarded at fair and reasonable prices. Instances where misinformed and unqualified KO's who do not serve the Government's best interest will be greatly reduced.

c. Competent KO's leading the Acquisition team will enhance the acceptance of only quality products. The increase in quality will reduce overall costs throughout the procurement process.

d. In conjunction with the receipt of quality material and products is KO assurance, through team coordination that products are delivered on time. Timely deliveries would contribute to the overall accomplishment of major program goals.

e. The upgraded KO with his increased expertise and leadership abilities could maximize the utilization of available resources. He sould act as the catalyst for

the best application of existing team assets. A highly qualified KO can foster improved relationships not only among team members but he can use the influence and authority of his position to enhance inter- and intraservice relationships throughout the Goverr nt. These improved relationships would lead to better coordination between activities and, in turn, a better acquisition process.

My final conclusion is that a more qualified Government contracting agent approaching the "Acquisition Guru Status" would project the highly respected image necessary to insure the trust of both the general public and private industry. I think the Government's procurement image has suffered immensely in the past, and this proposed upgrading of our KO's is the "facelift" required to improve our current posture.

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NOTE:

MUCH OF THE INFORMATION IN THIS PAPER IS THE RESULT OF THE AUTHOR'S PERSONAL EXPERIENCE WHILE WORKING FOR THE U.S. ARMY IN VARIOUS POSITIONS AND SHOULD NOT BE CONSIDERED A STATEMENT OF DEPARTMENT OF DEFENSE POLICY.

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PREREQUISITES FOR THE ESTABLISHMENT OF A PROFESSIONAL ACQUISITION WORK FORCE

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ADP002763

ABSTRACT

Government, Industry, and Academe can make and are making great strides toward establishing a professional acquisition work force. Prerequisite to achieving that goal is that each component do everything it can individually as well as collectively. Presently, there are tremendous barriers to establishing a professional work force and an additional danger of losing ground already gained. Too much is made of some gains that on the surface appear significant. However, by working together the goal of a professional work force can be achieved, but failing to work together will keep it beyond grasp.

INTRODUCTION

In July 1982, William N. Hunter, Director of the Federal Acquisition Institute stated, "By joining forces with our peers in the agencies, the professional associations and the private sector, much has been accomplished together that none of us could have accomplished alone." [6] This is the Synergism that is the central theme of the 1983 Federal Acquisition Research Symposium, "Government, Industry, Academe: The synergism for Acquisition Improvement." Among the key elements to achieve these synergistic effects are cooperation and organization of efforts. Some of that is occuring now, but there are not enough group efforts adequately organized to achieve anywhere near the potential for progress that true synergism of Government, Industry, and Academe can offer. Because of this, the future of the acquisition work force and acquisition in general is facing a crisis. The crisis is the question of whether professionalism in the acquisition work force can be achieved. And this is not a question limited to the problems being generated by the Office of Personnel Management (OPM). The problem is that Government, Industry, and Academe have not done enough, individually or collectively, to create and maintain a professional work force in acquisition management. One of the issues that we face in achieving professionalism is that each element of this acquisition "triumvirate" has yet to "get its own house in order", as a prerequisite to establishing a professional work force. Each individual component must drive to establish a professional acquisition work force. If all components do not work together to accomplish the task, it will not happen.

GOVERNMENT

The Government is the first element of this triumvirate and speaks out for the need for professionalism. The Proposal for a Uniform Federal Procurement System states, "As procurement becomes more complex and important in carrying out agency missions, professionalism of the procurement work force becomes increasingly critical." [11] In his testimony on the Federal Procurement Work Force, Donald E. Sowle, Administrator for Federal Procurement Policy, Office of Management and Budget, said, ". . .I believe that a program to develop a more professional and competent work force would rate near the top." [16] At the same hearings, Professor Harry Page of George Washington University testified as to the present state of this professionalism. "Very few of the present work force are so prepared. Perhaps one third are college graduates and no one knows how many of these have actually studied business and management or related subjects." [9]

The philosophy would appear to be toward a professional work force, but what of the reality. There has been a tremendous amount of criticism leveled at the OPM because of attempts to lower the grade levels of acquisition professionals (GS-1102 Series Positions) from one to two grade levels. Lloyd J. Walsh of the National Contract Management Association National Board of Advisors, views this with alarm, "A recent Office of Personnel Management (OPM) action will, in my judgement, seriously impact the professionalism of the Government contracting community...diminish the liklihood of successfully accomplishing major Government acquisition procurements... A further impact will be the inability of the Government to attract entry level personnel with appropriate education and training to cope with complicated government procurement processes." [18] Although Mr. Walsh points to the potential of a bleak future, the situation is that the bleak future is already with us because of the failure of OPM to establish professional level requirements for hiring of acquisition personnel. "The prevailing qualification standards and selection procedures have encouraged the promotion of clerical and technical employees into professional-level procurement positions, while inhibiting the recruitment of college graduates. In recent years, two-thirds of the Government's entry level procurement positions were filled from clerical and technical ranks. Although some of these employees perform well, many lack

the aptitude and analytical ability necessary to function effectively as procurement professionals." [11] In recent news stories, we have seen the results of this policy as it was disclosed that the Government was purchasing spare parts at exorbitant prices. "Defense Secretary Caspar Weinberger blamed spare parts overpricing on 'an absolute pattern... of clericalization'." [1] If this were a singular example, there would be no reason for concern. However, it appears to be just one instance indicative of a growing pattern.

The problem is not, however, the result of only the OPM. A recent Department of Defense Audit Report stated that all three services had failed to establish adequate career programs in acquisition management for either military or civilian personnel. [5] Recruiting Bulletin DCP 83-2 for Professor of Procurement Management at the Air Force Institute of Technology neither required nor requested a professional designation, required only a Bachelor's Degree which included or was supplemented by major study in education or in a subject field appropriate to contract management (listing eight examples, none of which was acquisition or contracts), and allowed substitution of graduate work in lieu of contracting experience. Are those the qualifications of a Professor of Procurement Management? The problem is not one that is limited to the Department of Defense. "Intern programs are one of the proven sources for developing highly qualified procurement personnel. However, most agencies have not given such programs sufficient priority; many agencies have no program at all." [11]

The problem of professionalism in the Government acquisition work force is further compounded by the fact that those individuals that are in the work force cannot get the training that they need to do an adequate job. "As a result, (of lack of funds) many procurement specialists have not been given needed training." [11] In addition to the lack of funds, there is a lack of sufficient personnel to both accomplish the mission and allow individuals to go off and get the training that they need to do an adequate job. [9]

Lack of standards for hiring, lack of programs for advancement, and lack of adequate training contribute to the fact that the Government procurement work force has not established itself as a professional work force. And based on the evidence available, the future would not appear to hold anything to brighten the view. The only result of this can be that there will be more examples of waste, abuse, and fraud in the future.

INDUSTRY

The second component of the triumvirate is Industry. Anthony Ratkus, Jr., the National Contract Management Association Certification Director, seems to think that the private sector is doing much better than the public sector in promoting professionalism in the acquisition work force. "The proof of any professional credentialing program is acceptance by employers. Recently, I counted in my local newspaper, 15 advertisements for procurement personnel. Of these, 10 listed the CPCM as desirable. To me this demonstrates a need of employers to separate the 'wheat from the chaff'." [13]

The results of a similar study of my local newspaper, the Los Angeles Times, is not as heartening. A study of 450 advertisements appearing from 2 February 1983 through 19 June 1983 reveal some disquieting statistics. Taking the area of Professional Certification, from any organization, 2.89% of the advertisements made such a request. Not nearly as many as in Mr. Ratkus' local newspaper. Professional degrees (MBA, Law, Engineering, Accounting) were requested in 20.44% of the advertisements. And only .44% requested Acquisition Training. These results compare to such areas as Citizenship (23.33%), Travel (6.00%), Ability to Interface (13.33%), and Foreign Language (1.33%). It is interesting to note that knowledge of Korean, Spanish, or the ability to work in short sleeves were all of equal importance with acquisition training.

The results of a study of 69 advertisements appearing in Contract Management, the NCMA's official publication, from January 1982 through June 1983 were also very disquieting. The expectation would be that the requirements listed here would have been much greater. Acquisition Training appeared in 5.80%, Certification in 13.04%, and Professional Degree in 39.13%. These compare with such requirements as Travel (5.80%), Citizenship (21.74%), and Salary History (49.28%). It should be of great concern to all of us that Industry appears to be much more interested in what are our salary requirements than in how well prepared we are as acquisition professionals.

The Government is, obviously, not alone in needing to reform its own internal requirements. Both Government and Industry must accomplish a good deal of internal reform. There should come a day in which all Government positions and all Industry positions require Acquisition Training (100%), Professional Degrees (100%), and Certification (100%). That day would appear to be very far away, with the potential to get farther and farther away if all components of the triumvirate do not reform themselves and begin to work together for common goals.

ACADEME

And what of the third member of the triumvirate, Academe? The strides that the academic community has made are tremendous. "In the past decade, there has been a remarkable growth in the number of colleges and universities offering procurement related courses. Today, such courses are available from more than 230 colleges and universities." [11] Unfortunately, one of the operative phrases in the citation is procurement related courses. In some instances, this can be as little as one course in Government Contract Law or just Contract Law. The truth of the matter is that one is more likely to see a school curriculum contain Transactional Analysis or the Psychology of Human Sexuality or Sailing.

A survey of educational institutions conducted by the Federal Acquisition Institute indicated 24 institutions offering Master's, 7 offering Bachelor's, and 6 offering Associate's Degrees in procurement. [8] When one considers that California alone has 19 California State Colleges and Universities, 9 Universities of California, 114 California Community Colleges, and 130 Private and Alternative Schools, 272 schools in all, the great strides forward appear somewhat less promising.

There is a degree of synergism present in this situation. Unfortunately, it has the reverse effect of achieving a professional acquisition work force. "Even though the history of procurement goes back many years, it has a relatively low status as an occupation. One cause of this situation is the fact that no distinct curriculum has been available." [10] That situation is changing, as the recent past has indicated, but a tremendous amount of work lies ahead in establishing a distinct curriculum for acquisition and in persuading schools to adopt it. Continuation of the same pattern will prevent acquisition from becoming a profession.

GOVERNMENT, INDUSTRY, ACADEME

Each of the individual parties of the triumvirate have a good deal of work ahead. But an even greater amount of work must be done to achieve the synergistic effects that are possible. And that work needs to be started in several areas. "The professional certification movement should be recognized by OPM." [9] The big hurdle in the future will be the Government's recognition of the acquisition/contracting degree or professional certification (preferably both)... Without this kind of recognition, we will not make the kind of breakthrough that is necessary to reach a high state of professionalism." [2] Government, Industry, and Academe must recognize the needs for improving the acquisition, and must work together, as well as separately, to achieve that improvement.

The work to achieve synergism has already begun. Industry is taking advantage of the courses and programs that educational institutions are making available. "Our company (TRW), like almost every other company, lends encouragement and financial support to employees who wish to improve themselves in this way." [15] The problem has been, in many cases, that the schools have not been offering the courses and programs needed. "Educators have been slow to recognize the necessity for a purchasing curriculum." [10] Where the educational institutions have been slow to come to understand this need, Industry and Government have worked together with Academe to achieve the synergistic effects that are so desirable. The programs established at American University [7], Northrop University [14], and Saint Mary's College [3] are all very fine examples of what can be achieved through cooperation. Brigadier General William E. Thurman, then Commandant of Defense Systems Management College, asked about the importance of this cooperation responded, "It would be appropriate for us to do that, because the sooner we can start the education process, the less we'll have to do down stream when the individual graduates from college and comes to work for government or industry...so we're really helping ourselves." [12]

Some of the programs that have been designed and implemented have been highly successful. The program at American University offers a combination of classroom experience and cooperative education with industry or government. The result of the program is a 99% placement rate. [7]

SUMMARY

There is a great potential energy in Government, Industry, Academe for acquisition improvement. Each area must, however, overcome the inertia and stumbling blocks in its own arena and, at the same time, reach out in an organized, cohesive way to try and initiate further development of those connections which will bring the Government, Industry, Academe synergistic effects to full fruition. Eacn element of the triumvirate must be assured that its efforts will be recognized and utilized by the other segments in building a strong, effective, and professional acquisition work force that will lead us into the twenty-first century.

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TRAINING REQUIREMENTS FOR CHANGING TIMES

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ABSTRACT

Federal Managers in the procurement career series have become concerned that there appears to be a need to increase the skill level in the career field. The Office of Personnel Management has demonstrated a perception of the procurement career field, as less professional and more administrative in nature, by their efforts in revising the job standards. This perception and current events highlight the subject matter of this paper. The author utilizes data researched from the Federal Acquisition Institute on the educational level of the Government procurement careerist to arrive at his conclusions. The statistical data is supplemented by discussions conducted with industry and Government leaders during recent National Contract Management Association (NCMA) meetings and symposiums.

The author makes certain recommendations to improve the overall development of the procurement career professionals.

DISCLAIMER

The views expressed in this paper are those of the author and do not necessarily reflect the official policy or position of the Department of the Army or Department of Defense.

BACKGROUND

The Office of Personnel Management (OPM) has been developing job standards for the Procurement Career Field (GS-1102 series) for the past several years. These standards have been challenged by Government Agencies who are concerned that there would not be an allowance for nonsupervisory GS-15 positions for Contract Specialists or Contract Negotiators. These special positions are used to provide top flight Government negotiators the pay they deserve for handling major system contracts. Other solicitudes voiced were that the OPM action would result in a general downgrading of about two GS grade levels across the board in the GS-1102 series. Industry joined with the Government Agencies to raise their concerns that this general downgrading would result in the eventual loss of quality people in the Government and would consequently make industry's job more difficult. Industry has already experienced some difficulty with some of the new people who have been placed in positions to negotiate for the Government.

What has prompted OPM to take this radical step? What has contributed to the proposed downgrading? OPM gathers statistical data on the educational level of all career fields, which OPM reviews for Government educational training needs for the career fields. In addition, at a recent NCMA Symposium on Professionalism, in Florida, one of the panels indicated that there is a perception that the procurement career field is viewed by OPM as being more administrative than professional. Why? Because of the substantial number of people who have entered the procurement career field with little or no college training, was one thought voiced by a panelist who was directly interfacing with OPM on the job standards. This lack of a requirement for college training during the progression up the career ladder was tendered as another consideration. Also, those who do have college training have little or no business type courses in their academic background. Another viewpoint, which was expressed by top leaders in the Government who attended the symposium, was that upward mobility has been mandated to fill many vacancies throughout the Government in recent years and that this upward mobility has emerged from the clerical and administrative ranks or from other groups of people with little more than high school educations. This socially inspired action has allowed OPM to develop a jaded perception of the procurement career field as being one in which people with only an administrative background can master. They do not look upon the procurement careerist as being in the same class as lawyers, engineers, accountants, personnel specialists, etc. This assessment, as indicated by one speaker in private discussions with the author, has been fueled by the rapid progression of these new procurement careerists, who have had little or no college level business training to supplement their Government courses or on-the-job training, into journey level positions. One panelist pointed out that OPM does not view Government courses as substitutes for college level training, but more as a survey or supplemental training which builds upon basic education.

Most of the Federal Civilian Agencies do not provide much formal Government training to their procurement work force. It has long been recognized that the Department of Defense (DOD) has the finest training program for procurement personnel. Some of these courses which have been developed by DOD are prized by the Federal Civilian Agencies. Consequently, those Agencies make a substantial effort to obtain spaces in DOD procurement courses for their employees.

When we look at the Procurement Intern Training Program in the Army, we see a very structured training program which is an acknowledged model for the development of procurement careerists. In the initial development of the Army Procurement Intern Program, the managers did not plan to have college level courses included in the Program of Instruction (POI) because most of the interns had college degrees as they were being recruited from college campuses. The managers determined that these procurement interns could be trained successfully, utilizing only Government conducted procurement courses and on-the-job training. During the course of the several updates to the Procurement Intern POI, the author had stressed the need to have a core of college courses included as part of the POI. These courses would incorporate business related subjects which would benefit all those Procurement Interns who did not acquire college training in the business disciplines. However, some of the managers argued, successfully, that because of conflicts with scheduled training required for this program, it may not be possible for these individuals to secure the additional training in business related subjects concurrent with their initial 2 years of the scheduled program of instruction. The training for the Contract Specialist, Price Analyst, Contract Administrators, and Procurement Analyst journey level people who are needed in the career field must not be limited to the Government sponsored procurement courses and on-the-job training. Management at Headquarters, US Army Armament, Munitions and Chemical Command (AMCCOM) has long recognized the need to provide business courses to the work force and has contracted with local colleges to provide a basic course in accounting on the installation, immediately after the workday. Employees who need or desire this type of training for their job are encouraged to attend the course, and the command has agreed to subsidize a major portion of the cost. This is just one of many examples of AMCCOM Management's commitment to upgrade its work force. AMCCOM has for years allowed the procurement interns to take college courses and post graduate courses, which were job related, in order to enhance their capability in their on-the-job performance. Many Army Interns were provided tuition assistance from AMCCOM's training budget even though it was known that they may not remain at AMCCOM. Other commands in the Army have not been as liberal and did not permit this type of training.

AMCCOM, in cooperation with the NCMA's Quad Cities Chapter, has encouraged St. Ambrose College in Davenport, Iowa to develop and offer an undergraduate degree program in procurement. This program provides an opportunity for people who lack certain elements of training in the business discipline to take this training during the evening and on weekends. In fact, a 4-year degree program can be completed in 4 years in a program conducted Tuesdays, Thursdays, and Saturdays. These courses are scheduled at convenient times which allow Government and industry employees an opportunity to take such courses while they continue with their normal employment. These are just a few examples of the leadership in education that has been exhibited by AMCCOM over the years. Managers throughout Government must understand that the training courses which have been developed by the Government are only intended to build upon other training and experience received in college and in the private sector work world. Government training adds dimension but does not act as a substitute for basic knowledge. Training in college or university provides the needed understanding of certain business principles which permits the employee to understand the language of the business world.

The Government must determine what the future procurement careerist will need in the way of training and basic knowledge in order to perform that mission of making purchases of supplies and services for the Government. There is little doubt in anyone's mind that the future of the procurement process will be automation. Much of the routine clerical work, that is performed today, will be accomplished automatically by computers. On the leading edge of this technology is the expanded use of computers during the course of negotiations. The Procurement Directorate of AMCCOM is already using mini-computers for should cost teams, which have proven to be effective, even with the limited application that has been made of these computers to date. What we will see in the future will be a dramatic increase in the use of these mini-computers to perform more of the routine procurement work elements and freeing personnel for other more important person-to-person tasks.

INDUSTRY SPEAKS OUT

At an NCMA Symposium in Florida in the Spring of 1983, the author talked to several industry leaders who explained that when they faced well-trained, intelligent Government employees, their job was made substantially easier in many respects. As an example to clarify this statement, contractors, in dealing with people, who have business training at the college level do not have to pause and educate Government negotiators in the understanding of some basic accounting and economic principles during the course of their business dealings. This eliminates a lot of unnecessary irritation during negotiations. One contractor whose firm has done a lot of Government work with NASA and the Department of Defense indicated that his firm was concerned by the OPM effort because it could cause a lot of good people to leave the

Government. This could leave on the Government's rolls only those people who could not obtain employment elsewhere. The industry spokesman indicated that these people tend to be slower in issuing contract modifications and processing paper because they lack the knowledge and professional confidence which is exemplified in the higher quality people. This loss of time would adversely affect a contractor's cash flow and, thus, increase the time to process even simple change orders to contracts.

WHAT DOES THE FUTURE HOLD?

The Government must take some guidance from industry in their hiring and promotion of people. As a common practice, industry fills their mid-level management positions with college trained people. Industry assures that people already possess or actually obtain the necessary formal business or speciality training and other experience to allow them to be tested in the marketplace. Remember that industry's objective is to make a profit and stay in business. Mistakes are costly in career progression as well as impact directly upon survival of the company.

Industry has already advanced to the use of electronic technology in the office place because of its cost effectiveness. Many legal firms have purchased computer assisted legal services that remove much of the routine work from legal research and provide more time to develop case positions. The stock brokers, because of the volume of stocks being traded, must rely on the computers for buying/selling stock and a host of other technical services. Industry is moving at a rapid pace into a world of paperless offices. It has already introduced this paperless effort into contracting with some of its suppliers. Industry is only a few years away from the point where all of the contracting will be accomplished via computers. The capabilities of this concept exist in the technology which is currently available in the computer equipment advertised today.

STATISTICS FROM FAI

In order to determine the educational level of the GS-1102 career workforce, the author contacted the Federal Acquisition Institute (FAI) for some information. Mr. Michael Miller of FAI indicated that they obtain OPM statistical data on the educational level of the GS-1102 series, and they had data through September 1982. The data is used in the development of training needs and for other purposes by FAI. The information used is for the fiscal years ending in September 1981 (FY 81) and September 1982 (FY 82). The data is as follows:

GOVERNMENT WIDE DATA FY 81

The following data is provided on the entire work force:

24.4 percent of employees had only BA degrees,
8.2 percent of employees had post-BA training
1.0 percent of employees had first professional degrees,
7.0 percent of employees had Master's degrees,
.2 percent of employees had Doctorate degrees,
40.8 percent of employees had a college degree or better.

Mr. Miller also provided the following information on 2241 people who entered the career field for the first time in fiscal year 1981:

13.4 percent of employees had only BA degrees,
4.2 percent of employees had post-BA training,
.7 percent of employees had first professional degree,
5.0 percent of employees had Master's degrees,
23.3 percent of employees had a college degree or better.

- 1044 persons were hired from outside Government and had the following educational backgrounds:

33.0 percent of employees had only BA degrees,
11.8 percent of employees had post-BA training
2.7 percent of employees had first professional degrees,
13.3 percent had Master's degrees,
.5 percent had Doctorate degrees,
61.3 percent of employees had college degrees or better.

Combining these figures shows another picture:

19.6 percent of employees had only BA degrees,
6.6 percent had post-BA training,
1.3 percent had first professional degrees,
7.6 percent had Master's degrees,
.1 percent had Doctorate degrees,
35.2 percent had college degrees or better who entered the 1102 series in 1981 fiscal year.

The data for FY 82 indicates that there was some improvement from the statistical data of the prior year, but only a small improvement. The following is the statistical data for FY 82:

- 2157 employees entered from within Government during FY 82 and had the following educational backgrounds:

-- 32 percent of employees with BA degrees or better,

-- 68 percent of employees with no college degree,

- 852 were hired from outside Government and had the following educational backgrounds:

-- 70 percent of employees with BA degrees or better,

-- 30 percent of employees without a degree.

The statistical data of FY 82 indicates a similar trend to the FY 81 data. This trend shows that employees brought into the GS-1102 series from within the Government tend to have a lower educational level than those hired from outside the Government. Let us examine some additional statistics that were provided by FAI:

Government Wide GS-1102 Employment

22,165 employees in the GS-1102 series on board 30 September 1982
13,062 employees do not have degrees
9,103 employees have degrees

Of the 9,103 employees with degrees only 4,766 have business related degrees (21.5 percent). The balance possessed degrees in Engineering, Law, Mathmatics, Physical Sciences, Public Administration, etc. Mr. Miller indicated that although the Government had hired 6,294 people in the GS-1102 career series in the last 2 years (28 plus percent of the entire procurement career work force on board 30 September 1982) the total statistical average of those with degrees over the past 5 years had remained flat. He indicated that the Government had an excellent opportunity to make an appreciable improvement in the percentage of employees with degrees but, for whatever reason, did not. What is even more alarming to the author is that only 21.5 percent of the entire work force has business related degrees in a field which is business oriented. Is this lack of formal business training significant? Does it manifest itself in the quality of procurement? Are courses in business absolutely necessary to perform satisfactorily in the procurement career field? The answers to the first two questions require additional in-depth study, but the answer to the last based on current statistical trends and management's socially oriented actions, must be a qualified, "NO."

PROBLEM AREAS

In recent weeks, we have read newspaper headlines which proclaimed that Government Procurement personnel had awarded contracts for repair parts at prices which were, on the face, exorbitantly high. Facts were presented that the Government was literally giving away money for an item which at a local hardware store should cost a couple of dollars, but for which the Government ended up paying several hundreds of dollars.

Does this mean that the system under which we purchase products is wrong, or is it the lack of effective training of those people who are involved in the procurement system? At the annual meeting of the NCMA in Los Angeles in June 1983, the author discussed this matter with some high level Air Force policy-makers, and it was felt that what was needed was less automation and more qualified people who are better trained to think. The feeling was that well trained buying personnel, who understood marketplace operations and knew the product that they were buying, could make an analysis of cost and pricing data, and would not make some of the basic mistakes or overlook such conditions which resulted in the news grabbing stories being published. One must be well trained in the language of the marketplace, as well as in the language of Government Procurement, in order to perform professionally in Government contracting. There are those who can now attack the Government for not adequately providing its personnel with business training in such situations. Management can not say, "We have done all that is possible to insure that our people are fully qualified to do the job," in defense of their stewardship of the procurement dollar, unless the training program they utilize is complete.

At the NCMA Annual Meeting, more than one procurement manager indicated that the educational level of the work force is an area that must be targeted for improvement. This lack of basic academics is why the NCMA and the FAI are working to have more local colleges offer undergraduate training for procurement and contracting people in industry and Government. The NCMA is also urging that the colleges provide the training during periods of the day which are convenient for the employed student to stimulate more individuals to obtain this training and not interfere with their family life.

Another area that was highlighted at the NCMA Annual Meeting in discussion with Government managers was the need for good file documentation. This documentation is essential when the unit price of an item being purchased is unusually high. The Contract Specialist with proper training could develop the correct documentation that would provide the necessary rationale to permit an investigator to see how

the price was justified as fair and reasonable. An understanding of economics, accounting, and other elements of the business disciplines are essential in order to properly make this analysis. This skill, coupled with the ability to write proper English, would go a long way toward eliminating most of our procurement problems.

Education that provides training in economics can provide the procurement careerist with a better understanding of the economic trends of the market place and how these trends and forces affect basic costs. Understanding of accounting principles can provide the Contract Specialist with an understanding that each item produced has to share an appropriate amount of indirect costs as well as the general and administrative costs of the company. It also provides an understanding of start-up costs and how, when they are amortized across a small number of products, these costs can distort the picture of the per item costs. In addition, the understanding of other business related subject areas may also assist the buyer to make a good analysis of cost or price which can be of benefit to the Government.

CONCLUSION

The world of the paperless office, with the expanding of electronic visual sending, storage, and retrieval systems, will become commonplace in every Government office before or shortly after the year 1990 and will require substantial additional training for Government employees. More and more people will need to be trained, not only in the basic use of computers, but in how to apply these time saving computers in the contracting arena. By the use of special programming to solve many of the contracting problems, the Contract Specialist will be able to devote more time to development of negotiation parameters and to the task of face-to-face negotiations. Further, a more professional, well trained procurement work force should preclude problems such as those recently identified. Contracting people will be able to preclude the paying of unreasonably high costs by their evaluation of the proposals and will facilitate better negotiations. With better documentation of contract files, a price that appears unreasonable on the surface would be explained or challenged immediately. This challenge is required to be made by contracting personnel to the requirements people who may have to purchase additional quantities to obtain price breaks or to cancel the requirement and wait until more units can be ordered.

In no event will the evolution of computer technology mitigate the need of contracting personnel to have more knowledge in the area of accounting principles, economics, commercial law, and other related business subjects. Knowledge in these areas is required to be coupled with the computer technology so that contracting practices can improve and preclude problems such as have been described in this paper.

RECOMMENDATIONS

The Government must move immediately to tighten up the requirements for entering the 1102 procurement career series. The development of a replacement for the PACE examination should be high on the list of priorities to be accomplished.

More stringent criteria for the promotion above the GS-09 level, or even to the GS-09 level, should be developed. For example, the US Air Force requires enlisted non-commissioned officers who are in the procurement career field to pass written examinations in order to qualify for promotion to the next higher grade. These tests are a survey of how much the non-commissioned officer knows of the Defense Acquisition Regulation (DAR), which is the basis for all the decisions on procurement that contracting people must make during the course of their work. It would appear that a similar examination for civilian procurement careerists would be appropriate. This would allow the development of a list of people who have enough knowledge of their career field to be considered for advancement. Before advancing from GS-11 to the GS-12 level, serious considerations should be given to requiring the passage of the NCMA test for Certified Professional Contracts Manager. The passage of this examination would not, in itself, guarantee a promotion, but would place the person on the list of people to be considered for promotion. At this point, the usual interview and performance rating considerations would have to be used as the discriminators between the average and the best qualified of the candidates for any vacancy. Selection would still be based on more than the passage or score of the test taken for advancement.

The Government must begin requiring more business training for those entering or progressing in the procurement field. This is not limited to those without degrees, because those with degrees in other than business disciplines need the aforestated business courses. The Procurement Intern Training Programs must be revised to provide for this type of training if the interns have not already had the training prior to their entrance. The Procurement Intern Training Program could provide for the necessary formal training, and also, for the completion of that training before the intern qualifies to be promoted to the next higher grade. This requirement for business training would be set out in the announcement for the program so that the

applicants would know that such formal training in principles of accounting, economics and cost accounting, business law, basic college English, and college math would be required of all interns before graduation from the Procurement Intern Training Program. The individuals who were selected for the Procurement Intern Training Program would be given an individual development plan to include the course of training. This course of training would consider all formal training. Those with college degrees in non-business disciplines would also be required to obtain the needed college level core business courses before they would be promoted above the GS-09 or GS-11 level, depending upon the grade they entered the career field. These courses would be provided during normal work hours and could be contracted for by the training activity or funds could be provided for the Procurement Intern to take the training at area colleges near the training location. Certain courses would be required prior to the employee advancing to the GS-07 and GS-09 levels. How rapidly the intern could advance would be governed by the amount of the business training that had been accomplished prior to enrollment in the Intern Program and how quickly the person could accomplish the required training and, thus, be eligible for promotion to the next higher level. Satisfactory completion of all training would be mandatory prior to the successful completion of the phase of training. In addition, the intern must be exposed to computer training to insure that the person would be able to function in the world of computers, a world into which we all are entering.

The Government must begin to introduce the existing procurement work force to more computer training, on a systematic basis, in order to be ready for the office technology that is being thrust upon the Government. This training should not be designed to make computer analysts or computer programmers of the procurement careerists, but permit these people to use the modern tools that are available and will become available to them in an efficient manner in the execution of their daily tasks. This training should be provided initially to procurement careerists who have an immediate need because of their job. Later, if the training funds are available, all could be trained. It is important that the work force receive this training to insure smooth transition into the total automated office, which will exist by the year 1990.

A DYNAMIC PERSONNEL ASSIGNMENT MODEL IN THE R & D ENVIRONMENT

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ADP002765

ABSTRACT

This computer simulation captures the contributions of inexperienced and experienced personnel to overall effectiveness in a typical research and development organization.

The model is appropriately responsive to changes in expereience level, System Program Office (SPO) leadership, priority, funding, and other factors. Given a fixed number of total personnel authorizations and fixed percentage of inexperienced personnel, the model indicates that assigning the inexperienced to the lower priority SPOs results in a maximum organizational measure of effectiveness (MOE). It also shows that an assignment policy based upon both priority and funding level may have only small impact upon this high MOE. Similarly, assigning all of the inexperienced to the high priority SPOs results in a relatively low MOE. Improving the SPO leadership increases the value of the MOE, but cannot compensate for high percentages of inexperience. The model can also be used to assign SPO leaders.

INTRODUCTION

Personnel assignment policies can significantly affect the performance of any organization. This pilot study dynamic computer simulation captures the cause and effect relationships of experienced and inexperienced personnel assignment policies with overall organizational effectiveness.

The model is quite flexible and includes multiple R & D phases and several different R & D Programs. Other innovations are included that significantly add to the utility of the model.

BRIEF SUMMARY OF METHODOLOGY AND MODEL

After developing a general flow diagram of the weapons system development process and with the assistance of Captain Michael Tankersley of the Air Force Business Research Center and Mr. James Cooley of the Aeronautical Systems Division (ASD), the author explained this diagram to eight eminently qualified ASD program managers. They understood the objectives of the study, their participation requirements, and the causal effect relationships associated with the weapons system development process.

These program managers (PM) also completed a survey instrument that was used to quantify their perceptions of SPO operations. The PMs plus nearly two dozen other qualified SPO program managers were next provided a second survey that measured their perceptions of the relative importance of cost, schedule, and performance.

The model is based upon the feedback relationships of personnel contributions upon cost, performance, and schedule during the weapon system development process. This initial model contains multiple R & D phases. It shows cost, performance, and schedule progress plus the measures of effectiveness as a function of time in both graphical and tabular form.

SURVEY AND SIMULATION RESULTS AND FINDINGS

Survey Results: The initial survey was completed and returned by six participants. The results show: 1. Not only that the more capable SPO Director make a greater impact on progress than a less capable person, but also the respondents' perception of the magnitude of this effect. 2. That increasing funds by 50% will increase progress by only 24%. Decrease funds by 50% results in nearly a 50% decrease in progress. 3. That the respondents perceived that the top SPO Directors can effect significant (43 percent) changes in progress when they desire to do so. The worst SPO Directors actually can slow progress when they desire and take action to improve progress. 4. That the respondents' perception of the time delay required between progress and the reporting of that progress within a SPO. The data indicate a four plus month delay that is little affected by the size of the SPO. 5. That respondents perceived that high priority SPOs could receive additional funds much sooner that low priority SPOs. 6. That the respondents perceived that education can significantly affect individual performance with the M.S. holder believed to be the top performer. 7. That individual performance is greatly affected by grade level. The GS-12 and 13 are perceived to be the highest performers in the SPO environment. 8. That the respondents perceived that performance continues to increase as more and more R & D experience is gained. 9. That little variability, indicates the respondents believed that the number of different SPO assignments had little effect on individual performance.

The second survey instrument was designed to solicit paired comparison responses in order to quantify an overall "ASD" measure of effectiveness (MOE) as a function of individual SPO cost, schedule, and performance activity. This survey indicated that the most

powerful factor in structuring a measure of effectiveness for ASD is cost and that being on or under cost is very significant. Being over cost is the most damaging to overall program or SPO success. Performance generally is more important than schedule. This indicates that when trades in performance or schedule are required, SPO personnel will prefer performance over the schedule--the system may be delivered late but it will meet the performance specifications. See Figure 1.

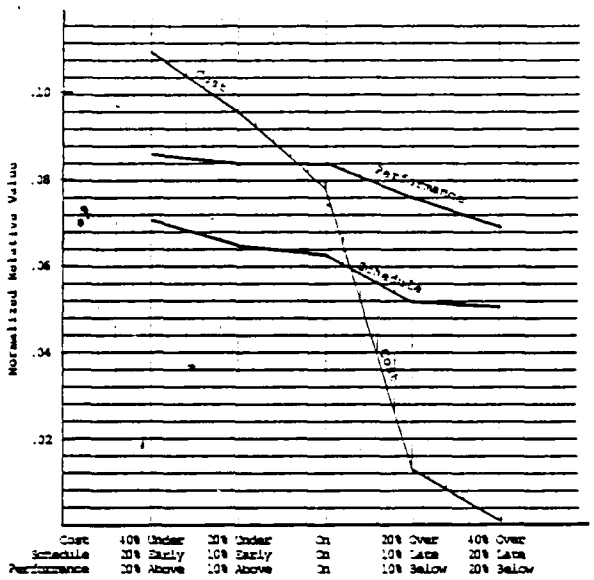

Figure 1.

Also included with this survey were questions concerning funding level and priority. The respondents were asked to indicate which would be a better organizational performance measure. Twenty of the twenty-one surveys received has this section completed appropriately. Three respondents selected funding level and seventeen selected priority as being the more important factor for use in the MOE equations.

Findings: Several factors can affect an overall organizational measure of effectiveness (MOE) and the model indicates that SPO Director effectiveness, priorities, and funding (dollar values) can significantly affect the resultant MOE value. Since most survey respondents considered priority rather than funding level as critical in determining a MOE, the basic model assumed an equal funding level for both high and low priority programs.

Table 1 shows the data for various alternative assignment policies used in a small demonstration of how the model would be used in the R & D environment.

ORGANIZATION DATA FOR DEMONSTRATION

Assumptions: 6 SPOs in the organization
1500 Total personnel
300 Inexperienced personnel
1200 Experienced personnel

SPO Identifier	SPO Priority	Relative Funding	Combination	Authorized Personnel
A	1	5	5	500
B	2	2	1	200
C	3	1	.333	100
D	4	2	.5	200
E	5	4	.8	400
F	6	1	.167	100
			Total	1500

Table 1.

SPO Priority = Organizational Priority
Relative Funding = (SPO Funding)/(Funding of Minimum Funded SPO)
Combination = (1/Priority) (Relative Funding)
Authorized Personnel = (Relative Funding)(100)

NOTE: Only one phase is used from model results in the demonstration. Multiple phases could easily be used if desired.

Possible Policies:

I. Equal distribution of experience
II. All inexperience to low priority SPOs
III. Inexperience to low combination of priority and funding
IV. All inexperience to high priority SPOs

Measures of effectiveness for each SPO with each policy and an organizational MOE are shown as the total in Table 2.

	Policy			
SPO	I	II	III	IV
A	30.96	33.77	33.77	24.55
B	6.19	6.75	6.75	6.75
C	2.06	2.06	1.31	2.25
D	3.10	3.10	2.62	3.37
E	5.39	4.19	5.39	5.39
F	1.12	0.65	0.65	1.12
Organizational Total	48.82	50.52	50.49	43.43

Note: All the numbers in the table are organization MOEs.

Table 2.

These demonstration results show the impact of four different personnel policies for a six-SPO organization. In this case, Policies II and III are superior to either I or IV. Assignments of inexperience personnel should be either to the low combination of priority and funding or exclusively to the low priority SPOs. Various priority and relative funding would impact on the MOE and the solution would be appropriately different from those shown in Table 2.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions: This pilot study shows that computer simulation can contribute to improving personnel assignment policies for the R & D organization. The affects of varying the assignment policies to both experienced and inexperienced SPO personnel, the effects of SPO priority, funding, and leadership are demonstrated by the model.

This study utilized two rather small surveys and has not been validated by actual test or implementation.

Recommendations: This pilot study is the beginning of a series of efforts that must be completed prior to implementing the results. Below are listed the recommended steps necessary to validate the model results.

1. Conduct and evaluate a formal and large-scale survey of R & D personnel perceptions of the Research and Development process. The initial survey of this study could be modified and used to meet this need.

2. Conduct and evaluate a formal and large-scale survey of R & D personnel perceptions of the relative values of cost, schedule, performance, priority, and funding in R & D as it applies to the organizations. The second survey of this study will require significant modification and improvement for clarity, but is a beginning for this effort.

3. Conduct and evaluate a formal and large-scale survey of R & D personnel perceptions of other factors such as leadership, delays, etc. that are significant to model results.

4. With these new survey data the model should be modified and exercised. A significant number of policies should be tested in order to seek out the best possible and workable personnel assignment policy for the organization.

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ADP002766

TRAINING ACQUISITION PERSONNEL THROUGH A LOCAL COLLEGE

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ABSTRACT

There are two important keys to effective and cost conscious acquisition of goods and services for the Air Force: The first is a work force trained in current acquisition skills; the second is a reservoir of qualified people for entry into the acquisition career field.

To enlarge the pool of qualified people and to provide training opportunities for people in the career field, our Directorate initiated action to establish an Associate Degree Program in Purchasing and Contracting at Oscar Rose Junior College. The program is now in being and a number of our people, both clerical and professional, are attending classes offered through this program.

INTRODUCTION

From 1979 to 1982 our Directorate's dollar expenditures increased from $1.2 Billion to $2.2 Billion while our work force has remained around the 500 level. Our older people are retiring, and we are also experiencing a turnover of trained personnel leaving for what they consider better opportunities. We need to enlarge the pool of qualified personnel for entry into the career field. We have three possible sources of people. One source is outside hires. Our authority to hire from outside the Government is limited at this time. Another source is clerical personnel currently in the Directorate who qualify through an Upward Mobility Program. The third source is current Tinker AFB employees (from outside our Directorate) who have qualified themselves through education.

Another need is to provide training for those already in the career field. DOD Manual 1430.10-M-1 sets forth mandatory training courses. For the GS-1102 Contract Specialist/ Contract Negotiator job series they are:

ENTRY LEVEL (GS-5 through 8)

Management of Defense Acquisition Contracts

Principles of Contract Pricing

Defense Contract Negotiation Workshop

INTERMEDIATE LEVEL (GS-9 through 12)

Management of Defense Acquisition Contracts (Advanced)

Government Contract Law

Introductory Quantitative Analysis (When required by position)

Other courses are mandatory for personnel in GS-1101 and other GS-1102 specialties.

The third need is to provide an avenue for our clerical people to progress into the professional job series. We find that there are many highly-motivated, and otherwise qualified, people in the clerical job series who strive for positions in the professional job series. The Upward Mobility Program provides them that opportunity, but, until now there were few specifically acquisition-oriented courses available.

PLANNING THE PROGRAM

To meet these needs our Directorate initiated action to establish an Associate Degree Program in Purchasing and Contracting. In early 1981, an "Ad Hoc" Committee was formed by our Deputy Director, Mr. Harley Main. Representatives of the purchasing functions of the Federal Aviation Administration, the State of Oklahoma, the City of Oklahoma City, and private industry, together with the Tinker AFB Training Branch and our Directorate met to define our common needs. A survey of interest questionnaire was developed and circulated. Within our Directorate, of 186 questionnaires distributed, 130 were returned with 97 positive responses.

The "Ad Hoc" Committee presented our needs to the Chairman of the Business Division of Oscar Rose Junior College. The committee and the college designed a curriculum leading to an Associate Degree in Purchasing and Contracting. An alternate curriculum leading to a "Certificate" was also designed. The Associate Degree required general education courses in addition to program specialty courses. The Certificate Program is primarily specialty courses. Oscar Rose officials were enthusiastic and most helpful in developing the program.

Oscar Rose submitted the programs to the Oklahoma Board of Regents who must approve and fund all new programs. Approval was obtained in December, 1981 and funds were included in the budget for 1982. The first courses were offered in the fall of 1982.

THE COLLEGE

Oscar Rose Junior College is a community college within a few minutes of Tinker AFB. They are officially designated Rose State College effective 1 November 1983. Oscar Rose and Tinker interface in many areas. Because of its proximity, many Tinker employees are enrolled there. It offers some of its courses on-base during the lunch hour and in the evenings. Through the Oklahoma Board of Regents, Oscar Rose is contracted with to perform Supervisory/Management training courses for Tinker Supervisors.

THE ASSOCIATE DEGREE PROGRAM

The Associate Degree Program consists of the following:

General Education Courses 23 Credit Hours

Program Requirements Courses 30 Credit Hours

Support and Related Courses 9 Credit Hours

The General Education Courses are English, History, Math, Psychology, etc.

The Program Requirements Courses are as follows:

ECONOMICS

3 Hours

Principles of Microeconomics

MID-MANAGEMENT

6 Hours

Industrial and Government Marketing

Introduction to Logistics

PURCHASING AND CONTRACTING

18 Hours

Purchasing and Materials Management

or

Small Purchasing

Purchasing Management and the Computer

or

Introduction to Data Processing

Negotiation Techniques

Contract Administration

Government Contract Law

Manufacturing Cost Procedures

POLITICAL SCIENCE

3 Hours

Introduction to Public Administration

Support and Related Courses include, among others, Business Ethics, Principles of Finance, Principles of Pricing, I and II and Management of Defense Acquisitions Contracts I and II.

Recognizing that DOD will be a major user of the program, specific courses were designed to be made available for students. Seven of the courses cover essentially the same material as the DOD Courses:

Management of Defense Acquisitions Contracts I and II

Principles of Pricing I and II

Defense Contract Negotiation Workshop

Government Contract Law

Contract Administration

These college level DOD related courses are all taught by highly qualified people from our Directorate who are screened by and meet the academic standards established by Oscar Rose. Students who attend, although responsible for tuition and their books, are given duty-time to attend those courses taught on base at the lunch hour.

One of our pressing needs is to train our people in the DOD Mandatory courses. The most critical are:

Principles of Contract Pricing:

Number requiring course	289
Number completed	183
Number who still need	106

Defense Contract Negotiation Workshop:

Number requiring course	289
Number completed	167
Number who still need	122

Government Contract Law

Number requiring course	222
Number completed	153
Number who still need	69

We are applying through the Federal Acquisitions Institute for equivalency of the Oscar Rose courses to the DOD Mandatory courses. Although DOD will pay the tuition and books for the student, it will still result in thousands of dollars in savings to the Government in TDY and school expenses.

PROGRAM COURSES OFFERED TO DATE

The following program requirements courses have already been taught;

Purchasing and Materials Management

Small Purchasing

Purchasing Management and the Computer

Negotiation Techniques

Principles of Pricing

Introduction to Public Administration

A mix of acquisition personnel, both professional and clerical, and others outside the career field have taken the courses.

Attendance has been greater in those courses offered on-base during the lunch hour. Those offered on campus were largely from outside our organization while those offered on-base were largely from our workforce. The summer session of the Principles of Pricing course offered in our Conference Room was made up of 13 in the professional job series and 14 in the clerical series.

REQUEST FOR DOD EQUIVALENCY

The Federal Acquisition Institute is implementing a procedure to recommend to the Defense Contracting/Acquisition Career Management Board appropriate college courses for approval as equivalent to the DOD course. As part of the review process a Local Educational Review Committee is established to review each of the courses in depth. Our review committee is made up of the Civilian Personnel Officer, Chief of the Training Branch, our Educational Development Specialist, the Deputy Director of Contracting, the Contracting Career Program Manager, the Chief of the Procurement Division at FAA, and a representative from the Defense Contract Administration Services Office.

The Committee has reviewed and reported its findings. As a result of the review, a change is being made to divide the Principles of Pricing Course into two 3-hour courses to adequately cover the material.

We hope to report at the Symposium that the courses are approved.

CONCLUSION

Now that the program is under way we are very pleased at its progress. We believe that not only does it create an interest in the acquisition field but it also enlarges the reservoir of qualified people with some knowledge of acquisitions. It is our belief that approval of the ORJC courses is forthcoming. The approval will save thousands of dollars in DOD TDY and School expenses and assure training in a more timely manner.

BALANCING GOVERNMENT AND INDUSTRY INTERACTIONS

Panel Moderator: Captain William Havenstein
Deputy Commander for Contracts
Naval Sea Systems Command

Papers:

Cost Accounting Standards, A Time for Government and Industry Action
by Patrick D. Sullivan

Government - Contractor Interaction
by David M. Thomas

Needed Help for the Federal Acquisition Regulations Council
by Charles D. Woodruff

ADP002767

COST ACCOUNTING STANDARDS, A TIME FOR GOVERNMENT AND INDUSTRY ACTION

Patrick D. Sullivan

INTRODUCTION

From its inception in 1970, the Cost Accounting Standards Board (CAS Board) was the subject of considerable controversy. Among the issues was the vesting of the function of establishing cost accounting standards in a board, independent of the executive branch, since those functions are the responsibility of the executive branch. In addition, the law required the Board to report to the Congress the probable costs and benefits of the Standards. This was never done.

In September 1980, Congress declined to continue funding of the Board and it ceased operations. But the nineteen Standards promulgated by the Board continue today as a part of the law. Consequently government and industry alike have found themselves without an authoritative body to interpret the Standards and issue corrections, exemptions and waivers.

At least two of the Standards, CAS 409, Depreciation of Tangible Capital Assets, and CAS 414, Cost of Money As An Element of the Cost of Facilities Capital, are claimed to be having a negative effect on the nation's industrial base. They also have been the subject of considerable Congressional interest because of DoD's actions to recognize more rapid depreciation of assets. Inherent in these issues is the need to find a sponsor for the Standards so that appropriate action can be taken on these as well as other questions. This paper will examine the history of the Board, some of the current problems, and discuss several of the alternatives that are available at this time for dealing with the situation created by the demise of the Cost Accounting Standards Board.

ORIGIN OF THE BOARD

". . .The lack of uniform accounting standards is the most serious deficiency in government procurement today."[16] It was criticism such as this by Vice Admiral Rickover and Senator William Proxmire that caused the Congress in 1970 to pass an amendment to the Defense Production Act of 1950, creating the Cost Accounting Standards Board. This Act, P.L. 91-379, established the Board as an agent of the Congress, independent of the executive departments. The Board was established to promulgate cost accounting standards which were designed to achieve uniformity and consistency in the cost accounting practices followed by defense contractors and subcontractors.[5]

During hearings in 1968 and 1970, Congress expressed a general dissatisfaction with the evidence presented to them of the lack of rigidity in cost accounting for negotiated government contracts. In the majority of cases, where contract price was based upon product costing estimates, it was argued that a uniform cost accounting system was vital, since reimbursement to the contractor from taxpayers' monies was the logical result of the cost proposal. The Armed Services Procurement Regulation offered some general guidelines in the form of Section XV Cost Principles, but directed contracting officers to generally-accepted accounting principles on the complex issues of product costing, i.e., measurement of costs incurred, assignment of costs measured to cost accounting periods, allocation of assigned costs to final cost objectives, and consistent application of the practices chosen. Generally-accepted accounting principles, however, were harshly dismissed during the debates. They were referred to as "accounting fantasies" that were never intended to resolve the difficulties of government contract costing. By allowing considerable discretion in the manner in which contractors accounted for costs, they provided for neither uniformity nor consistency.[3]

The solution proposed by the House of Representatives would have required the Comptroller General to formulate uniform cost accounting standards, however, the Senate directed the Comptroller General, in cooperation with the Secretary of Defense and the Director of the Bureau of the Budget, to undertake a study to determine the feasibility of applying uniform cost accounting standards in all negotiated defense prime contract and subcontract procurements of $100,000 or more.[14]

Subsequently, in January 1970, the Comptroller General reported to Congress that it was feasible to establish and apply cost accounting standards to provide a greater degree of uniformity and consistency in cost accounting as a basis for negotiating and administering procurement contracts.[6]

Thereafter, the Defense Production Act of 1950 was amended by Senate Resolution 3302 which proposed the establishment of a Cost Accounting Standards Board as an agent of Congress. This resulted in P.L. 91-379 of August 15, 1970 which provided that: "The Board is authorized to make, promulgate, amend and rescind rules and regulations for the implementation of cost accounting standards. . . Such regulations shall require defense contractors and subcontractors as a condition of contracting. . .to agree to a contract price adjustment, with interest, for any increased costs paid to the defense contractor by the United States because of the defense contractor's failure to comply with duly promulgated cost accounting standards or to follow consistently his disclosed cost accounting practices in pricing contract proposals and accumulating and reporting contract performance cost data."[15]

EXECUTIVE VS. LEGISLATIVE POWERS

In signing the bill authorizing the creation of the CAS Board, President Nixon said that he had no objection insofar as the bill provided for the establishment of cost accounting standards. However, he was opposed to vesting that function in a board, independent of the executive branch, consisting of the Comptroller General and his appointees. He requested the Congress to enact an amendment as soon as the House returned from its recess to place the functions of the Board in the executive branch.[8]

In response to the President's request, the Senate proposed to establish an independent Cost Accounting Standards Board within the executive branch of the Government.[18]

However, apparently due to the delay in acting on an amendment to relocate the Board, the Comptroller General said, "When the creation of a Cost Accounting Standards Board was being considered over two years ago, I favored placing it in the executive branch. Regardless of the merits of the position taken at that time, I could not now favor an interruption of the Board's vigorous activity and consequent delay by its transfer to the executive branch. . . The obvious delays, the loss of forward motion in these days when effective defense procurement is essential not to mention the waste of time and effort already invested by the present Board, industry, the accounting profession, and government agencies is far too high a price to pay for any theoretical advantages which might result from placement of the Board in the executive branch."[19]

Thus, with one of the chief proponents of the change unwilling to support the amendment, the action to place the Board in the executive branch expired.

COST/BENEFIT OF THE STANDARDS

During the testimony presented at the House and Senate hearings in the spring and summer of 1970, various federal agencies and industry representatives commented on the GAO feasibility study. Among the criticisms of the study was the concern that the cost of implementing and complying with standards would outweigh the benefits. Admiral Rickover, in his 1968 testimony, had estimated that uniform accounting standards would save the government $2 billion a year.[16] This was disputed by industry witnesses and sufficient concern was raised during these hearings over the potential cost of the standards that Congress was motivated to require that "in promulgating such standards the Board shall take into account, the probable costs of implementation compared to the probable benefits."[15] Further concern with the costs of the Standards, after the Board began operations, resulted in amending this provision in 1975 to require the Board to report to Congress on the cost of any rules or regulations implementing the Standards as well as the Standards themselves.

The Board in response to this requirement, in its presentation of the operating policies, procedures and objectives in May 1977 said that, it viewed costs and benefits in a broad sense. All disruptions of contractors' and agencies' practices and procedures were viewed as costs. Benefits included anticipated reductions in the number of time-consuming controversies stemming from unresolved aspects of cost allocability. The Board also expected that benefits would be achieved through simplified negotiation, administration, audit, and settlement procedures. Finally, and most importantly the availability of better cost data stemming from the use of Cost Accounting Standards would permit improved comparability of offers and facilitate better negotiation of resulting contracts."[7]

However, once the Board began operations, the Logistics Management Institute reported that a cost/benefit analysis was not feasible. They recommended that attention be shifted away from estimating total costs to industry and DoD. Instead CAS Board promulgations and DoD procedures should be studied to reduce

administrative effort and minimize the impact of changes that must be made by contractors.[9]

A subsequent report by consultants to the Chairman of the CAS Board further highlighted the difficulty in measuring costs and benefits when they concluded that "no objective cost benefit calculation in aggregate quantitative terms is possible for CAS Standards as a whole or for any of them individually."[17]

It is not surprising therefore, that throughout the life of the CAS Board there was criticism of the costs being created by the imposition of the Standards. A leader in this criticism was the Aerospace Industries Association (AIA) which stated in 1979, that experience shows the continuing burdens of CAS and attendant costs are not warranted no matter how viewed whether by taxpayers, by federal agencies, by the accounting profession, or by government contractors. AIA criticized the published statements by the CAS Board, which justified certain standards and the Board's continuance, as self-serving. AIA estimated the added cost of CAS to the public in terms of incremental and lost opportunity costs to be in excess of $50 million a year.[1]

However controversial the discussion of cost and benefit may be, or however difficult to measure, one fact is clear - the CAS Board did not comply with the law when it ignored the specific directions of Congress to report the probable costs and benefits.

LEGALITY OF THE STANDARDS

In addition to questions of executive vs. legislative powers and cost vs. benefit, there remains a question as to the legality of the Standards. The Boeing Company challenged the constitutionality of the Board on the basis that it was unconstitutionally constituted because its members were not appointed by the President with the advice and consent of the Senate.

However the Supreme Court upheld the Court of Claims and ruled that this issue need not be considered or ruled upon in as much as: (a) the principle of de facto officer prevents past acts of the Board from being held invalid and (b) the Defense Department had independent authority to adopt CAS 403 on its own.[4]

In addition, during June 1983, the U.S. Supreme Court struck down the reservation to one House of the Congress of a power of legislative veto, a power permitting either the Senate or the House of Representatives to block agency action if either considers the action unauthorized or unwise. Some kind of legislative veto provision appears in approximately 200 statutes, including the authorizing statute for the CAS Board. Though the CAS Board statute differs from the one the Court struck down in that a concurrent resolution passed by both Houses is required to invalidate action by the Board, it may be subject to some of the same objections; the Court's decision emphasized that the chief executive's role could be circumvented by a legislative veto to the extent that it permits Congress to avoid the constitutional requirement of "presentment" to the president. It is as yet unclear what effect this decision will have, although Justice Lewis Powell opined that his colleagues had apparently invalidated all legislative veto provisions.[8]

CURRENT PROBLEMS

Compounding these issues is the current problem created by the absence of a body to interpret the existing standards and issue exemptions, waivers, and amendments. With the expiration of the CAS Board in 1980, the Defense Department and other agencies that had adopted the Standards were left without an authoritative source for waivers from the Standards and for interpretation and clarification of existing Standards. In addition to these problems, two of the Standards, CAS 409 and CAS 414, are claimed to have a negative effect on the nation's industrial base. CAS 409 has been known to be a problem for some time. It and CAS 414 were addressed by the Defense Industrial Base Panel in its report on December 31, 1980 to the House Armed Services Committee. Their report illustrated two key issues: The inappropriateness of the Standards; and the helplessness of the agencies to do anything about the Standards. However the panel failed to make specific recommendations with regard to solving the problems with either of these Standards.

Subsequently the current Secretary of Defense created a special task force to look into ways to improve the performance of the Defense Department. Among the findings of this task force was that productivity in the defense sector of the U.S. economy has been lagging in large part because of low levels of capital investment compared to U.S. manufacturing in general.

As a result, DoD adopted several measures to encourage capital investment. Among these was Acquisition Improvement Program Initiative 5 which provided that the General Counsel should support legislative initiatives to permit more rapid capital equipment depreciation and to recognize replacement depreciation costs by amending or repealing CAS 409, Depreciation of Tangible Assets.

However the General Accounting Office opposed DoD's recommendation and took the position that before the DoD proposal on CAS 409 was implemented, relevant budgetary cost estimates should be prepared.[8] Ironically the Comptroller General asked that DoD defend the cost of amending or repealing CAS 409. No such consideration was given by the CAS Board when they enacted CAS 409. Yet when DoD proposed to change the Standard in the interest of increasing productivity and reducing hardware costs, they were challenged to defend their proposal on the basis of cost. DoD was tasked to do what was not done by the CAS Board, of which the Comptroller was the head.

In response to Initiative 5, DoD in December 1982, issued a memorandum which encouraged the use of advance agreements on shorter depreciation periods for certain assets than would otherwise be determined by CAS 409.[21] Representative Jack Brooks criticized DoD's proposal as tantamount to practical repeal of the depreciation standard. Representative John J. LaFalce also responded by requesting DoD to rescind immediately all actions to implement any changes in the Standards until GAO had made a report on the matter.

Subsequently, on May 19, 1983, Senator William Roth's Committee on Governmental Affairs conducted a hearing to review the effectiveness of CAS 405, 408, 409 and 414. Among the witnesses was Clark G. Adams, of GAO, who stated that GAO believes that DoD's memorandum should be withdrawn or modified to correct what GAO believes is focusing undue attention and emphasis on what is essentially an exception provision of the Standard.[2] However Ms. Mary Ann Gilleese, Deputy Undersecretary for Research and Engineering (Acquisition Management) confirmed at the hearing that DoD does not intend to pursue repeal or amendment of CAS 409, nor does DoD desire to use asset replacement value for determining depreciation cost. Thus the dilemma of implementing CAS 409 continues.

In addition to these difficulties with CAS 409 and 414, there is the continuing problem facing both defense and nondefense agencies in providing waivers of the Standard to those companies who cannot or will not accept government contracts containing CAS clauses. In March 1982, NASA used Public Law 85-804 to waive the CAS requirements for Kerr-McGee Chemical Corporation, a subcontractor to Thiokol Corporation, so as to avoid a delay in the space shuttle launch schedule.[12] NASA chose an unorthodox solution, but had they not been able to do so, they concluded that the impact would have been an unacceptable effect on the nation's space and defense efforts.

Without a forum for resolution of problems such as these, both industry and government face the prospect of potential program delays and costly legal battles as the need for interpretation and change continues to grow. Since the Standards are embedded in the law, and in the absence of a body to issue exemptions, waivers and amendments, industry and government alike must look to the courts to resolve honest differences of opinion. In addition, use of unorthodox solutions to the problems of waiving the Standards such as NASA has done can only provide limited relief from a pervasive problem. All these conditions, created by the demise of the Board, argue for prompt action by Congress to provide relief.

ALTERNATIVES

The Congress has a number of alternatives available at this time. One of these is to do nothing. This would require government as well as industry to continue to rely on interpretations and clarifications obtained through litigation. A second is to reconstitute the CAS Board for the purpose of clearing up the present problems with some of the Standards and to act on requests for waivers. A third alternative is to appoint a special commission to review the Standards and recommend appropriate legislation. Or Congress could assign the responsibility for maintenance of the Standards to an existing office or agency. Alternatively, the Congress could repeal the Standards and charge the executive branch with the responsibility for implementing those Standards that are proven to be cost-effective prior to adoption.

Congress could wait and do nothing, but this would be unconscionable. There are real problems impacting national interests caused by

some of these Standards and to force government and industry to rely on the lengthy and expensive litigative process only compounds these problems. Even GAO recognizes the need for action now. In recent testimony, Clark G. Adams said that "it appears increasingly more difficult for contractors, agency officials, and those charged with resolving CAS related disputes to continue to operate efficiently without the aid and benefit of the Board. The environment in which the Standards exist continues to change while the Standards themselves remain fixed. Our belief is predicated on numerous problems which would either be resolved or dramatically improved if the Board were in operation".[2]

The second of these alternatives, to reconstitute the Board, would have the benefit of capitalizing on the experience of the former Board and would make use of a process that has already been developed. Under the law, the basis for the Board still exists. Only the funding has been discontinued. To reconstitute the Board invites the continued promulgation of restrictive and costly Standards and fails to establish the needed flexibility to make enforcement of the Standards the responsibility of the executive agencies most affected by the Standards.

Creation of a commission to study the problem would offer an opportunity for those individuals and organizations impacted by the Standards to make their views known and to examine the costs and benefits in a public forum. However, action is needed now! A study would prolong the critically needed changes and further inhibit the executive branch while the hearings are conducted and appropriate legislation is developed.

Assignment of the Board's responsibilities to an existing organization is feasible, provided that the location and extent of the powers of the new sponsor are clearly defined. But major problems exist in deciding on the appropriate location for the Board's functions. GAO would like to head up the Board.[2] DoD favors a CAS function within the Executive Branch.[10] The current Director of the Defense Contract Audit Agency prefers it be located in the financial management side of the Office of Management and Budget (OMB).[20] In this regard, an abortive attempt by Congressman D'Amours in 1982 to amend the Defense Production Act to recreate the CAS Board in the Office of Federal Procurement Policy with full powers to make, promulgate, amend and rescind rules and regulations for the administration of cost accounting standards was withdrawn by the sponsor, ostensibly because of the opposition to the inclusion of the authority to issue additional new standards.

However all of the above actions fail to get to the root of the problem and that is the Standards themselves. As long as they continue to exist in the law, government and industry are proscribed from making sound business decisions that are contrary to the Standards. Recent testimony by the former Director of the Defense Contract Audit Agency supports reducing the Standards to the level of regulations, primarily as a means to avoid future litigation.[13] Repeal of the Standards as law is a quick and sure way of remedying this problem. Congress could remove the onerous Standards from the law without losing any benefits. The Defense Acquisition Regulation (DAR) has the force and effect of law. The Department of Defense could quickly incorporate into the DAR those Standards which it determines to be beneficial and not inhibiting to the re-industrialization of America's mobilization base. Congress would retain its normal oversight over the expenditure of public funds and have the ability to ensure that uniformity and consistency are maintained in a cost-effective manner. By repealing the legislation which created the Standards, the Congress would remedy the situation by eliminating these overly restrictive requirements and at the same time put the responsibility in the proper branch of government. To the extent that the Standards have application to the civilian agencies, the Standards having direct benefit could be incorporated into the Federal Procurement Regulation. Ultimately the actions taken by DoD and the civilian agencies could be incorporated into the Federal Acquisition Regulation.

To continue the Standards without regard to these considerations will prolong the operation of their inequitable and wasteful provisions. If swift and decisive action is not taken by Congress to repeal the Standards, the problem will be perpetuated.

CONCLUSIONS

Congress must take action now to repeal the Cost Accounting Standards and require the Department of Defense and the civilian agencies to immediately incorporate into their procurement regulations those Standards which they can justify as being cost-effective and not

inhibitive of building a strong industrial base. Neither government nor industry can afford to depend upon the Boards of Contract Appeals and federal courts to settle questions relating to these Standards. While the objective of Congress in 1970 was to achieve a greater degree of uniformity and consistency in cost accounting, they never foresaw the disruptive and wasteful effects of administrative rules cast in the rigid mold of law as opposed to the flexible and economical effect of regulation. Government and industry must put aside any perceived differences and join in a concerted effort to demonstrate to Congress that action now to repeal the Standards is the first step toward achieving uniformity and consistency in contract costing without the divisive and costly effects created by continuing the Standards as law.

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GOVERNMENT - CONTRACTOR INTERACTION

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ABSTRACT

The development of the Administrative Contracting Officer represents an advance in the Government system of contract management because it provides an individual with knowledge, time, and a specialized function to insure performance of Government contracts. However, the development has created a dichotomy between the award and the post-award function which increases the adversary relationship with Government contractors. This paper advocates that this adversary relationship can be decreased if PCOs and ACOs are provided with opportunities to serve in the assignments of the other.

INTRODUCTION

The majority of Government contracts are awarded, performed, paid and closed with minimal adversary perturbation. Why then, do both Government and Contractor personnel consider the adversary relationship between the two to be such a problem? The answer, at least for contracts awarded through negotiation, is that the possibilities for adversary behavior are increasing and will continue to increase for the forseeable future.

Part of the adversary relationship involves the legitimate striving of organizations which at least partially are seeking different objectives. The adversary relationship exists when one of the Parties wants something the other is not prepared to give up easily. The amount of profit and period of performance are obvious examples. The tremendous number of dollars and rights at stake in Government contracts make this part of the adversary relationship inescapable and legitimate. The bad effects of this can be mitigated by increased professionalism and training on both sides. Another aspect of the adversary relationship derives from the nature of a Government contract and the method of contract management which the Government has developed. The part of the adversary relationship deriving from the method of contract management is the concern of this paper. With its accumulation of complex clauses, a Government contract is a wooden document. It is performance by the Parties that gives the contract life. A Government contract is not a document which is designed to be read and followed in the same way a "How to" article in a popular magazine is designed to be read and followed or in the same way a daily newspaper is meant to be read for information. This aspect the Government contract shares with others such as Internal Revenue Code and insurance policies. It's a legal document made up of clauses written by lawyers to avoid the mistakes and problems of the past. As such it is not a document which is designed to be read, but one designed for use of professionals who are already familiar with the interpretations of the clauses. I can vouch for the uneasy feeling of a Government Contract Specialist facing a potential new Government contractor who states he is the producer of widgets, has found out the Government wants to buy widgets and with the commercial economic slump and Mr. Reagan's decision to build up the military, he'd like to make some widgets and sell them to the Government. The reason for this uneasy feeling? At that moment it is brought home to the experienced Government employee with overwhelming force the enormity of just plain regulations, procedures, rules and paper that Mr. Potential Contractor is going to learn to come to grips with before Mr. Potential Contractor becomes a seasoned Government contractor, if he decides to continue on that route.

How have the Parties treated the bureaucratic aspects of procurement? To a small extent, the Government has sought to adopt standards from the commercial world. The overwhelming response is for Contractors, either through hiring or training, to obtain experienced people in the Government area and to develop the private bureaucracy. Early in my career in Government contracts, I was told by a wise professional in the business, "You have the public bureaucracy facing the private bureaucracy." The complexity of Government contracting has increased in recent years, spurred by the enormity of Federal spending and the complexity of weapons systems and accelerated by such innovations as Cost Accounting Standards, PL 87-653, Facilities Capital Cost of Money, Weighted Guidelines, and others. Both industry and Government have responded by increasing their respective bureaucracies and each increase means a contracting process even more different from the commercial world.

DIVISION OF CONTRACT MANAGEMENT

To better manage its contracts, the Department of Defense divided the award and the post award functions utilizing the Procuring Contracting Officer (the PCO) and Administrative Contracting Officer (the ACO). This dichotomy resulted in more effective and intensive management of DOD contracts, which is to the Government's advantage. It also created a new problem.

In a speech before our local Chapter of NCMA, a counsel from one of the major defense manufacturers - while providing an industry viewpoint- remarked that industry considers the PCO to be his customer but industry considers

the ACO to be part of the bureauacy. I disagree with this particular comment but I think in a nutshell it is an excellent statement of one aspect of the Government - Contractor adversary relationship and it also indicates why the problem associated with these relationships will increase in the future rather than get better.

Once a Purchase Request is received by the Procuring Contracting Officer, if that Purchase Request is to become a contract, the PR must be negotiated with the potential Contractor and a meeting of the minds reached over the contract terms and conditions. Here various influences begin to impinge on the PCO. The PCO, who is charged with the responsibility to make the contract award, obligate the money, and get the program underway may find these factors outweighing the substance of the negotiation. A meeting of the minds results, the parties shake hands, the contract is signed, the contract is distributed, and the ACO and the other members of the contract administration team will receive their copies to perform administration of the contract. The Government focus on that contract will shift to the ACO.

The ACO operates in an atmosphere different from the PCO. The ACO, to a greater extent than the PCO, has a job which is elastic - one that can expand or contract according to the energy, ability, knowledge, and inclination of the individual ACO. The ACO works in an atmosphere with more discretion, where management by exception is the rule and where there is at least some choice on the part of the ACO over matters in which to get involved. Contrast this with the PCO who is under pressure to make an award. In the main, the ACO will have a greater awareness of the strengths and foibles of the Contractor than the PCO who awarded the contract. This has advantages. After administration of a number of contracts, the ACO will develop a realization for the Contractor who has strong cost controls, habitually overruns, has a history of quality problems, has a history of good quality, rarely performs on time or has a history of meeting delivery schedules. This tendency, which is valid, is increased by the human tendency to think in stereotypes, and to develop a kind of local folklore about contractors who cause a lot of problems. However, for better or worse, the result of this can be an unexpected and unintended change of emphasis on contract performance.

Because a Government contract is a wooden, inflexible instrument made up of standard clauses, terms and conditions, which do not fully state the subtle intentions and understandings of the parties, it is possible for a PCO to overlook a matter to conclude a difficult negotiation, send the contract out for administration, and have the ACO pick up on the matter. The PCO and the ACO each consider the actions of the other and wonder why the other is ignoring the Government's interest.

The creation of the Administrative Contracting Officer presented an advance in the Government system of contract management because it provides an individual with knowledge of the contractor and with time and a specialized function to insure contract performance. Now the need is to develop and improve to ensure a synthesis and consistency of the award and post-award functions. The best way for each to understand the problems of the other is to experience them first hand. Toward this end, I believe that Government Contracting Officers, both PCOs and ACOs, should be provided with opportunities to serve in the assignments of the other.

SYNTHESIS

The reason for this suggested approach? As one examines the complexity of Government contracting, it is clear that no magic formula exists to increase the efficiency of the Government contracting process. The procurement community is striving toward professionalism. One of the problems which blocks the road to increased professionalism is the exceptional diversity of talent required in the Government procurement community. Some examples - engineers, negotiators, contract administrators, lawyers, auditors, price analysts, accountants, quality assurance specialists, production specialists and others. Many of those listed are members of groups which have well developed professional standards in their own area of expertise. When this variety of individuals act together, the diversity is compounded. The tremendous complexity of Government procurements means these problems will not get simplier. A government contract frequently requires a trade-off between the view-point put forth by the various team members. It is unrealistic to expect procurement ever to overcome this diversity, the best that can be hoped for is a better understanding and better appreciation of the functions performed by the other individuals.

Another factor exacerbating the situation is the tremendous concern about and impact from the Government budgetary process. This impact is overwhelmingly on the contract negotiator. Why should this be since economic decisions are a part of everyday life. The individual is constantly faced with economic decisions whether he can afford to buy a new house or a new car. The impact from the Government budgetary process is quite different and acts as a compulsion on the PCO to make awards. (If we didn't have this compulsion to award, would anything ever get awarded?) The fact that his money may be taken away from him for another program acts as a stimulus on the PCO which is

external to the negotiation and it impacts on the PCOs decision on what factors to emphasize or soft pedal.

The acknowledged goal of Government contracting is timely production of quality goods and services at reasonable prices. The perturbations begin when the specifics are filled in. When is delivery necessary to be timely? What constitutes reasonable price and acceptable quality? It is the function of the Government Project Manager to make these decisions and to make the program trade-offs between cost, quality and delivery which are necessary for his program. He is responsible to decide if an acceleration in delivery is necessary even though it means an increase in costs.

The separation between the PCO and the ACO was a significant step forward in Government contracting because it permitted the ACO the time to insure contract performance to the benefit of the Government. It permitted the PCO to concentrate on his primary purpose which is awarding contracts. The dichotomy provides for an increase in skill and efficiency which comes about through specialization. This dichotomy, however, permits the possibility that the ACO will overmanage the contract and it also provides the possibility that the ACO will emphasize aspects of the contract in ways which the negotiator or the Contractor never considered.

Obviously the principal duties of the ACO are performed during contract performance and the duties of the Contract Administration Office leading to the areas of greatest conflict with the Contractor are synonymous with contract performance. Although the ACO has some opportunity for input through pricing reports, the ACO is normally not part of the bargaining process which results in the initial contract. He does not sit in on the give and take which takes place before the parties shake hands and conclude negotiations. The significance of this is that the Contractor is not afforded an opportunity to weigh the concerns of the ACO and to account for them financially or otherwise before the conclusion of his negotiation with the PCO.

The Contractor negotiates with the PCO - which is often not an easy job in itself and the result is an agreement for the Government to pay a specified number of dollars. When the contract goes out for administration, Mr. Contractor then may find the ACO doing something which, in effect, may take away part of what Mr. Contractor believes are the negotiated dollars. It may be asked, what is the harm of this, since if the Contractor hasn't done something wrong, he wouldn't have trouble with the ACO. A glance at those areas most likely to be a source of conflict between the ACO and the Contractor show why this is not necessarily true. Some examples are: Cost Accounting Standards, defective pricing, rent paid for use of GFP, and allowability and unallowability of costs including taxes and pensions. These areas tend to be abstract, complex to deal with, subject to varied interpretation, and require the exercise of considerable judgement. While Section 15 of the DAR goes to considerable length to list allowable costs, specific issues of allowability still require considerable judgement. Another example-are there any contractors doing a sizable amount of negotiated Government work who have not been notified that they are in non-compliance or potential non-compliance with some Cost Accounting Standard?

The ACO has more visability of the Contractor's cost system, knowledge of his performance capability and familiarity with the Contractor in general. The ACO also has more time to delve into the contractor's systems, which in itself increases the perturbation. To the extent it protects the interest of the Government and results in lower costs to the taxpayer, it is completely valid. To the extent it increases the adversary relationship without cost savings, it defeats the intention of the position and increases the cost of the contracting process.

The ACO tends to be very concerned about delivery schedules. Under the present system it is possible for the Contract Administration Office to badger a Contractor about a delinquency while at the same time the Government Project Manager may not be concerned about a delinquency because he is more concerned about other aspects of the program. Presently the system suffers from the overspecialization of the PCO and the ACO to the exclusion of the other and from the fact that each does not fully realize the emphasis of the other. The result is a lack of unitary emphasis to the contractor on the part of the Government with different individuals speaking on behalf of the Government in different areas. The present system allows the ACO who guarantees contract performance on the part of the Government to take on a life of his own. To the extent he does this, it is frustrating the role of the Government Project Manager.

The natural response to the occasional horror story of excessive charging is frequently new law and administrative regulations. This increased administrative burden then falls on the procurement community. The great majority of Government contracts are not awarded and performed in an atmosphere of excessive pricing, but in a much more reasonable atmosphere where the two parties are trying to find that mutual equilibrium which will allow them to carry out their efforts with a maximum of individual benefit and a minimum of perturbation.

I believe that rotation or career progression that allows Government contracting officers to

perform in the function of both PCO and ACO will help to alleviate some of the dichotomy and adversary perturbation which results from the present system. I think such a synthesis can contribute several advantages:

1) Appreciation of the role played by the the other in the Government procurement process.

2) A better appreciation of the problems encountered by the other.

3) A greater understanding and appreciation of the essential priorities driving a Government program as distinguished from superficially established priorities. The really essential priorities should be determined by the Government project manager.

4) A greater appreciation of the specialized abilities and knowledge of the other.

The possibilities and opportunities for adversary relationships are increasing and will continue to increase for the foreseeable future. Adversary relationships founded on poor judgement increase the cost of Government contracting and detract from the timely production of quality goods. It is difficult to find the degree of understanding about Government contracting problems outside the procurement community necessary for meaningful reform. That is why we should strive for more effective changes from within.

CONCLUSION

The development of the Administrative Contracting Officer presents an advance in the Government system of contract management because it provides an individual with knowledge, time, and a specialized function to insure contract performance. Now the need is to develop and improve to ensure a snythesis of the award and post-award functions.

I believe that PCOs and ACOs should be provided with opportunities to serve in the assignments of the other as the best way to gain the knowledge of the other. This will provide insight into what is really essential in the contracting process and some things will be rearranged on the priority list.

NOTE:

The information in this paper is the result of the author's personal experience and should not be considered an expression of official policy.

NEEDED HELP FOR THE FEDERAL ACQUISITION REGULATIONS COUNCIL

Charles D. Woodruff

ABSTRACT

Writing and maintaining of the FAR regulation will be a tough job as it has been with the DAR. The subjects covered will be complex and technical. All available capabilities should be brought to bear in the process if regulations which are fair, which can be administered economically and which effectively accomplish their purposes are to be achieved.

Discussion of a few aspects of DAR 1-324 Warranties and DAR 1-330 Contractor Liability for Damage to Government Property and the related contract clauses shows the two coverages to be deficient in many respects. A need particularly for more and earlier assistance from industry in the writing of regulations is indicated. The experience and expertise of industry personnel should supplement that of the government personnel who will be rotated in and out of the FAR Council. A document with the impact the FAR will have deserves full use of available talent.

INTRODUCTION

Writing the Defense Acquisition Regulations (DAR) is a tough and all too thankless a job. The same will be true for the Federal Acquisition Regulation (FAR). DAR overall is a rather well written document. Such presumably will be true of the FAR. However the DAR is not and the FAR will not be, by any means, perfect. In fact many parts of the DAR are inadequate, faulted in one way or another. Some, in spite of years of continuing effort fail even to accomplish basic purposes or effective implementation of stated policies.

These shortcomings in the DAR reflect a need for more help, more expert assistance for the Defense Acquisition Regulatory Council (DARC) and in the future for the Federal Acquisition Regulatory Council (FARC). Quite possibly, more staffing would help, but particularly more help should be accepted from industry. This should come at as early a stage as possible in the development or revision of a part of the regulation.

In the paragraph which follows, I will discuss the DAR coverage of two subjects on which the DARC and the before it the ASPR Committee have labored almost continuously for more than twenty years, only eventually to give up on the most recent efforts both initiated in 1980.[1] I have been involved on behalf of industry since the inception of work by the ASPR committee on these two subjects. I have witnessed the slow progress on them due to the lack of understanding and expertise and newness to the subject of involved members of the DARC and its subcommittee. In the efforts on these related subjects everything points to the need for greater and earlier involvement by industry in the regulatory development process.

I do not blame the individual members of the DARC. Almost uniformly I have had high regard for the individual members of the DARC and the dedicated efforts they applied to the DAR. I blame the system, particularly as related to participation by industry.

If the DARC has had problems and needed help presumably the FARC will have them and will need it, perhaps even more.

THE DAR 1-324 WARRANTIES AND THE 7-105.7 (a), (b) AND (c) WARRANTY CLAUSES

The first DAR coverage of warranties was published in September 1964.[2] Overall the initial coverage seemed better than the current verson. It was shorter, more straightforward and less encouraging for the use of warranties. It had only one example contract clause where the present DAR has three largely duplicative clauses. Current DAR 1-324 in effect in essentially its present form since 1974 wanders on at some length discussing when warranties should be used, their preparation, various limitations and pricing aspects. The instructions leave little room for changes in the three example clauses but provide no guidance as to which of them to use, this, such as it is, is provided with the clauses in DAR Section VII.

The Three Clauses: The fixed price supply contract clauses are: the 7-105.7 (a) WARRANTY OF SUPPLIES clause "for use in accordance with 1-324," the (b) WARRANTY OF SUPPLIES clause "an example for use in accordance with 1-324 in contracts for deliverable complex items," and the paragraph (c) CORRECTION OF DEFICIENCIES clause "an example for use in accordance with 1-324 in contracts for systems and equipment when performance specifications and design are of major importance."

The three rather lengthy clauses cover so much the same ground that it is difficult to see justification for three instead of only one as in the original ASPR coverage. They add to the confusion by use of differing terminology and different arrangements. In addition to

common substance, the (a) clause provides for sampling, the (b) clause for the contractor to submit a recommendation as to the possible corrective action and the (c) clause likewise for contractor recommended corrective action after notification of deficiency but also after contractor discovery of a deficiency and for notification by the contractor of any deficiencies of which he becomes aware before acceptance. Paragraph (d) following the three clauses provides for six different alterations which might be made to any one of the three clauses. It could be used to provide for the substantive differences in the three clauses with appropriate explanations as to usage using only one basic clause. An example is the sampling provisions, the only unique part of the (a) clause. This would shorten the coverage and possibly make for the development of a better basic clause than provided by any one of the present three clauses.

Some of the differences in the three clauses are almost amusing, not much more. Others are troublesome. For example the (a) clause at the end provides only a definition of "supplies" the (b) clause starts out with definitions of "acceptance" and "supplies" the (b) windy and fancy language clause does not say anything is warranted and starts out with definitions for "deficiency" "correction" and "supplies". One wonders how, if at all, "deficiency" differs from freedom from defects and conformance with the specifications and other contract requirements warranted in the (a) and (b) clauses. The definition of "deficiency" does not mention defects in material and workmanship only saying "any condition or characteristic . . . which is not in compliance with the requirements" of the contract.

According to paragraph 1-324.4(b), correction or replacement is to be "at the contractor's expense." The (a) clause gives the Contracting Officer the right to return supplies for correction or replacement, that's all. The (b) clause says correction or replacement "at no increase in contract price." The (c) Correction of Deficiencies clause, while using "at no increase in price," speaks in terms of correction or partial correction of a deficiency.

DAR 1-324.4(b) says the Government may "direct the contractor to repair or replace defective items," that "a warranty might state that the Government may return defective items to the contractor for repair, (or) direct their replacement by the contractor." In the (a) clause, one option the Contracting Officer has is to "return all nonconforming supplies to the contractor for correction or replacement." The (b) clause, provides that "the Government may . . . require the contractor .... to repair or replace, at the Contractor's election" (emphasis added) and the (c) clause says "the Contracting Officer, at his sole discretion, shall give the Contractor written notice not to correct any deficiency, or ro correct or partially correct." Is correction or replacement at the contractor's election? It would seem that contractors generally should have the election, but do they under the (a) and (c) clauses and per 1-324.4(b).

There is a similar bit of confusion or lack of preciseness in the way 1-324 and the clauses treat with correction of defects or replace parts versus a contractor being required to correct or replace supplies.

A puzzle is that the (a) and (c) clauses both spell it out about warranting notwithstanding, inspection and acceptance or conclusiveness of any other contract provision, but the (b) clause says nothing about it.

There seems to be no reason for the differing arrangements and terminology and saying things and not saying them, the examples discussed and other such not discussed. Some have the making of disputes as is generally true of fuzzy and mixed up contract provisions.

Finally, a strange thing about the three clauses, as they have evolved, is that they are all special purpose clauses, none being for ordinary supply items. The (a) clause seems particularly to be for items involving sampling. The (b) and (c) clauses are for "complex" items and "when performance specifications and designs are of major importance," respectively, both cases in which it is questionable that warranties should be used, where perhaps the Government should apply its self insurance policy instead.[3]

Commercial Items -- The ASPR committee has struggled unsuccessfully with warranties for commercial items. The original 1964 policy called for, and the contract clause provided for, the contractor to agree that supplies or services furnished "shall be covered by the most favorable commercial warranties he gives to any customer for the same or substantially similar supplies or services, and the rights and remedies provided by this clause are in addition to and do not limit any rights afforded to the government by any other clause of this contract." Contractors objected on several grounds. Where they gave different warranties to different customers who would say which was the most favorable. A very favorable, warranty perhaps the most favorable, might not be desirable from the government's view point. That any such warranty was not to limit the government's rights under any other clause added confusion and probably would substantially alter the contractor's warranty. The October 1, 1967 revision, Number 25 to the ASPR (1963 edition) authorized the use of a warranty clause, "which is a standard or customary in the trade, or one which is substantially similar to and not in excess of a standard or commercial trade warranty." What was "standard or customary" might not be easy to establish and when estab-

lished might turn out to be quite different than some of the bidding or proposing contractor's warranty practices.

The current DAR treatment of commercial items, I believe, goes back to 1974. If any thing, it seems as much subject to question as the earlier tries. DAR 1-324.3 (c) says that, for commercial items having normal usage and not substantially altered by government specifications, use the 7-105.7 (a) or (b) clauses modified as directed by 7-105.7 (d) (2). This causes a substitution of the Uniform Commercial Code implied warranties of merchantability and fitness for purpose plus other UCC strictures for the warranty of freedom from defects and specification and contract conformance. Alternatively, the contractor's standard commercial warranty may be accepted when the contracting officer finds it not inconsistent with the rights under the (a) or (b) clauses or other provisions in the contract.

The principal trouble with the use of U.C.C. provisions is that commercial item warranties generally do not follow the UCC. Quite generally they negate other warranties express or implied, in part as done by the DAR clauses when they say the warranties of merchantability and fitness "are hereby excluded from any obligation contained in this contract." Commercial warranties also generally say no consequential damages, which are not waived by the DAR clauses. As to the alternative, few if any commercial warranties could be found by the C.O. not to be inconsistent with the (a) and (b) clauses.

On 1 May, 1968, a Defense Industry Advisory Committee "Working Group on Contract Warranties" was established by charter, executed by then Deputy Secretary of Defense Paul Nitze.[4] The first of the five questions the group was to review and make recommendations on was, "Under what circumstances should the DOD consider the use of express contractual warranties or guarantees similar to those in common use in commercial business?" Its report submitted after approximately a year of work by the Group Said "First it was concluded that the government should demand only the suppliers standard warranty provision when purchasing standard commercial items, especially in base procurement and small purchases."[5] The Working Group had six representatives of government, six of industry, and as chairman, Air Force General Lindbergh.

More recently, commercial item warranties were studied for the Department of Defense by the Logistics Management Institute (LMI). In the Executive Summary of its report, dated October 1980, LMI said, "We conclude that, for most commercial items, there was little to gain by refusing a warranty. . . . When warranties are offered on competitively priced commercial items, we recommend that they be accepted.

For most commercial items, the question is not a contracting one, whether to use a warranty, but a maintenance one, how to administer effectively."[6]

Thus, none of the three tries by the ASPR Committee on warranties of commercial items are good or consistent with the two prestigious reports. Unfortunately the proposed FAR would essentially do the same as the present DAR, the third try. The DARC seemingly intended to retain the present coverage in its recently abandoned proposed rewrite.[7]

Latent Defects -- DAR 1-324.3 (b) says, "Any warranty clause included in a contract shall not limit any rights afforded to the Government by the provision of the inspection clause related to latent defects, fraud, or gross mistakes that amount to fraud." As reported in a Federal Contract Report "Analysis" of August 30, 1976,[8] according to a subcommittee report the ASPR Committee, at one point, acceded to the urging of industry and to the recommendation of the DIAC Working Group and was going to permit the application of a time limit to the rights of the government with respect to latent defects as is done in the warranty clauses with respect to patent defects. After noting that latent defects were the subject of considerable deliberation by the subcommittee and the ASPR committee the subcommittee report concludes, "No position has been made that there would be any benefits falling to the government in the form of reduced prices if this relaxation of rights occurs." The "Analysis" discussed the fallacies in the position as did an NCMA Journal article.[9] Also it is directly opposed to the DIAC Working Group recommendation. After noting that the majority of the members of the DIAC Group did not agree to apply the same warranty time period to latent defects as to patent defects the Group's report said, "However, the members were unanimous in recommending that ASPR be changed to allow for a time limitation on contractor liability for latent defects. It was recognized that such time periods would be contractually be specified but would not necessarily correspond to the time periods established for patent defects."[10]

Actually retention of latent defect rights for an extended period of time is of questionable value to the Government. Writers, government and industry's, have repeatedly pointed out that the principal result of retaining latent defect rights is costly litigation in which the government tends to come out the loser because of the burdens of proof which are imposed on it.[11]

ASPR 1-330 CONTRACTOR LIABILITY FOR DAMAGE TO GOVERNMENT PROPERTY

Implementation of DAR 1-330 Policy -- DAR 1-330 states the policy of the Department of Defense to be "generally to act as a self-insurer for loss of or damage to property of the government" resulting from defects or deficiencies in supplies or services. The reason for this policy was stated in Defense Procurement Circular 86 of February 12, 1971 which said that it was the result of a long period of study aimed at reducing procurement costs by limiting the contractor's risk. Unfortunately, the implementation of the policy contained in DPC 86 did not, and succeeding versions of 1-330 have not, at all effectively accomplished the underlying purpose of "reducing procurement costs", instead well enough may have increased them.

On August 13, 1973, the Council of Defense and Space Industry Associations (CODSIA) addressed a letter to Captain Leroy E. Hopkins, SC USN, then chairman of the ASPR committee about the then proposed revision of ASPR 1-330 and the contract clauses. It discussed the effectiveness of 1-330 and the clause in some attached General Comments. After referring to what DPC 86 said about its purpose being to reduce procurement costs by limiting contractors risks and thereby causing a reduction in contractor insurance costs it said:

> "The DPC coverage of LIMITATION OF CONTRACTOR LIABILITY FOR DEFECTIVE SUPPLIES did not and the proposed ASPR 1-330 Contractor Liability and Damage to Government Property and related contract clauses would not reduce procurement costs. On the contrary, the proposed coverage, we believe, would add very substantially to costs of contract negotiation and administration. For effective reduction of insurance costs and for negotiation and administration purposes, the Government should fully self-insure, not half-way or two-thirds self-insure. To the extent that the Government, in its policy and clauses, fails to fully self-insure or fails to fully relieve contractors of products liability, it leaves contractors with risks against which they must be expected to insure or include a contingency factor if insurance is unavailable."

The Report of the Commission on Government Procurement states (Vol. 4, p. 96):

> "From a purely cost-effective standpoint, it is cheaper for the Government to act as a self-insurer than it is to shift the risk of loss or damage to private contractors. The contractors simply would pass on to the Government the cost of private product liability insurance premiums, including the addition of applicable indirect expenses and profit.

Claims paid by insurance carriers are said to account for about half of the premiums charged to contractors, the balance being administration costs and profit. The theoretical saving from self insurance by the Government then is, say, one-half of the reduction in premium costs plus contractor indirect and profit and probable savings of administrative costs by both the Government and contractors.

A second attachment to the CODSIA letter referred to above provided 35 numbered comments enlarging on the statements made in its letter and General Comments. I will discuss a few of the points covered by CODSIA.

The Contract Clauses -- DAR 1-330 Contractor Liability for Damage to Government Property refers to four different clauses. The 7-104.45(a) Limitation of Liability clause, the 7-104.45(b) Limitation of Liability-Major Items, the 7-1912 Limitation of Liability-service contract clause and the 7-204.33 clause for cost reimbursement contracts. The first of the above clauses is to be inserted in all fixed price contracts exceeding $10,000 for supplies except (1) when contractor liability can be preserved without increasing the contract price, (2) the second of the above clauses is called for, (3) a catalog or market priced item is involved or (4) a purchase order is used unless the clause is specifically requested. It relieves contractors of liability for Government property loss or damages, except the end item. The second clause is to be used in the procurement of major items (normally exceeding $100,000 in unit cost), the contractor being relieved of liability for loss of or damage to the end items, as well as other Government property.

Both of the first two clauses may be required in the same contract. In such a case, the major items clause is to be preceded by a statement that its provisions shall apply only to those items identified in the contract as major items. If services are called for in the same contract the third of the above clauses also is to be included. Conceivably some catalog items would have to be identified as not subject to the liability clause or clauses.

All the clauses say that their substance including the flow-down requirement is to be included in all subcontracts. This seemingly is without regard to whether or not liability could be preserved without increasing the subcontract price, or catalog or market price or purchase items are involved. The second, or major items, clause says to include the substance of the first but the substance of the second with the advance written consent of the contracting officer. As with prime contracts, both clauses are to be included as appropriate and presumably the service contract clause if the subcontract calls for services.

Without as yet looking at the substance of the clauses and how well they accomplish the intended purposes it certainly appears from the above that a considerable administrative problem is created for the government and contractors. Not including any clause or selecting the clause or clauses to be included and in some cases identifying the items to which the major items clause is applicable and approving and disapproving the flow-down of the major items clause all adds up to a lot to be done by the government. The prime contractor seems only to have to decide which clause or clauses not where there should be no clause.

However, including the substance of a clause in a subcontract is not so simple as inserting the clause by reference and saying substitute "contractor" for "the government" and for the "Contracting Officer". That would not provide a relief of liability by the Government. Other problems are presented.

So it goes from no clause in a contract, or any subcontract, to possibly as many as three clauses in the prime contract and hundreds of suitably altered clauses in subcontracts of all kinds and sizes. Without too much thought or effort and probably more fully accomplishing the government's basic purposes one clause could do it all including extending the relief of liability to subcontractors.

One Clause and Automatic Flow Down -- For many of the reasons already touched upon in the introduction and the above discussion of the use and limitations on use of the clauses, it would be much better to have only one clause. This would greatly simplify administration for the government and contractors. Contractors could negotiate better premium reductions.

In the mid-1970's the Federal Procurement Regulations Office after three or four years of work on the subject including obtaining several sets of comments from industry and extensive discussions, did develop a single clause which I understand was approved by an inter-agency review group. I believe it nevertheless was never published.

To eliminate the very considerable problem of the substance clauses having to be included in all subcontracts and in lower-tier subcontracts simply add the underlined words in the clauses where the relief of liability is stated so it reads: "The contractor and its subcontractors at any tier shall not be liable for loss of or damage to property of the Government." Similar addition of reference to subcontractors at two or three other places would be all that is necessary. The paragraphs about inserting the substance of the clauses in subcontracts could be dropped.

Either way it is done, as now or as suggested, subcontractors are relieved of liability for loss of or damage to government property. The present way is cumbersome. The suggested way creates no greater privity, a matter always of concern to Government lawyers.

All Loss or Damage Suffered by the Government -- The limitation of liability clause as now written leaves tag ends of possible liability to the government for loss or damage resulting from defects in supplies other than loss of or damage to Government property. A DARC subcommittee report draft of September 21, 1971, which appears to have become the report to the DARC of January 14, 1972, notes that CODSIA also recommended that "the limitation clauses be modified to disclaim contractor liability for all forms of government damages for delivery of defective items" except for remedies specifically provided for in the contract. The subcommittee said it did not concur in this recommendation because "It is impossible to define all the possible forms of damages that the Government may suffer as a result of acceptance or use of defective contractor delivered items."[12] So from that early time to the present the policy has remained to act as a self-insurer for loss of or damage to property of the Government. However, by letter dated 16 October 1980, transmitting proposed changed in 1-330 and the limitation of liability clauses, CODSIA was advised that the DAR Council had developed the proposed changes to: "(1) eliminate contractor liability for consequential damages (except personal injury and death) resulting from defects or deficiencies in supplies or services; and (2) apply the revised limitation of liability clause to latent, as well as patent, defects."[13]

Industry was pleased by the indicated intention of the DARC to adopt a policy of government self insuring for all loss or damages that it might suffer as a result of defects. CODSIA did, however, comment at some length on the way in which the DARC proposed accomplishing the broadened application of self insurance.[14]

Also, CODSIA said the clause always had applied to loss or damage resulting from latent

defects. Neither the policy statement nor the clauses make any exception relating to latent defects. DAR 1-330 declares a policy of the Department of Defense generally to act as a self-insurer ".... when the loss of or damage to property results from any defects ...." (underlined for emphasis). The clauses say loss or damage resulting from "defects." Concern was expressed that the reference to latent defects in the policy statement and in the clauses in the proposed revision could be taken as meaning that contractors under the thousands of contracts containing the present clauses are responsible for such loss or damage.

Also pointed out was that the addition of the language about latent defects was proposed to be added in the DAR 7-204.33 and the 7-1912 limitation of liability clauses for cost reimbursement and service contracts, respectively, and that neither of these types of contracts contain inspection clauses making acceptance conclusive except as regards latent defects, fraud or such gross mistakes as amount to fraud. Clearly the latent defects language should not have been proposed to be so added.

Putting aside discussion of the glitches on latent defects which could easily be corrected, the important item in the proposed revision was that of broadening the implementation of the government's policy to self insure to all claims by the government for loss or damage versus only for property loss or damage. This would have been a significant and desirable step in furtherance of the policy of self insuring. The soundness of this policy so far as I know has never been questioned. Additional savings from reduced insurance premiums in costs passed on to the government could be expected from the extension of the policy and the improved position in which it would place contractors in negotiating premium reductions. What happened to the proposed revision after all of the work that had gone into it, the years of considering the subject by the government and work on the industry side commenting on it? The DAR case, Number 80-43, was closed, dropped, no further action to be taken on it.

CONCLUSIONS/SUMMARY

The very few aspects of the two DAR coverages discussed illustrate the need which exists on the part of the DAR Council for more and earlier help in the drafting or revising of regulations. In the case of the warranty coverage, the foundering has gone on for over twenty years and on contractor liability for damage to government property for some fourteen or fifteen years. A few years ago, the then Chairman of the DAR Council in a talk to the FBA-BNA Western Briefing Conference[15] on Government Contracts reviewed something of the history of the development of warranty and contractor liability coverages, observing at one point that "Particularly on matters as complex and controversial as warranties, the participation of industry and other government agencies is essential." Later he observed that "The complexity of the warranty coverage is revealed by the fact that industry comments were solicited on five separate occasions between 19 October 1970 and 27 November 1973." He said that 60 days are normally provided for industry and professional association and other government agencies to review and comment on proposed regulations or revisions. A CODSIA Warranties and Consequential Damages Committee on which I served and chaired for most of the period remained active for over ten years in the 70's because there were always proposed revisions of the warranties and contractor liability coverages in process. Occasionally, a point of ours was accepted, where there was simply no room for argument and requiring little change in what had been proposed. A recent CODSIA letter[16] observed at one point, "After the DAR Council has made a judgment on the appropriateness of the DAR case language, there is little chance for industry to cause any significant changes in the proposed regulation. Industry is faced with a DOD position, not a proposed position which can be objectively discussed." Sixty days, even with the thirty or sixty days extension which is almost the rule is inadequate for reviewing and commenting on long, complex proposed regulations. The simple fact is that more and earlier involvement including face-to-face discussions is necessary to get points across on complex matters, to gain acceptance by DAR Council and subcommittee members of facts as known by industry personnel. Government personnel frequently are new to subjects under consideration and do not have experience and background for dealing with them. To this is to be added the fact that even at this policy developing level, some of that unfortunate adversarial attitude is to be found.

The warranties and contractor liability coverages are not isolated examples. The FAR will have many of the same flaws, probably a few new ones resulting from the relatively crash effort to put it together and the final executive review by DOD, NASA, and GSA. The FARC will have much the same kind of problems as the DARC has had. It will need and should have indusltry input including direct involvement, from the start of work on a regulation or revision.

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CAPITAL INVESTMENT INITIATIVES

Panel Moderator: Dr. Richard A. Stimson
Director, Standardization and
Acquisition Support and
Acting Director, Industrial Productivity
Office of Secretary of Defense, Research
and Engineering

Papers:

Analysis of Incentives for Productivity - Enhancing Investment
by Geneese Gottschalk, Myron G. Myers, and Michael J. Konvalinka

The Industrial Modernization Incentives Program: An Experimental Effort to Improve Defense Contractor Productivity
by A. Douglas Reeves

The Government Relationship to Industry in Technology Transfer and Development
by David H. Swanson

ADP002770

ANALYSIS OF INCENTIVES FOR PRODUCTIVITY-ENHANCING INVESTMENT

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ABSTRACT

There is evidence that Government contractors perform production contracts using high-cost methods leading to higher than necessary prices to the Government. Capital investments which lower total cost of performance are discouraged or at least not encouraged by current policies and market environment.

This paper describes a model of contractor investment behavior within existing DoD contracting principles. A preference for investments which confer low rates of productivity gain is shown to exist under current contracting policies. A discounted cash flow investment analysis model is used to explore a number of correctives to current policies including increased weight on facilities capital employed in Department of Defense (DoD) profit policy, sharing of cost savings, and investment incentives such as accelerated depreciation. Finally, the payoff to the Government and DoD if each corrective were adopted is explored.

INTRODUCTION

Many characteristics of the defense marketplace have historically discouraged industry investment. Among these have been the existence of large stocks of Government-provided plant and equipment, the cyclical nature of defense demand, annual funding of contracts, and, perhaps most importantly, cost-based profit policy. Although some marginal changes have been made over the past few years, the defense system of basing profits largely on the amount of costs expected to be incurred has discouraged contractors from making cost-reducing investments in facilities. In an attempt to counter the negative incentives of program instability and cost-based profit policy, the DoD is experimenting with programs for protecting a contractor from loss on his investments in case of early program termination and with the sharing of savings associated with investments in productivity-enhancing facilities and equipment. This Industrial Modernization Incentives Program (IMIP) test has been ongoing for a year.

As both the Government and industry participants in the IMIP test look to strike "win-win" business deals (those with benefits to both parties), each needs a methodology for evaluating the benefits associated with proposed projects. In our support of the IMIP Steering Group, we at Logistics Management Institute (LMI) have been using discounted cash flow analysis to examine the role of incentives (savings sharing) in encouraging contractor investment, and, more specifically, to examine the role of various elements of Cost Accounting Standards (CAS) and Weighted Guidelines profit policy in contractor investment decisions. In the balance of this paper, we will give a brief overview of the discounted cash flow analysis model and then discuss what sample results from the model suggest about how shared savings incentives, relevant CAS 409 and 414 and Weighted Guidelines profit policy interact to determine contractor and Government benefits from alternative investments.

OVERVIEW OF DISCOUNTED CASH FLOW ANALYSIS

The procedure employed to analyze a productivity-enhancing investment is to consider its effects on contractor cash flows and Government acquisition costs. The analysis is for incremental effects of a productivity-enhancing investment -- what additional return is earned by placing in service an investment which causes a reduction in the cost of production? The pre-investment profit, based on overall contract cost and facilities already in place, is not considered in the framework employed. Changes in contractor cash flow depend on contracting cost principles, profit policy, tax policy, and the inherent productivity of the investment. Because profit is based mainly on estimated cost of performance, investments which lower cost may lead to insufficient return on investment. Consequently, sharing of cost savings may be required to make the contractor's investment worthwhile. The Government gain from the investment is affected by the same factors except that the Government pays out monies in accordance with cost principles and profit policy. In turn, it receives benefits in the form of lower acquisition price. Net Government benefit is the difference between the total productivity gain and all payments to the contractor, whether costs, profit or shared savings. Discounted cash flow analysis considers the magnitude and timing of all effects on cash flow due to a contractor's investment. It is incremental in that an investment's cash flow effects on a contractor are over and above any investments already in place. Items of cash inflow and outflow are not only quantified in magnitude, but their timing is also considered through discounting. This technique reflects the fact that a dollar of immediate positive cash inflow is of more value than one due in the future. An after-tax stream of cash inflows and outflows is summarized by a single number, the internal rate of return (IRR), representing the value of the

investment to the contractor. The IRR is precisely the discount rate that makes the present value of all cash inflows equal to the present value of all cash outflows. It represents the after-tax earning power of an investment and thus is a standard of comparison with other investment alternatives.

Under Government contracting and tax conventions, an investment by a contractor leads to cash inflows based on allowable costs, profit and tax credits. Under capital cost recovery principles, a contractor is reimbursed for depreciation based on the original acquisition cost of the asset and its life under CAS 409 guidelines. An additional related cash inflow arises as imputed cost of money under CAS 414 based on the asset's remaining book value. Payment for profit also contributes to contractor cash inflow. Profit is paid on annual depreciation expenses, since they are allowable costs, and on facilities net book value under Weighted Guidelines. Profits for annual depreciation costs and on facilities capital are paid at different rates under Weighted Guidelines. Finally, tax policy recognizes an investment tax credit at the time the asset is put in service.

Offsetting the cash inflows occasioned by the facilities investment are a number of outflow items. The major cash outflow is the payment for the facilities themselves at time of acquisition. In the event the facilities are financed by borrowing, there are annual outflows for principal and interest payments. Additional income tax effects also occur. Tax payments are based on the difference between all additional revenues generated by the investment and all expenses recognized for tax purposes. Such expenses are different from contracting costs (e.g., interest and Accelerated Cost Recovery System (ACRS) depreciation are used for tax purposes). Finally, in the event the investment reduces the cost of contract performance, a reduction in cash inflow occurs since pre-investment profit is based in part on cost incurred. A cash outflow representing "lost profit" occurs to the extent that investment lowers the cost base on which a portion of profit is determined.

The net of all cash inflow and outflow items produces a stream of annual flows -- typically negative in the year of facilities acquisition and positive in subsequent years. The IRR associated with this stream indicates the profitability of the investment to the contractor. Sharing then represents additional cash inflows, funded from productivity savings, which can be offered to raise the contractor's IRR if necessary.

A similar analysis can be made from the point of view of the DoD program and the Government in total. The rate of return to the Government is merely that rate associated with the stream of all investment-related cash outflows paid the contractor by the Government and all benefit inflows received by the Government. Outflows are those associated with capital cost recovery, profits and income tax credits. Benefit inflows to the Government are from reduced acquisition price from cost savings plus any additional income taxes paid less any sharing of savings with the contractor. In the analysis described here, intangible benefits such as product quality improvement or reduced lead times and tangible savings benefits received beyond the program life are not included. Tax effects are counted in the total Government perspective but not in the DoD program analysis. Direct Government funding for Phase I and/or II analysis can be introduced in the model as an up-front cash outflow item to the Government.

The discounted cash flow model is merely a year-by-year tracking of all cash flow items, summed to produce net after-tax cash flows. The model has been constructed using one of the many "spread-sheet" programs available for use on a personal computer. A sample output from the model is presented in Table 1.

TABLE 1. IMIP SHARED SAVINGS COMPUTATION

	Year:	0	1	2	3
1 Contractor Investment		100.00			
2 Cumulative Contractor Investment		100.00	100.00	100.00	100.00
3 Direct Goverment Funding		10.00			
4 Cumulative Goverment Funding		10.00	10.00	10.00	10.00
5 Shared Savings			2.17	2.17	2.17
6 + Imputed CAS 414 Interest	14%		13.22	10.99	8.26
7 + Profit on Facilities	18%		17.00	14.13	10.63
8 + CAS 409 Depreciation			11.11	20.83	18.06
9 + Profit on Depreciation	8%		0.89	1.67	1.44
10 - Profit on Savings	12%		-3.60	-3.60	-3.60
11 BEFORE TAX CASH FLOW			40.79	46.18	36.96
12 - ACRS Depreciation			-19.00	-30.40	-22.80
13 Taxable Income			21.79	15.78	14.16
14 Income Tax	46%		-10.02	-7.26	-6.51
15 Investment Tax Credit	10%		10.00	0.00	0.00
16 AFTER TAX CASH FLOW			40.77	38.92	30.45
Cumulative After Tax Cash Flow		-100.00	-59.23	-20.31	10.14
17 Productive Savings at	30%		30.00	30.00	30.00
18 Contractor IRR w/ shared savings	20.0%				
19 Contractor IRR w/o shared savings	17.6%				
20 DOD Program Benefit		-10.00	-10.79	-16.18	-6.96
21 Cumulative DoD Program Benefit		-10.00	-20.79	-36.97	-43.93
22 DOD IRR	15.2%				
23 Total Goverment Benefit		-10.00	-10.77	-8.92	-0.45
24 Cumulative Goverment Benefit		-10.00	-20.77	-29.69	-30.14
25 Government IRR	27.7%				
26 Contractor Payback Period	2.7	yrs			
27 DoD Payback Period	6.9	yrs			
28 Goverment Payback Period	5.3	yrs			

Numerical values employed in Table 1 are essentially similar to those used in the 1982 draft DoD IMIP Guide and include a contractor target or hurdle rate of 20 percent. The values shown correspond to DoD policy guidelines and are intended to be representative.

The model calculates contractor IRR without sharing and IRRs to the DoD program and Government. It also allows for selection among four shared savings streams each of which leads to the targeted 20 percent after-tax return to the contractor. Theoretically, an infinite number of streams to achieve the desired IRR are

possible, and we simply chose four for illustrative purposes.

POLICY IMPLICATIONS OF DISCOUNTED CASH FLOW ANALYSIS

The Role of Shared Savings Incentives. The discounted cash flow model was run under a number of different assumptions for the purpose of assessing returns to the contractor and Government from productivity-enhancing investments. In particular, we are interested in the incremental return to a contractor as he puts in service facilities with varying associated productivity gains and the incremental return to the Government with necessary sharing, again as productivity varies. Within these cases, we also change profit parameters and include inflation savings to assess their effects on contractor and Government returns. All of the analysis reflects incremental effects of productivity-enhancing investments; the absolute level of profit without the investment is not considered.

In Table 2 we have reproduced model results showing for various productivity gains, the after-tax internal rate of return on contractor investment. The values calculated in Table 2 are based on a CAS 414 rate of 14 percent, profit on facilities of 18 percent, profit on depreciation of 8 percent, profit on cost savings of 12 percent and no inflation. The annual cost-saving productivity gain is expressed as a percentage of the original acquisition cost of the facilities investment.

TABLE 2. PRODUCTIVITY GAIN VS. PROFITABILITY: NO SHARING

PRODUCTIVITY GAIN (% of Investment cost)	CONTRACTOR AFTER-TAX IRR
15%	19.6%
30	17.6
45	15.5
60	13.1

Without sharing of savings, the contractor receives the highest incremental return by selecting the investment with the worst productivity gain (worst-first). This result follows from the cost savings' effect on profit; the higher the savings, the lower the cost-based profit, as all other cash inflow items stay the same.

For the parameter values used, the highest after-tax return (19.6 percent) is earned with an investment that annually saves 15 percent of its original acquisition cost. More productive investments earn progressively less. A low of 13.1 percent return after taxes is earned with a highly productive investment of 60 percent.

Contractor sharing of savings from productivity gains offsets the incentive to invest first in the least productivity-enhancing facilities. Sharing, in effect, offsets the profit-reducing aspects of cost-related profit and adds to the return if it is necessary to raise the contractor IRR to an acceptable level. Consequently, highly productive investments require the most sharing dollars but also provide the necessary funding for such sharing.

The model was used to calculate sharing required to achieve a 20 percent after-tax IRR to the contractor. This target hurdle rate is offered as a prototype and can be increased or decreased depending on such factors as alternative returns available in the economy, program risks, the size of the productivity gain, and overall DoD profit objectives. Results are displayed in Table 3. Values for CAS 414 and profit components are the same as those used for the calculation in Table 2.

TABLE 3. PRODUCTIVITY GAIN VS. RETURN TO THE GOVERNMENT: WITH SHARING (Contractor's After-Tax IRR Set at 20%)

PRODUCTIVITY GAIN (% of Investment Cost)	CONTRACTOR AFTER-TAX IRR	GOVERNMENT IRR
15%	20%	0%
30	20	28
45	20	93
60	20	210

As the productivity of alternative investments improves, more sharing dollars must be awarded to maintain a target of 20 percent after-tax IRR for the contractor. Consequently, the contractor is indifferent to selection among investment opportunities with varying rates of productivity gain -- a 20 percent IRR is always earned. The Government return, however, escalates dramatically with high productivity gains and approaches 100 percent for investments yielding annual savings of 45 percent of original investment cost.

This fixed 20 percent IRR is a convention of the analysis. In practical application, the very high potential return to the Government from investments with high productivity gains suggests that the Government should consider negotiating higher contractor IRRs when the productivity gain associated with the investment is high.

We also used the model to determine the extent of productivity gain necessary, absent inflation, to yield a 10 percent return to the Government. Such a Government return would be necessary to meet the Office of Management and Budget (OMB) guidelines. The model indicated a 23 percent productivity gain (i.e., about a four-year payback period) is necessary to yield a 10 percent IRR to the Government. This finding is specific to the values used in the model as reported in the discussion of Table 2 and should not be construed as a general guideline.

Finally, note that if inflation had been included in the analysis and inflation-avoidance

savings counted, all results would have been magnified. Absent sharing, given productivity gains would lead to lower IRRs to contractors (Table 2); while with sharing, Government returns for a given productivity gain would be higher than rates indicated in Table 3.

The Role of Capital Recovery Policies and Profit Policy. As noted above, contractor facilities investments give rise to cash flows based on Government capital cost recovery policies and profit policy. The return on investment can be examined by considering contractor investment (a cash outflow) relative to the stream of inflows received under capital cost recovery and profit policies as distinct from the inflow occurring because of shared savings incentives. The rate of return on this additional net cash flow stream indicates whether or not an investment, for whatever purpose, is likely to be undertaken in the absence of shared savings incentives. The rate of return earned on the investment must exceed a contractor's hurdle rate to be undertaken.

Capital cost recovery and profit flows, as outlined above, consist of the following elements:

- Reimbursement for depreciation on facilities capital under CAS 409;
- Profit on annual depreciation costs under Weighted Guidelines profit policy;
- Reimbursement for the imputed cost of money on facilities capital under CAS 414;
- Profit on the undepreciated balance of facilities capital through Weighted Guidelines; and
- Change in profit because of changes in costs incurred (lost profit if costs are reduced).

It is clear from the definitions of the aforementioned profit and cost recovery principles that they are interrelated and also related to the level of other costs incurred in contract performance. Recovery for depreciation under CAS 409 calls for use of the same method (e.g., straight-line, sum-of-the-years' digits) as is used by the contractor for financial accounting over an expected service life reflecting the assets' usefulness. Thus, recovery is quicker the shorter the service life used and the more accelerated the depreciation method used. However, the cost recognized under CAS 414 for imputed cost of money is based on unrecovered investment in facilities. Higher depreciation recovery using short service lives and accelerated depreciation methods implies lower undepreciated (book value) balances and thus lower "cost of facilities capital" reimbursements.

A second effect based on this same phenomenon occurs in the determination of profit objectives. Depreciation raises profit based on cost because depreciation is an element of overhead cost. Depreciation reduces profit based on facilities book value because depreciation lowers facilities book value. Furthermore, depreciation also lowers profit to the extent that a depreciable investment lowers other costs of performance. Any savings in, say, direct labor input resulting from contractor investment in productivity-enhancing facilities implies a reduction in that portion of profit based on lower direct labor costs.

It is evident that total capital recovery under CAS 409, CAS 414 and Weighted Guidelines Profit Policy is composed of many facets, some running counter to others. Trade-offs are evident since faster recovery through rapid depreciation and associated higher profit on depreciation costs imply lower subsequent recovery for those reimbursements which are based on undepreciated balances -- namely CAS 414 cost of money and Weighted Guidelines profit on facilities capital. Furthermore, more immediate recovery is of greater value than equivalent recovery at a later time due to the "time value of money." The timing as well as the magnitude of recovery must be considered.

Once again we used discounted cash flow analysis to examine discounted after-tax cash flow rates of return on contractor investment as asset service life under CAS 409 depreciation, profit rates on facilities capital employed and CAS 414 rates are varied. Cash flows considered are those affected by contractor facilities investment:

- the investment value itself
- imputed cost of money (CAS 414)
- depreciation reimbursement (CAS 409)
- Weighted Guidelines profit on depreciation
- Weighted Guidelines profit on facilities capital
- reduced profit on cost from productivity-enhancing investment (when applicable)
- Federal income taxes
- investment tax credit.

As before, we assume an investment of $100 with a productivity gain of 30 percent (i.e., $30 per year). In this case, however, the contractor receives no direct benefit (i.e., retained savings on the instant contract or shared savings incentives). Having all contractor benefits accrue as a result of capital recovery and profit policy enables us to focus on the policy implications of varying these and related elements such as equipment service life.

In order to analyze whether profit or depreciation policies, by themselves, could serve as effective incentives to motivate productivity-enhancing investments, we took the base case of Table 1 (combined CAS 414 and facilities capital rates of 32 percent), two other hypothetical cases (combined rates of 20 percent and 14 percent) and then varied the equipment service lives. The results are presented in Table 4.

TABLE 4. INCREMENTAL RATE OF RETURN ON FACILITIES INVESTMENT: NO SHARED SAVINGS

PROFIT RATE			CAS 409	
CAS 414 Rate	Facilities Capital	Depreciation Costs	Service Life (Years)	Rate of Return
14%	18%	8%	20	19.2%
14%	18%	8%	10	18.4%
14%	18%	8%	5	15.3%
14%	6%	8%	20	10.4%
14%	6%	8%	10	11.0%
14%	6%	8%	5	8.9%
14%	0%	8%	20	5.5%
14%	0%	8%	10	7.1%
14%	0%	8%	5	5.5%

The results from Table 4 suggest that a reasonable rate of return (about 20 percent) is achievable given a 14 percent CAS 414 rate and 18 percent facilities capital profit rates. In this case, however, shortening the asset service life reduces the contractor's IRR. When the combined CAS 414 and facilities capital profit rates drop to 20 percent or below, returns to the contractor become much less attractive. Faster depreciation recovery does little to improve the contractor's IRR. With the CAS 414 and facilities capital profit rates lowered to the hypothetical combined 20 and 14 percent respectively, there is little difference in contractor IRR between a very long and a very short service life. In fact, the intermediate 10-year asset life yields the best IRR.

This analysis suggests that profit (including CAS 414 considered as profit) based on investment is a more important motivator of investment than rapid write-off for depreciation. It should also be noted that without sharing, the contractor is still motivated to choose the investment that reduces cost least. Thus, sharing is still needed to offset the "worst-first" incentive no matter how high the profit rate on facilities capital.

SUMMARY AND CONCLUSIONS

This paper has summarized LMI's use of discounted cash flow analysis to examine the policy implications of various approaches to encouraging defense contractors to make productivity-enhancing investments. Our use of discounted cash flow analysis to date leads us to the following preliminary conclusions:

- Without sharing, "worst-first" low productivity investments are encouraged by the current largely cost-based profit policy.
- With sharing, a contractor could be offered high rates of return to make investments with high productivity gains.
- Savings from productivity gains can offer high returns to the Government if sufficient cost reduction occurs to provide lower prices to the Government even after it has funded the sharing.
- A short service life does not necessarily increase a contractor's rate of return. In fact, when combined CAS 414 and facilities capital profit rates are relatively high, a longer service life is preferred.
- Generous combined CAS 414 and facilities capital profit rates can be an effective incentive to investment, but sharing is still needed to offset "worst-first."
- Each proposed business deal requires discounted cash flow analysis to determine what terms are necessary to provide a "win-win" situation.

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THE INDUSTRIAL MODERNIZATION INCENTIVES PROGRAM: AN EXPERIMENTAL EFFORT TO IMPROVE DEFENSE CONTRACTOR PRODUCTIVITY

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ABSTRACT

This paper concentrates on the philoshophy and concepts behind the current test of Industrial Modernization Incentives Program (IMIP). The paper discusses how the test has been structured and applications to date. The test program is still in the early stages and the paper stresses that there are currently many more questions than answers. The aspects requiring further analysis are explored in detail. The paper also ties together other areas that relate to the IMIP and encompass the total environment motivating contractor productivity improvement efforts. These include Weighted Guidelines, Cost Accounting Standards, employee productivity incentive and bonus systems, multiyear procurement, economic production rates, the source selection process, and manufacturing technology.

INTRODUCTION

Several factors have converged in recent years to focus attention on productivity. The general economic conditions of the country, international competition, and rising defense system acquisition costs coupled with low capital investment rates and the potential for major manufacturing improvements due to technology advances have presented unparalleled opportunities as well as challenges. Just as productivity has become a paramount industrial concern at the national level, so too has the achievement of increased manufacturing efficiencies by defense contractors become of paramount concern to the Department of Defense. It is an important element to an improved defense posture and, most importantly, to reduced acquisition costs.

The Department of Defense buys such a wide variety of products from such a number of sources under different acquisition circumstances that sweeping generalizations about productivity and capital investment levels cannot be made. There are many bright spots and many areas where major improvements are needed. Productivity problems and solutions in the various segments of industry vary. However, a significant portion of manufacturing done on defense programs is done in an environment that can be characterized as utilizing out-dated and inefficient capital equipment and as labor intensive.

Batch production methods are used extensively in manufacturing for the DoD. Quantities are small and deliveries are over a period of time. Engineering changes frequently occur. It should be noted that, as a result of these factors, flexible manufacturing systems appear to offer the greatest promise in the DoD manufacturing environment. These computer-controlled and integrated machines, work stations, transfer mechanisms, and tooling allow production of a wide variety of products in small numbers.

In Defense two problems have been cited most frequently as inhibiting modernization and progress in the productivity area. These are program uncertainties and a profit policy which is based on cost. In the first instance risks are introduced which hinder investment amortization and inhibit long-term planning. In the case of our cost-based profit policy, a contractor may actually see profits reduced as a result of efforts to improve productivity and reduce costs.

Initiation of the test of the IMIP authorized by the Deputy Secretary of Defense on November 2, 1982, is a response to these challenges.[1]

OBJECTIVES

The objective of the IMIP is to develop, test, and refine contract incentives encouraging industry to make productivity enhancing capital investments. The incentives include shared savings rewards and contractor investment protection. Other incentives, such as award fees, are permissable but have as yet received less attention.

The IMIP test evolved out of successes the Air Force has achieved in its Technology Modernization (TECHMOD) Program and strong Tri-Service support for continued development of the concepts. The IMIP encompasses, expands, and provides a common framework for Service programs such as TECHMOD and Industrial Productivity Improvement and is a primary vehicle for implementation of Defense Acquisition Improvement Program Initiative No. 5, "Encourage Capital Investment to Enhance Productivity."

Data and information on the effects of various incentives and their motivational aspects developed during the IMIP will provide a solid basis for future policy development. The test program offers the opportunity to learn what works and what does not work, and to make adjustments accordingly.

The test of the IMIP is a uniquely structured effort in many respects. Although productivity problems are well recognized and documented, solutions are not as apparent. By providing an "umbrella" of a test, the DoD Components have the opportunity to be innovative and creative. Reluctance to try new

ideas because precedents do not exist, coupled with a uni-polar reward system that only penalizes mistakes, are the psychology being attacked. The incremental approach to implementation allows knowledge to develop as to what works and what does not work, and to make adjustments accordingly. It overcomes the "catch 22" of not being able to develop policy without knowing all of the effects, and not being able to gain the necessary experience because policy is not in place. It is indicative of the "bias for action" necessary to achieve results.[2] Success of the test IMIP may result in its being used as a model for other programs.

PROGRAM PRINCIPLES

Charter Provisions: Key provisions of the DEPSECDEF authorization and charter for the test of the IMIP are as follows:

- The test of the IMIP is decentralized to the DoD Components and is under the purview of an executive level steering group.
- In order to encourage innovation and experimentation, reasonable deviation from existing DAR coverage is permitted in conducting the test.
- Incentives are aimed primarily at motivating contractors to invest their own funds. Investments are to be encouraged which would not otherwise be made.
- Critical issues to be considered during the IMIP test are identified and are to be analyzed as concepts are applied.
- Documentation in the form of a draft DoD Instruction, draft contract clauses, and a draft DoD Guide are to be evaluated during the test.[3,4,5]
- Specific recommendations for changes to existing and proposed policy guidance are to be developed within one year of the test authorization based on experience gained during this period.

Organization: The DoD Components have the responsibility for developing their own approaches in conducting the test. The steering group has been established only to provide guidance and oversight. The steering group has met approximately quarterly since the IMIP test authorization. Rear Admiral Joseph S. Sansone, Jr., Deputy Chief of Naval Material (Contracts and Business Management), is serving as the initial chairman. A working group meets more frequently and is responsible for providing necessary support.

The IMIP test has received considerable publicity since its authorization. An IMIP information package was distributed to the industry associations on January 26, 1983. Two industry conferences, under the sponsorship of the National Security Industrial Association, were held in July and August, 1983. DoD Component information packages and implementation plans have been developed and distributed to field activities. Initial DoD Component training sessions have been held to introduce the concepts and procedures to the wide variety of personnel (technical, contracting, program management) at various levels within the organizations necessary to support development of IMIP agreements. The Navy is taking a somewhat unique approach by establishing formally designated multi-disciplined IMIP teams in its field commands.

Program offices play the key role in IMIP applications. This is also where experience and exposure (both on a conceptual and practical level) is most limited. We don't have a precise "how to" set of procedures. There is great flexibility and few constraints. However, both government and industry personnel may have trouble operating in this environment. We need to work through more examples, and to build a base of people (government and industry) who are confident, comfortable, and experienced with the concepts.

Despite progress to date, we still have a long way to go before program offices don't feel "caught in the middle." Figure 1 indicates how IMIP activity originates.

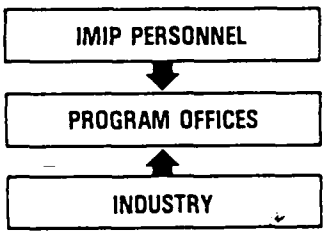

Figure 1. IMIP INTEREST

Phases: IMIP encourages a systems engineering approach to modernization. Normally, a "phase 1" factory analysis occurs as the first step of an IMIP. This is followed by definition of details for specific projects, enabling technology development, and implementation. The process can be expected to be progressive, continuing, and iterative and to contain some overlap. It is advantageous to negotiate a "business arrangement" as early in the process as possible.

The IMIP may be viewed as a departure from normal acquisition constraints and a "business arrangement" is the critical component. The idea is to negotiate an "arrangement" that makes sense to both parties that may not have been possible otherwise. The DoD is willing to do things differently under IMIP if acquisition costs are reduced. The premise is that

without added IMIP incentives things will be one way -- and that with the incentives benefits will occur for both parties.

There will be instances where, for a variety of reasons, a "business arrangement" will turn out to be impractical. The improvements suggested through rigorous examination of the facility may be of such a nature that the contractor would undertake them on his own. Or either party may feel that the deal is not satisfactory.

Proposals: A contractor proposal will ultimately form the basis for any IMIP arrangement. They may vary in detail based on the stage of negotiations. Initially they may be simple, "ball-park" estimates of cost and benefits and broad ideas on what is to be done. They may be expected to become progressively more definitive, and can ultimately be expected to address areas such as:

- identification of assets to be acquired by the contractor
- identification of items they will be used to produce
- description of the difference between the contractor's production methods with and without the proposed investment
- detailed cost estimates for the existing contract requirements and the proposal (including a realistic assessment of the effects on direct and indirect costs, implementation costs, etc.)
- analysis of effects of learning, variations of quantities, changes to make-or-buy plans, subcontracting, labor contract agreements, and other similar factors
- a suggested business arrangement describing government and contractor benefit sharing over existing and future contracts.

Case Studies: Possibly the single most important aspect of the IMIP test is the "case study" approach being used to document on-going efforts and to analyze the complex issues. The Logistics Management Institute has been given the assignment of developing appropriate case studies in support of the program. At the time of this article, they were working on the General Dynamics and Westinghouse agreements.

Compilation of detailed contract status sheets and development of an initial series of issue papers to crystallize ideas, focus attention, and ensure a common understanding of issues are also being pursued by the working group.

The intent is to develop, in a systematic way, a comprehensive body of knowledge on which to base future program direction. There is also a need to communicate the fundamentals of particular agreements. This is true both within government and industry.

Care is being taken to avoid being judgemental as to specific approaches or results. There is a danger in providing too much visibility and exposure while trying to encourage people to try new, untested ideas. It seems to Defense that there is often more time and resources to scrutinize what was done after the fact than there is time to do the job originally. The case studies represent a constructive effort to develop a body of knowledge, and are not intended to "second-guess" program decisions.

ROI Approach: It is the opinion of this author that shared savings is in many ways a misnomer. Connotations of the value engineering approach are immediately engendered. There is, however, a much greater sentiment towards the concept of carefully evaluating the cash flow that results from investment decisions and utilization of a return on investment approach as a basis for incentivizing these investments. As a hypothetical example, assume an investment of $50 million would result in cost savings of $200 million. It would be difficult for most individuals to rationalize a shared savings reward of $100 million on a $50 million investment. This is not to say that a common shared savings percentage may not eventually evolve -- but any percentage figure would most likely be balanced by return on investment considerations both in a general sense and on an individual application.

One tool to assist in evaluating the return on investment for particular investments is a discounted cash flow model suggested by the "DoD Guide for Improving Productivity in Defense Contracting" and being refined by the Logistics Management Institute in support of the IMIP. It is basically a spread-sheet financial analysis program on a personal computer. It has been used in support of IMIP negotiations, and plans are to make it widely available. Inputs include both before and after tax cash flows projected over a number of years. Positive cash flows to a contractor include reimbursements for CAS 414 interest, CAS 409 depreciation, and a special shared savings reward pool. One of the offset factors is lost profit as a result of productivity savings. The result of the cost flows to the government, including productivity savings, are factored into the model. This allows calculation of internal rates of return for both the contractor and the government. The model promotes a common framework for the evaluation and understanding of the effects of an investment decision; however, there is still plenty of room for discussion and dispute in selecting the data

used in the model. Sensitivity analysis allows introduction of questioning of model assumptions and evaluation of areas of risk. It is entirely conceivable that the model will indicate the desirability of making an investment apart from any special shared savings rewards or an IMIP.

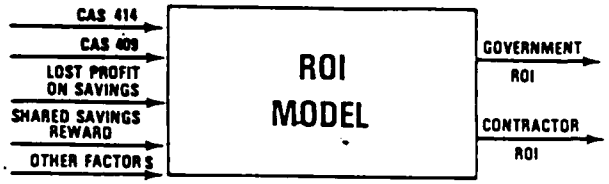

Figure 2. AN ANALYSIS TOOL

Benefits Tracking: The intent to keep the IMIP process as simple and straight forward as possible is complicated by the need to have results which are auditable and can be substantiated. The problem of establishing measurement baselines (which can be separated from numerous other acquisition factors such as quantity changes, engineering changes, and learning curve effects) suitable for contractual purposes is of particular relevance in establishing shared savings rewards. Questions on rate of return calculations, basing incentives on projected savings instead of measured savings, and risks if savings do not occur complicate an already complicated acquisition process.

It is the opinion of this author that care must be taken so as not to get carried away in this area. It would be preferrable to structure IMIP agreements based on the best up-front estimates available, and to realize the limitations of trying to compare actual costs based on data available with an artificial "would have been" situation. Measurement systems are not that sophisticated and the data can easily be manipulated to indicate whatever is desired -- the statistics are in the "noise level." Nor can we afford a massive data gathering system which, in itself, may serve no other useful purpose.

This is not to suggest that we should not be concerned about measuring improvements that result from IMIP agreements. We must realize, however, the inherent limitations of any system and ensure it will realistically serve our purposes. What we should be striving for as part of the modernization process is a measurement system that is aimed at process control. Computerization of the manufacturing process will provide this type of data. Direct costs and overhead costs must both be considered.

In order to shed additional light on the subject, the Army Procurement Research Office with support from the Air Force Business Research Center is conducting a contractor productivity measurement study. The objective is to develop practical measures of productivity relative to defense contracting. Results are expected to support both IMIP agreement negotiations and overall contractor productivity assessments.

DAR Issues: Reasonable deviations from existing Defense Acquisition Regulation (DAR) coverage have been authorized in conjunction with the IMIP test. The test charter provides details and limitations on this authority. Whether this authority is of more value for psychological or practical reasons is moot.

DAR 3-815 currently describes criteria for using contractor investment protection (or termination liability) for the purpose of improving productivity. IMIP applications may be expected to parallel this clause in most respects. In particular, the test charter is very careful to preserve the requirements of DAR 3-815(d)(2) to assure high level approval of contingent liabilities is obtained and to notify Congress in advance of the use of this technique.

Use of shared savings rewards and application of contractor investment protection to areas such as management information systems (as opposed to severable plant equipment) is not inconsistent with existing DAR coverage or the intent of existing coverage; however, they do go beyond present coverage. There are different opinions as to whether this constitutes a DAR deviation. In any event, one goal of the test is to present in DAR case format simplified, permissive changes to DAR language based on tested concepts.

Funding: Interim policy guidance and procedures as to sources of funding for the Industrial Modernization Incentives Program were issued in June, 1983.[6] Contractor funds are to be used for actual capital investments. Contractor funds, weapon system funds, and PE-78011 funds are to be used in the order of preference as listed for applications engineering and IMIP structured analysis. There is DoD Component movement toward contractor funding of efforts in all phases. Funds available in FY85-and-on under the new PE-78011 subelement for IMIP will be very limited, and may be expected to be used for unique situations such as subcontractor involvement.

Unfunded Liabilities: Legal issues regarding unfunded liabilities are being carefully addressed on each particular application. Use of unfunded liabilities are anticipated only when the DoD has a low probability of actually incurring expenses, and when amounts are known and within reprogramming authorities. It should be noted that termination liabilities are used for other reasons than productivity and IMIP -- such as when a new facility must be built for increased production capacity.

Congressional Liaison: IMIP information was circulated in December, 1982, to Congressional Committees, and informational briefings were offered if further information was desired. Program concepts have been discussed with staff members of the Senate Armed Services Committee, the House Armed Services Committee, and the House Appropriations Committee (Subcommittee on Military Construction). Reactions have been favorable. Briefings are continuing on a low-key basis until more results (successes) can be emphasized.

APPLICATIONS

Discussions, "Phase 1" factory studies, or agreement implementation are underway with over thirty contractors. However, experience in many important respects is limited. Actual experience to date is summarized below:

General Dynamics, Fort Worth. The F-16 TECHMOD effort was the fore-runner of the current program. Concepts were applied on a new, large acquisition at a dedicated GOCO facility with a modernization requirement for production startup. Following a factory-wide analysis, the Air Force participated in funding modernization efforts (Air Force funding was approximately $25 million with a General Dynamics investment of approximately $100 million) in exchange for lowered negotiated acquisition costs. Incentives included an award fee based on contractor implementation, shared savings based on a negotiated ROI, and termination protection. Cost avoidance to the government is estimated at $220 million. The F-16 also has an aggressive program aimed at the subcontractor level. General Dynamics is currently working with about 13 of its major suppliers. Most are in the factory studies phase; however, a few are entering into business arrangement negotiations. The Air Force is providing General Dynamics with a management fee for conducting this effort.

Westinghouse, Baltimore: The Air Force and Westinghouse recently concluded negotiation of a "framework" agreement following a factory wide analysis for a modernization program affecting a large DoD electronics business base and approximately 22 Air Force programs. Eventual Westinghouse investment is estimated at approximately $55 million with cost benefits to the government of approximately $400 million. A shared savings reward, based on a negotiated ROI, is the primary incentive. This reward will be structured as a separate contract line item on the three major on-going programs. Payment will be in four equal increments at various implementation stages. Explicit termination is not provided; however, there is an agreement to adjust program sharing arrangements if projected acquisition plans do not materialize. The Air Force and Westinghouse are currently pursuing negotiation of individual capital investment plans under their framework agreement.

Other Programs: The Air Force has six "business arrangements," including the two discussed above. However, implementation, in some cases, has not proceeded beyond the factory study phase. In the instance of Rockwell International on the B-1B Program, the Air Force may invest approximately $50 million with a contractor investment of approximately $80 million. Contractor investment protection and shared savings rewards (based on a savings-split approach) are being provided. Estimated cost benefits to the government exceed $ 400 million. The Army is close to reaching (subject to second-sourcing considerations) its first IMIP type agreement with the AVCO Corporation, Lycoming Division, for modernization of facilities used in production of turbine engines for the M-1 tank. Contractor investment protection and shared savings rewards would be provided in return for a contractor investment of approximately $60 million and savings to the government of over $200 million. The Navy currently is pursuing a number of promising proposals.

ISSUES

The IMIP test charter contains a list of issues to be addressed during the IMIP test. Limitation as to the length of this paper does not permit discussion of all of these issues or the many others that could be added. However, thoughts on a few of the critical issues are provided.

Complexity of the Process: Although the IMIP is simple in concept, development of specific contract language has proven time consuming, manpower intensive, and complex. It complicates an already complicated acquisition process. The Westinghouse agreement has taken over two years to consumate, and we are only now moving past the "framework agreement" stage. Difficulty may be expected to be alleviated as more experience is gained; however, we must also look for ways to simplify the process.

It becomes progressively more difficult moving from the single-Service, single-program application to a multi-Service, multi-program application. Yet this latter factory-wide application is potentially where the greatest benefits lie. The concept of a Lead Service supported by a Memorandum of Understanding is the tactic being tested in this situation.

One idea being discussed is setting a routine shared savings reward percentage capped by the investment cost. Another thought is to establish an award fee of say 20% of the investment cost that a program office has the latitude of using when certain criteria are met.

Competition: Everyone has the opportunity to compete for an IMIP, but what about the company already making significant investments on its own? Is it being penalized for acting aggres-

sively? Is an IMIP necessary for "customer relations?" Should a company hold off and wait for an IMIP? Once a company has an IMIP, should it only make future investments under the IMIP? Will IMIP adversely affect competition? At this stage, the answer to all of these questions is no. The IMIP is currently operating on investments "at the margin." Ramifications later may be more significant and, as the program grows, some of these questions will become more difficult.

Subcontractors and Vendors: IMIP is certainly feasible when a contractor deals directly with the DoD. Contractual mechanisms to reach subcontractors or vendor tiers are more difficult. Even the success the Air Force has had in programs such as the F-16 can be qualified in that a minimum number of complicating factors are present.

A major goal of the IMIP test is to find ways to impact the subcontractor and vendor level. The importance of this is illustrated by the B-1B Program where over 5,000 suppliers are involved. There is interest in developing industry-wide IMIP efforts. For instance, the Air Force is exploring concepts through a Traveling Wave Tube Program. Whether impact is feasible when quantities are small, price competition exists, and the DoD market share percentage is low is debatable. Direct government contracting in this situation is a possible alternative. Much remains to be done in this area.

Capacity: The test charter criteria for an IMIP is clear in stating that the investment should primarily support enhanced production efficiency of an existing or anticipated operation, not new production capacity. IMIP is not intended as a program to subsidize new production capacity. This is an easy determination when a facility already exists. The difficulty occurs when a new facility is required and an "anticipated operation" must be hypothesized for a "without an IMIP" baseline. The alternative must be realistic and not a matter of pure conjecture.

Government Approval and Involvement: DoD approval levels for contractor capital investment activities escalate when an IMIP arrangement is contemplated. A contractor may find that DoD visibility to his internal operations and approval of individual capital investment plans increases. Mid-level technical personnel will not only have to convince their own management that an investment makes sense -- they will also have to convince appropriate government representatives. Another layer of review and diminished responsibility is added to a system already accused of being nonresponsive. Some contractors may question whether the results are worth the cost.

DoD Cost Reductions: We will be able to see the hard cost reduction figures at times. A firm price or option price will exist and a reduction will occur directly attributable to an IMIP. However, there will be many cases when the DoD must look for decreases in future or projected prices. Whether enough confidence will exist when this occurs is a critical question to be answered.

Risk: It is the opinion of this author that we have not as yet adequately factored risk into the IMIP equation. Important questions include: What happens if savings do not materialize? Who loses -- especially if actual contract prices have been reduced? How does this affect return on investment negotiations?

RELATIONSHIPS

The test IMIP and its incentive features should not be viewed in isolation. DoD Acquisition Improvement Program Initiative No. 5, "Encourage Capital Investment to Enhance Productivity", is really a series of eight subinitiatives. These range from the IMIP, cost and finance principles, and manufacturing technology to data and patent policies. Additionally, the whole acquisition system provides the environment in which contractor productivity improvements are considered. These diversified elements must be integrated and viewed as a whole to see the synergism that exists. It is possible that expanding knowledge of how the DoD rewards productivity improvements -- the mechanisms present and the interest of the "customer" -- will in itself stimulate improved productivity.

CAS 409/414 and Weighted Guidelines: Capital cost recovery on cost reimbursable contracts is heavily influenced by Cost Accounting Standard (CAS) 409, "Depreciation of Tangible Capital Assets," and CAS 414, "Cost of Money as an Element of the Cost of Facilities Capital." The Weighted Guidelines is a method of determining profit levels in negotiated contracts based on a series of factors. Although the intent of the above is to allow a contractor to obtain a fair rate of return for his efforts and investments and not necessarily to encourage capital investment, they weigh heavily in any investment decisions.

CAS 409 allows recovery of depreciation expenses based on estimated actual service lives of capital equipment. It does not (nor should it) allow use of accelerated depreciation methods such as ACRS. A USDRE letter of December 20, 1982, draws attention to the flexibility inherent in CAS 409 to enter into advance agreements on depreciation of certain tangible assets when the actual economic or technical useful lives can be shown to be shorter than may otherwise be permissable. This flexibility will be considered during IMIP negotiations.

CAS 414, which went into effect on October 1, 1976, results in reimbursement to a contractor

on an interest-type basis for the undepreciated book value of his facilities. It is an imputed cost rather than an actual cost so as not to penalize a contractor who has financed purchase of facilities or equipment himself rather than obtaining loans for this purpose. Traditionally, costs of this nature have been recovered as an element of profit rather than as an element of cost. DoD profit policies were adjusted due to this allowance. Additionally, CAS 409 and CAS 414 are interrelated. Quicker reimbursement based on CAS 409 depreciation results in lower CAS 414 reimbursement.

The Weighted Guidelines contains two factors which might be expected to overcome contractor reluctance to invest in modern facilities and equipment. A Facilities Capital Investment factor and a Productivity factor are included. There has not been a great deal of experience with the Weighted Guidelines method of profit determination, but the limited experience that exists suggests its usefulness in motivating capital investment and productivity improvement is limited. Contractors perceive the method as a way to rationalize a predetermined and essentially invariable profit rate. The uncertainty that an investment will ever really result in increased profit levels is too great. The cause and effect tie is too tenuous.

One might wonder why the IMIP is needed given the existence of CAS 409, CAS 414, and a properly functioning Weighted Guidelines procedure. In an intensively competitive environment they may indeed be enough. But, as indicated earlier, pressures and rewards to modernize are not always present. A contractor may foresee a better profit picture without the inherent risks of modernization. It is in these circumstances that IMIP plays a complementary (rather than duplicative) role.

Other finance and cost accounting principles are also open to reexamination. Attitudes and methods of accounting for cost may have to be reexamined in the context of facilities modernization. Some argue that the tremendous pressure to keep overhead costs down inhibits modernization where the direct labor component goes down shifting costs to the indirect side. Others suggest we need to change procedures for the allocation of direct and indirect costs.

One recent DAR change is of particular interest. Defense Acquisition Circular 76-42 promulgated changes to DAR 15-205.21 to expand those activities included in the definition of manufacturing and production engineering, and their allowability in manufacturing overhead. Specifically, the allowability of development efforts for manufacturing or production engineering efforts to improve current production functions are covered.

Manufacturing Technology: The Manufacturing Technology Program is a well established program aimed at making first-case manufacturing process and equipment improvements in the production environment. An element of technical risk is involved. Government funding participation (nominally at $200 million a year) is significant. Efforts are on a project-by-project basis. IMIP is aimed at improvements on a factory-wide basis, and involves both well established and state-of-the-art technology. Perhaps the most important distinction is that the main thrust of the IMIP is on contractor funding for investments.

Program relationships stem from common purposes and the involvement of many of the same technical people on both programs. After manufacturing technology projects are completed, program criteria does not allow the same project to be undertaken a second time. IMIP may prove to be a vehicle for wider adoption of the highest-payoff manufacturing technology projects. It is also conceivable that one factor in the selection of manufacturing technology projects might be a contractor's broader commitment to productivity improvement, as evidenced by an IMIP agreement. Viewed in another way, manufacturing technology projects might be considered as part of the reward for broader IMIP undertakings.

Defense Acquisition Improvement Program: Two of the areas of emphasis evolving out of the Defense Acquisition Improvement Program are multiyear procurement and economic production rates. Both can be expected to have a big impact relative to IMIP. Multiyear procurement provides the program stability so important to program efficiency and productivity improvement. Economic production rates are essential for utilization of facilities in an efficient manner.

Human Resources: Human resource motivation is intended as an element under IMIP; however, incentives thus far have been primarily for capital investment. Activity regarding employee productivity incentive and bonus systems constitutes the first venture into this area. Two companies have requested clarification of guidelines and appropriateness of their systems. The DoD Components are exploring the issues.

Acquisition Process: It is becoming increasingly clear that the overall acquisition strategy is an extremely important consideration when developing an IMIP strategy. The question is not so much which is the driving force as whether the two are compatible. For instance, introducing additional competition into an acquisition may either mitigate the need for an IMIP agreement or act at cross-purposes to an IMIP agreement. Any IMIP strategy must carefully consider the acquisition strategy and, indeed, an IMIP strategy may be best developed as part of an acquisition strategy.

Similarily, IMIP and broader productivity considerations should be an integral part of source selection evaluations and DSARC deliberations. It is in these arenas that maximum leverage and emphasis occurs. Efficiency of the manufacturing process and manufacturing plans need more visibility. The Air Force has recently required productivity improvement plans as part of RFP responses. This represents a beginning in focusing attention on this critical area. Additionally, documents such as the Production Base Analysis (PBA) should prove of value in identifying manufacturing inefficiencies and opportunities for IMIP applications.

IMIP will not be the exclusive answer to productivity improvement in the acquisition process. Discussions with defense contractors who have excellent productivity improvement records indicate that it is the "little things" that have cumulatively resulted in large productivity gains. Much can be achieved from small investments in the right equipment and from the proper environment where all employees have the responsibility and opportunity to make needed changes and produce quality products.[7]

CONCLUSION

The IMIP is a very targeted and controlled way of fostering capital investment and modernization -- the DoD must see the prospect of reduced acquisition costs as a result of any "business arrangement" negotiated under the IMIP. It is an interesting phenomena that people can actually feel more nervous operating in this type of environment. For instance, an across-the-board 10% tax credit may be readily acceptable by the public. However, trying to selectively apply a program like IMIP introduces a great deal of subjectivity and judgment into the process. A selectively applied program may, on the other hand, yield a much higher cost/benefit ratio.

The IMIP is not a short term program or approach. Indeed, it will likely be in the test mode for a couple of years. Broad implementation and maximum benefits will span a much longer period. It is important that credibility be retained during this period and that expectations not be built too high. We must reasonably explain the purposes of the program and its strengths and limitations. Diligence and detailed analysis must be the cornerstones of the implementation process.

The IMIP is a tool to encourage increased capital investment and increased productivity. As indicated in this paper, it is not the only tool. What is unclear, at this point, is how widely IMIP can be used. Whether it can be applied in 90% or 10% of the aquisition circumstances is still open. Fundamental changes to the concept and procedures -- aimed at simplification -- will probably have to be made to approach the higher figure.

Nevertheless, the IMIP test presents a tremendous opportunity and challenge to shape the future of defense industry. The IMIP will undoubtedly make an important contribution to a modernized, efficient DoD manufacturing base and reduced acquisition costs.

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NOTE:

MUCH OF THE INFORMATION IN THIS PAPER IS THE RESULT OF THE AUTHOR'S PERSONAL EXPERIENCES WORKING WITH THE DOD COMPONENTS ON THE IMIP TEST AND SHOULD NOT BE CONSIDERED A STATEMENT OF DOD POLICY.

AD P002772

THE GOVERNMENT RELATIONSHIP TO INDUSTRY IN TECHNOLOGY TRANSFER AND DEVELOPMENT

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ABSTRACT

Iowa State University's Center for Industrial Research and Service conducted a survey of manufacturers in January 1982. This mail survey to the 3,764 manufacturers in Iowa was designed to reveal the problem areas and information needs of manufacturers and processors. The survey also addressed information sources, technology development, productivity improvement, and how managers expected to improve operations. The role of government, government laboratories, universities, equipment manufacturers, and trade associations in technology transfer and development was delineated in the analysis.

The major problems identified for the next five years were energy costs (76%); interest rates (73%); economic recession (63%); inflation (59%); Social Security cost (51%); and unemployment compensation costs (50%). The most needed information related to computers, employee motivation, planning, handling inflation and recession, information on new equipment, technology related to the manufacturing processes, and new markets. Interest in robotics (7%) and CAD/CAM (4%) proved not very popular with manufacturers, as did exporting (9%). Research laboratory findings were definitely needed by 13% of the manufacturers.

Areas which manufacturers identified as top priority in their efforts to increase productivity and efficiency were: (1) an expanding economy (27%); (2) cooperation of labor and management (26%); (3) new equipment (14%); and (4) research findings (6%). The areas where the executives expected to achieve productivity gain within their own operations were concentrated in marketing and production areas. These productivity gains would be achieved through motivation of workers and adding new equipment.

New technology that the manufacturers would utilize would be developed by equipment manufacturers (83%); their own companies (65%); universities and colleges (61%); trade associations (10%); government laboratories (49%); and consultants (40%).

Trade associations, equipment manufacturers, universities and colleges were most popular as its transfer agents--this transfer would be accomplished through articles and publications, workshops, and conferences.

Specific problem areas varied by type of industry, as did the need for information and reliance upon governmental sources. Food processors (24.7%) and nonelectric manufacturers (40%) expected to increase sales through exports, while instrument manufacturers (22.2%) relied more upon government sales for increased sales. New products were critical to virtually all manufacturing groups. Productivity gains and technology needs varied by type of industry. Apparel manufacturers, instrument manufacturers, and leather products relied more upon government as a transfer agent than did other manufacturers. Metal manufacturers heavily depended upon associations and equipment manufacturers. Textile, chemicals, and universities also expected government to develop new technology.

INTRODUCTION

The recognized importance of new technologies, research and scientific discoveries in the economic growth processes has placed increased pressure upon the laboratories and research institutions. The demands are to achieve competitive advantages in products and processes through the practical application of new discoveries. The emphasis is upon accelerating the transfer of select scientific information to the industrial sector. The assumption is that new scientific discoveries, their rapid utilization and assimilation, will produce an accelerated rate of economic growth, increased employment levels, increased wealth, protection from unexpected obsolescence, and sustainable growth in international power. The basic perception that new technology, or advanced technologies, will stimulate and sustain economic growth has given rise to strengthened methods to increase the development of new technology and the effective utilization of these new technologies. The role of research centers; government laboratories; and the understanding of advanced science, mathematics and communications, have become an integral part of the national goal of economic growth.

The shift of state emphasis and funding toward the science and technology, and the historical role of federal research efforts, demand greater understanding of technology transfer processes. Diffusion, adoption, new products, communication, learning, and related studies have helped provide directions to the development of more effective technology transfer efforts. These studies have not, however, been directed toward the specific technology transfer role of government, government laboratories, universities, equipment manufacturers, or trade associations.

A study of manufacturers and processors perceptions toward technology development and

transfer was conducted by Iowa State University of Science and Technology's Center for Industrial Research and Service in 1982. The mail survey to 3,764 manufacturers in Iowa provided insights into manufacturing executives perceptions and needs. The survey's 25.6% response rate, a representative sample of the industries, permitted a description of the manufacturers' problems, informational needs, expectations in technology, methods of acquiring information, and comparison of the role of various institutions and agencies in these areas. The study challenges some existing views on technology development and transfer. It also points out the complexity of the information transfer issues.

FINDINGS OF THE STUDY

Manufacturing executives clearly identified and ranked the problem areas and informational needs they expected during 1982-86. These concerns were altered somewhat from those identified in 1979, but the top concerns remained; insurance costs, the economy, and energy costs dominated the minds of manufacturing executives.

Table 1. Great Problems for the Company in the Next Five Years (1979 and 1982 Surveys Compared)

Rank 1982	Rank 1979	Problem	Response Rate 1982	Response Rate 1979
1	2	Energy costs	76%	52%
2	4	Interest rates	73	39
3	6	Economic recession	63	32
4	1	Inflation	59	75
5	7	Social security, insurance costs	51	30
6	7	Unemployment compensation cost	50	30

The executives recognized that they would need to acquire information if the problems were to be addressed. Although productivity is viewed as a problem area, it is not a major concern nor was research viewed as the solution to

Table 2. Productivity (Percentage Selection That Ranked)

Area	Rank 1	2	3	4	5	6	Not Selected
Needed to Increase U.S. Productivity:							
Expanding Economy	27%	17%	14%	12%	0.5%	%	21%
Cooperation of Labor Management	26	19	13	11	0.8		15
Investment in Equipment	14	22	20	13	0.3		25
Research	6	13	20	27	1		30
Area Where Productivity Gains Will Be Made:							
Marketing/Sales	31	19	8	5	3	3	19
Production	32	19	11	5	3	1	20
Distribution	4	13	14	10	9	6	40
Material Handling	3	7	10	14	13	8	44
Office	3	4	8	8	11	21	44
How These Gains Will Be Made:							
Motivation	15	10	5	3	1		29
New Equipment	9	9	6	3	2		45
New Product Design	5	4	6	4	2		67
Computerization	4	5	5	4	5		62
Existing Product Design	3	4	4	4	4		71

productivity problems. The expansion of the economy and cooperation with labor were viewed as major factors in increasing productivity in the United States. To the specific question of where within the individual company would productivity gains take place, the answers were marketing/sales and production--and the primary means of increasing productivity would be through employee motivation. Research, product design, and computerization were instruments to increase productivity, but they were not highly ranked.

The lower ranking of research and product design placed into clearer perspective the problems of transferring information about new technology and scientific discoveries. Many manufacturers simply do not perceive new products and technological advances, except in motivation and processes, as most important in addressing their operational problems and productivity concerns. Yet, 44% of the executives expected to introduce new products, 49% expected to increase market share in the next five years, and 70% expected an improved economy in 1983.

This understanding of the manufacturers problems and views helps us relate to the executives informational needs and where this information will be obtained. Manufacturers definitely needed information on managing economic changes, employee motivation, new equipment, new markets, and computers, but surprisingly, not technology. They did not express a strong interest in obtaining information on the popular topics of robotics, CAD/CAM, waste management, exporting, or laboratory results.

Executives' concern with production and the immediate practicalities of operating their businesses carries over into their expectations of who should develop new technologies and who should provide them with information on new technologies. Equipment manufacturers are the primary source of new technology, but their own companies, universities and trade associations play an important role in the development. Expectations in information transfer reveal the strong role of trade associations, publications, equipment manufacturers, and university/communications systems.

Table 3. Information Needs: Selected Areas

Area	Definitely Need	Probably Need	No
General Management			
Computers	31%	32%	14%
Employee Motivation	26	38	8
Planning	26	38	9
Handling Inflation	28	35	9
Handling Recession	26	36	10
Production			
New equipment	30	41	7
Technology	24	42	10
Robotics	7	12	35
CAD/CAM	4	12	31
Marketing			
Sales mgt.	17	37	15
Exporting	9	14	38
New markets	25	31	17
Other			

Table 4. Technology Development and Transfer (Percent)

	Rank							Not Selected
	1	2	3	4	5	6	7	
Expected to Develop Technology:								
Equipment Manufacturers	44%	14%	7%	4%	2%	1%	1%	17%
My Company	19	11	10	6	5	5	3	35
Universities, Colleges	6	15	12	10	7	6	2	39
Trade Associations	7	17	14	9	5	4	1	40
Government Laboratories	1	4	6	7	7	6	16	51
Consultants	1	4	6	7	11	10	6	54
Expected to Transfer Technology:								
Trade Associations	18	22	14	9	3	1	1	22
Equipment Manufacturers	28	15	11	7	4	2	1	26
Magazines & Journals	12	14	16	11	6	3	2	27
Universities, Colleges	8	9	11	12	9	6	2	37
My Company	12	7	7	4	6	7	6	46
Consultants	1	4	4	7	10	12	9	51
Government Laboratories	1	3	3	5	9	8	16	52

Table 5., Who Should Develop New Technology (By Type of Industry) (Percent)

Industry/Product	Equipment Manufacturers	Trade Associations	Government Laboratories	Universities	My Company	Consultants
Food Processing	73.1	41.8	11.9	44.8	52.2	13.4
Feed Processing	65.2	39.1	17.4	45.7	39.1	17.4
Textiles	78.6	35.7	28.6	14.3	28.6	7.1
Apparel	100.0	50.0	0.0	25.0	0.0	0.0
Lumber & Wood	71.1	57.8	6.7	33.3	51.1	11.1
Furniture & Fixtures	82.1	42.9	10.7	39.3	42.9	3.6
Paper	83.3	33.3	5.6	11.1	66.7	11.1
Printing & Publishing	88.6	49.2	11.4	28.8	28.8	9.8
Chemicals	62.5	45.0	20.0	45.0	62.5	12.5
Rubber & Plastics	84.6	42.3	11.5	25.0	50.0	17.3
Stone, Clay, Glass	58.8	47.1	0.0	29.4	52.9	29.4
Primary Metal	78.6	71.4	14.3	21.4	35.7	14.3
Fabricated Metal	77.1	39.4	12.8	35.1	46.8	10.1
Nonelectric Machinery	83.1	32.2	11.9	40.7	57.6	16.9
Electric Machinery	77.8	36.1	5.6	25.0	58.3	11.1
Transportation Equipment	81.0	47.6	14.3	42.9	47.6	14.3
Instruments	87.5	12.5	50.0	37.5	37.5	0.0
Other	74.1	42.9	16.1	48.7	49.6	14.7
	76.3	42.8	12.4	36.8	47.1	12.9

The response of executives varied some by firm employment size, type of industry, age of executive, level of education, and major area of training. Executives in larger firms had more confidence in their firm's ability to develop technology. They also were more interested in new technology, robotics, CAD/DAM, and research. The type of industry also influenced perceptions of who should develop technology or transfer information. Producers of food, chemicals, transportation equipment, and machinery were more reliant upon outside sources. Instrument and textile manufacturers were more likely to see government laboratories as developers of technology. Manufacturers also expected more from the universities than from government laboratories and consultants.

The transfer of knowledge about new technologies follow similar patterns to the development of technology. Consultants and federal laboratories rank surprisingly low except in special instances such as apparel and instrument manufacturers.

These findings are similar to findings of a 1979 study of where Iowa manufacturers indicated that the source of information in solving problems was in the private sector, such as banks, consultants, friends, and other manufacturers. Government--state, federal and local--was not a likely source of information.

The actual delivery of information to executives of manufacturing companies provides insights for those wishing to accelerate the technology transfer process. Executives generally prefer publications, articles, conferences, and workshops as the means to get information. Younger executives (21-30 years) have a greater preference for articles, less desire for conferences; and is the only group that has interest in classes for credit (22.5%). But the clear implication is that technology transfer involves a variety of delivery systems.

Table 6. Source of Advice/Help Utilized, 1979 (Percent)

Source (Firms Could Indicate More Than One)	Employment Size					
	1-20	21-50	51-100	101-250	251-500	501-1000
Friends	25.5%	25.4%	14.8%	18.3%	16.7%	4.0%
Consultants	33.6	49.2	53.7	57.0	55.6	48.0
Banks	45.2	38.7	25.0	22.6	16.7	12.0
Local Government	0.0	1.7	0.9	2.2	1.9	4.0
Magazines, Journals, etc.	13.9	14.4	13.0	9.7	11.1	16.0
Iowa Manufacturers Association	2.0	18.8	22.2	28.0	25.9	32.0
Federal Government	7.3	4.4	3.7	4.3	3.7	0.0
Trade Assoications	36.4	39.2	44.4	48.4	44.4	40.0
Other Manufacturers	28.5	35.4	39.8	33.3	40.7	36.0
State Government	2.3	3.9	3.7	1.1	5.6	0.0
Universities	17.9	22.7	19.4	17.2	13.0	8.0

Table 7. Method Preferred To Get Information (Percent)

Method	Rank						Not Selected
	1	2	3	4	5	6	
Articles & Publications	27%	14%	11%	10%	4%	3%	16%
Conferences	17	20	16	8	2	1	29
Workshop (in plants)	14	8	8	11	6	4	43
Workshop (outside plant)	14	20	15	7	3	1	34
TV/Films	2	6	5	8	12	15	52
Class/Credit	2	3	4	5	16	16	54

CONCLUSIONS/SUMMARY

Government has a significant role to play in the development and transfer of technology. The interrelationship with industry, however, is not well understood nor is it in the mainstream of industry. Manufacturing executives, except in a few select industries, do not perceive of government as either the developer or transfer agent for technology. Industry perceives equipment manufacturers, trade associations and universities as the developers of new technologies. These groups are also indicated as the primary agents of technology transfer.

Industry executives utilize a variety of sources and means to acquire information. This means that institutions and government laboratories can strengthen their relationships with industry by working with associations, producing articles and publications, and participating in conferences and workshops. The production of films, television programs, and formal classes are not viewed by executives as productive technology transfer mechanisms within existing structures and formats.

Executives acknowledge the need for information on new technology, materials and equipment, but the ability to provide them information on these needs will depend upon governments working with the equipment manufacturers, associations and other groups.

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COMPETITION

Panel Moderator: Colonel Marvern M. Mercer
Assistant for Contracting and Acquisition Management
Office of the Deputy Assistant Secretary of the Air Force for Acquisition Management

Papers:

Competitive Procurements: The Synergistic Linkage Among Government, Industry, and Academe
by Donald L. Brechtel, Edward J. Brost, and Steven J. Zamparelli

Competition: An Integral Part of the Acquisition Process
by Roger C. Head

Increasing Spares Competition in AFLC
by Thomas M. McCann and James R. Butterworth

COMPETITIVE PROCUREMENTS: THE SYNERGISTIC LINKAGE AMONG GOVERNMENT, INDUSTRY, AND ACADEME

Capt Donald L. Brechtel, Air Force Institute of Technology
Edward J. Brost, Air Force Audit Agency
Capt Steven J. Zamparelli, Air Force Logistics Command

ABSTRACT

Competition is looked upon by many as one technique to maximize the return from the procurement dollars available. Many members of Congress recommend the competitive method of purchasing for most Government procurement actions. However, the history of Federal procurement attests to the fact that competitive bidding is inadequate in some situations. Since competitive procurement does not always result in lower prices, program managers, contracting officers, and buyers should understand the conditions which may affect prices and aggressively seek competition for items that may likely result in net savings to the Government.

This paper includes a summary of competition theory and recent research conducted in the area of competition by graduate students at the Air Force Institute of Technology (AFIT). Two graduate research projects that addressed competition for weapon system replenishment spare parts are summarized in the paper followed by some concluding observations.

INTRODUCTION

Throughout the history of economic policy in this country, a continuing effort to encourage and preserve market competition and limit monopoly is reflected in anti-trust laws, procurement statistics and regulations, and a variety of other public laws (7:1). The maximum use of competition is universally stressed by the decision makers, and the emphasis on competition is strongly supported by the American public. Legislators perceive that regulations should insure "fairness" in acquisition practices (4:2). This perception, coupled with a "widely held belief that competition leads to better products at lower prices (15:27)," led to mandates by the Department of Defense (DOD) to require the use of competition to the maximum extent possible.

For more than twenty years, the DOD has attempted to increase competitive procurements in the weapons acquisition process (1:2). Because of pressures to spend funds wisely, the Government has sometimes tended to overstress and overuse competitive bidding (8:98). Competition is not always the best method of procurement for obtaining the best price and/or quality (14:2). The introduction of competition has, on occasion, led to nonusable parts, delays in delivery, increased administration, and higher total cost. Major empirical studies on the effects of competition have usually found that some measure of savings resulted from the use of competition. However, the empirical studies have also revealed cases in which losses occurred for competitive procurements. Strict adherence to the requirement for maximum competition may be inappropriate in some cases (2:93).

TEXT OF PAPER

Background

The concept of insuring fairness through free and open competition is not new. Legislative requirements to procure supplies and services through competitive formal advertising began in 1809 and were reemphasized in the Armed Services Procurement Act of 1947. Competitive bidding was and is believed to be an assured technique for wise expenditure of public funds (8:97). Competition is thought to cause lower prices, strengthen the defense industrial base, and increase public confidence in the integrity and fairness of our system of Government procurement (13:12).

Today, there are two methods by which DOD buyers may acquire supplies or services--formal advertising and negotiation. Negotiation came into being in response to rapid technological changes and national emergencies which necessitated a more flexible method of acquisition (19:72-75). Negotiation is the acquisition process employed under certain permissible circumstances that are prescribed by law, when formal advertising is determined to be infeasible or impractical (20:A1,B12). These permissible circumstances take the form of 17 exceptions to formal advertising. The Contracting Officer, after determining the need to negotiate based on one of the 17 exceptions, is allowed to enter into discussions with any or all potential contractors after offers have been made to the Government. Negotiation allows bargaining on price, terms, and conditions up to the point of agreement (21:2-103). Negotiation, although the most used method of acquisition, is still the exception method, for formal advertising is the "law of the land (4:2)."

Formal advertising is contracting through the use of sealed bids, from which award is made to that responsive, responsible bidder whose price is lowest. Responsive means that the bidder has met the user's written requirements. To be responsible, the bidder must have adequate resources, a satisfactory record

of performance and integrity, and otherwise be legally eligible to accept the contract (21:1-903.1i-iv). Formal advertising is the economist's strict definition of competition where contract award is based on price competition. The Defense Acquisition Regulation (DAR) requires that "procurement shall be made by formal advertising.....whenever such method is feasible and practicable ....procurement shall generally be made by soliciting bids from all qualified sources of supply and services deemed necessary to assure full and free competition consistent with procurement of required supplies and services (21:2-102.1A)."

Competition Theory

Competition Defined. Webster defines competition as "the effort of two or more parties to secure the custom of a third party by the offer of the most favorable terms (6:464)." A working definition of price competition used in DOD acquisition is contained in the Defense Acquisition Regulation (DAR). DAR states: "Price competition exists if offers are solicited and (i) at least two responsible offerors, (ii) who can satisfy the requirements, (iii) independently contend for a contract to be awarded to the responsive and responsible offeror submitting the lowest evaluated prices, (iv) by submitting price offers responsive to the expressed requirements of the solicitation. Whether there is price competition for a given procurement is a matter of judgment to be based on evaluation of whether each of the foregoing conditions is satisfied. Generally, in making this judgment, the smaller the number of offers, the greater the need for close evaluation (21:Para.3-807.7)."

Competition and the Defense Market Structure. Modern price and economic theory classifies markets by degrees of competition (12:2). Product prices may depend in part on the amount of competition in the marketplace. The amount of competition in the market depends on the type of market structure. A typical range of market structures is illustrated in Figure 1 (10:p.15-12).

Maximum _____ Degree of Competition ___No
Competition in the Marketplace Competition

PERFECT COMPETITION	PURE COMPETITION	MONOPOLISTIC COMPETITION	OLIGOPOLY	DUOPOLY	MONOPOLY

Figure 1 Market Structure Spectrum

In perfect competition, the market is characterized by many buyers and sellers with no single firm able to control price, homogenous products, free mobility of resources, and perfect market knowledge (5:241). In the perfectly competitive market, price is set by the marketplace. Theoretically, in the perfectly competitive market, the competitive forces should result in the lowest prices (12:2). However, Jacques S. Gansler, a former Deputy Assistant Secretary of Defense for Material Acquisition, has stated that: "The free-market system is not operating to achieve economically efficient or strategically responsive behavior in the area frequently referred to as the 'military industrial complex' (4:1)."

In a monopoly, the other extreme of the market structure spectrum, the market is characterized by one seller, a unique product, many barriers to market entry and exit, and imperfect market knowledge (5:277). In a monopoly, market results normally include higher profits and prices, less output, less employment, and lower wages as compared to a perfectly competitive market (5).

Within DOD, purchases may be made from firms in any of the market structures. While attempts have been made to classify the defense marketplace, the diversity of products makes a singular DOD market structure classification inappropriate, if not impossible (10:p.15-12). However, due to the highly specialized and technical nature of many weapon system components, the defense market structure has often been described as a bilateral monopoly (10:p.15-12; 5:275).

In a bilateral monopoly, there is one seller and one buyer (5:275). The DOD, in its quest for highly complex and state-of-the-art weapon systems, is the single buyer. Due to the large investment required, the single source of supply is usually a large firm with the capability to develop products which meet

the DOD's highly specialized needs.

In order to determine when the defense marketplace lends itself to competition, a review of the criteria for using formal advertising is necessary.

Criteria for Using Formal Advertising. It is important to understand the circumstances under which competitive bidding usually results in lower prices for items. Generally, four criteria dictate when competitive bidding is the best method of pricing (8:97). When all four criteria are present "competitive bidding assures the buyer of obtaining the lowest possible price (8:97)." The four criteria are: (1) the dollar value of the purchase is large enough to warrant the expenses of both buyer and seller; (2) explicit specifications describing the items are available; (3) an adequate number of sellers are willing to price competitively to get the contract; and (4) sufficient time is available for using the competitive method of procurement (8:97). The presence of the four criteria in the defense marketplace is many times questionable. However, competitive bidding has been and continues to be the preferred Government procurement method (21:Para.1-300.2).

Spare Parts Procurement

One defense product group that satisfies many of the criteria for using competition is weapon system replenishment spare parts. In 1982, Air Force Logistics Command (AFLC) spent 9.3 billion dollars for the acquisition of spare parts and related components, consuming approximately 39 percent of the Air Force budget (22:8-52). In recent months, the need for greater understanding and refinement of the spare parts acquisition process has become very evident. The development of numerous instances where spare parts have been bought at exorbitant prices has led Secretary of Defense Caspar Weinberger to state that the laxity by DOD has created an environment in which the contractor may "set his own price (17:11)." Congress and DOD have identified the lack of competition in spare parts acquisition as a major contributor to the "pricing abuses," and Secretary Weinberger established new departmental procedures aimed at increased competition (9:22).

In 1982, approximately 25 percent of AFLC's portion of the Air Force budget was competitively awarded (9). There is apparently much room for improvement in the area of competition. Yet, in recent years competition has become more complex, and the assumption that competition yields a better, less expensive product has not always held true (15:4). Competition can be a successful strategy in one program and a failure in another program (16:2). Competition may even lead to paying a higher price for an item (2:100). Contracting policy makers and buyers need additional empirical evidence on whether tangible savings actually accrue for competitive procurements and guidance on the criteria to use in making decisions for competition. "(Competition) is found to be an acquisition strategy that can result in significant benefit to the Government. It is a strategy that must, however, be selectively applied. If attempted in a haphazard manner, the cost to the Government could be astronomical (11:7)."

BROST'S STUDY

Summary of Background, Objectives, and Methodology

The Defense Acquisition Regulation (DAR) dictates that competition is the "law of the land" in Department of Defense (DOD) procurement (21:Para.1-302.2). The need for competition in the Government's acquisition of materials and services is continually stressed by Congress, taxpayers, and Government officials. The overall objective of Brost's research project was to determine the effect of competition on the prices of weapon system replenishment spare parts. Specifically, three research issues were addressed in the study. The three research issues were:

1. Is there a reduction in replenishment spare parts prices when competition is introduced?
2. Can a portion of any price change be attributed to the effects of competition?
3. Is the magnitude of any price change influenced by certain specified factors (i.e., type of item or number of solicitations)?

The data used to address the three research issues were obtained from procurement history files maintained by the Air Force Logistics Command (AFLC). From the five AFLC Air Logistics Centers' current procurement history files (i.e., approximately four years of data), thirty-six weapon system replenishment spare parts, which initially were purchased on a sole source basis at least three consecutive times and subsequently were competitively purchased at least three consecutive times, were selected for analysis. Multiple regression analysis and parametric statistical tests were used to analyze the procurement history data. In Brost's research project, price changes were attributed to three factors: inflation, order quantity, and competition.

Implications and Conclusions

Brost's research project succeeded in providing insight into the three research

issues. Although the author's research results should be considered preliminary and warrant further validation, the findings supported conclusions that:

1. The introduction of competition into the replenishment spare parts acquisition process does not guarantee lower prices;
2. For many items, competition accounts for a portion of the price change, but the effect of competition is just as likely to result in price increases as price decreases; and
3. Price changes are similar among commodity groups and are not influenced by the number of solicitations.

The empirical evidence did not support a conclusion that prices decrease when competition is introduced into the weapon system replenishment spare parts acquisition process. Further, there was an indication that prices of many spare parts actually increased when competition was introduced into the spare parts acquisition process.

Generally, Brost's research results were contrary to the results of previous empirical studies (13:82; 17:9) and competition theory (5:2). Thus, additional empirical research was needed to determine the actual benefits of competition in spare parts procurement.

ZAMPARELLI'S STUDY

Summary of Purpose, Objectives, and Research Methodology

In a recent spare parts buying scandal, inadequate competition was cited as the primary culprit leading to buyers paying exorbitant prices for inexpensive spare parts (18:3).

From Secretary of Defense Robert McNamara in 1965 to Secretary of Defense Caspar Weinberger in 1983, competition has been the policy for improving DOD acquisitions (3;18:1). The potential benefits to the Government resulting from the application of competitive acquisitions, however, are still a subject of controversy.

The purpose of Zamparelli's research project was to support or refute Brost's findings by employing a similar research methodology but using a much larger data sample. Four years of procurement history data collected from five Air Force Logistics Command (AFLC) Air Logistics Centers (ALCs) provided the data base for selecting samples to evaluate two research hypotheses. Four hundred and twenty Air Force replenishment spare parts, whose procurement purchase histories showed at least two consecutive sole source purchases followed by at least two consecutive competitive purchases, comprised the sample for Research Hypothesis 1 as follows: "A reduction in unit price is realized when competition is introduced in the acquisition of weapon systems replenishment spare parts previously procured on a sole source basis (23)."

Four hundred and fifty-three Air Force replenishment spare parts, with at least two consecutive competitive purchases followed by at least two consecutive sole source purchases, comprised the sample for evaluating Research Hypothesis 2. Research Hypothesis 2 is restated as follows: "An increase in unit price is realized when weapon systems replenishment spare parts previously procured through competitive means are purchased on a sole source basis (23)."

An additional objective of Zamparelli's research project was to evaluate certain subgroups of data in order to identify areas for which competition proved more or less beneficial. Four research questions were developed to evaluate the mean and median competitive savings among various subgroups (i.e., among the five ALCs, commodity categories, unit price magnitudes, and age of the spare parts).

Parametric statistical procedures were used to analyze the research hypotheses. Z-tests of means were conducted, and medians were statistically evaluated using Statistical Package for the Social Sciences (SPSS) computer programs.

Conclusions

Several conclusions were drawn from Zamparelli's analysis of the research findings:

1. The introduction of competition into the acquisition process generally led to a reduction in unit price. The researcher's findings supported the policy that is documented in current Department of Defense (DOD) guidance. However, Zamparelli's research indicated a probable savings of between 4.1 and 11.2 percent. The researcher's empirically-based competitive savings were much less than the savings identified in most earlier studies (8; 13; 17).
2. Unit prices increased for items that transitioned from competitive back to sole source acquisitions.
3. Replenishment spare parts with unit prices over $1,000 were less likely to show competitive savings when competition was introduced than spare parts with unit prices under $1,000.
4. In several situations, transitions from sole source to competitive acquisitions led to extreme price increases.
5. All competitive opportunities were not fully utilized in the acquisition of replenishment spare parts. Over 453 spare parts

had procurement histories which showed a solicitation to a single source subsequent to at least two procurement actions in which multiple sources were solicited.

Implications of the Study

The empjrical evidence from Zamparelli's study provided strong support for the conclusion that the introduction of competition leads to lower prices. However, specific characteristics of the spare part (e.g., the magnitude of the unit price) affect the amount of savings realized by the Government, caused by the solicitation to multiple sources. Thus, Zamparelli's findings, while supporting the continued emphasis by the Department of Defense on the use of competition, demonstrated that a selective approach to the use of competition needs to be developed.

Recommendations for Future Research

Additional research in the area of competition within the spare parts acquisition process is necessary.

1. "Competitive Forces" Versus "Competition". Before any other research effort is undertaken on the subject of competition, it is necessary to better define what competition actually means to a contractor. The theoretical basis for the expectation of lower prices due to the introduction of competition is because the contractor knows that other suppliers are competing within the marketplace (13:2). There has not been any empirical evidence generated on whether a contractor actually knows whether competition exists in the award of a contract or purchase order. Research has not been undertaken to identify if the threat of competition (i.e., "competitive forces") motivate a contractor to price differently or if actual knowledge of other sources of supplies is required. If competition is found to be a significant consideration, a follow-on research project should ascertain how often in the defense marketplace competition or the threat of competition must be exhibited in order to continue to affect contractors' bidding.

2. Compete Parts Previously Acquired Sole Source. Many of the unknowns and limitations of earlier studies could have been removed if the researchers had controlled the actual purchasing process for the spare parts. An improvement upon Zamparelli's research study would be for a researcher to select a number of spare parts identified as sole source, attempt to find additional capable sources of supply, and actually compete the subsequent purchase of spare parts to determine the impact on prices.

3. Administrative Costs of Competition. Several sources have argued that there are costs related to the introduction of competition into the acquisition process (13; 16). To date, little research has been conducted to quantify the administrative costs or even to identify the costs associated with the introduction of competition (23). The administrative costs may vary for base contracting offices, ALCs, and System Program Offices.

4. Analysis of Spare Parts Procurements. Recently, a relatively small number of poor procurement actions for spare parts (e.g., spending over $1100 for a one dollar item) made the news (9; 18). Are these procurement actions the exception or the rule in the area of replenishment spare parts buying? An indepth analysis of a random sample of AFLC replenishment spare parts to include an analysis of the available competition, the product itself, excessive specifications, and other factors, may provide evidence that the "poor procurement actions" are the exception rather than the rule.

5. Identification of Characteristics That Enhance Competitive Savings. Zamparelli's research project categorized savings by various subgroups to determine if factors such as the buying office or the type of commodity affected the amount of competitive savings realized. The commodity categorization deserves additional study to include a unit price trend analysis for the spare parts. Other comparisons could be made among those items with and without reprocurement data and for items procured from small business versus the items obtained from large business.

CONCLUSIONS/SUMMARY

The conclusions and implications of the authors' research projects indicate that the call for Department of Defense (DOD) buyers to seek competition will not diminish nor should it. Seeking competitive opportunities and utilizing existing competition are necessary parts of the Government buyer's job. Additional introduction of competition into the DOD marketplace should continually be planned and attempted.

The definitiveness of the support for competition does not diminish the need for continued study in the area of competition within the defense acquisition process. More empirical research needs to be accomplished to examine how and if competitive acquisitions actually work within the defense marketplace.

Additionally, empirical studies have indicated that there may be characteristics of the weapons systems, spare part or component, yet unidentified, that may affect the magnitude of savings realized from the use of competition.

Competition is considered to be a key component within a competent, fair procurement system. An intimate knowledge of the subject, developed through continued research, may lead to an operational competitive model that will guarantee that DOD buyers obtain the best possible item at the best possible price. Competition is the synergistic linkage among Government, industry, and academe.

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COMPETITION: AN INTEGRAL PART OF THE ACQUISITION PROCESS

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ABSTRACT

The concept of competition for defense acquisition is one that requires careful examination and discussion in today's cost conscious environment. The Office of Management and Budget Circular A-109 directs each government agency to ". . . depend on, whenever economically beneficial, competition between similar or differing system concepts throughout the acquisition process." This direction leads to the current high level attention that competition is receiving today. Competition is being examined as a major factor in cost control for weapon system procurement for the entire acquisition process. The need for complete preplanning and market research to promote effective competition is apparent when past procurement efforts are examined. Preplanning and market research in the early stages of the acquisition process are areas that need active management support.

INTRODUCTION

In a recent letter from General Robert T. Marsh to his field commanders in Air Force Systems Command, he addressed the subject of "Competition Management."[1] His letter outlined his competition policies as a major factor in controlling weapon system costs. Three particular policies are noteworthy:

- Emphasis will be given to maintaining competition in production through increased use of second sourcing, component breakout and competition of alternate systems.

- Effective subcontract competition will be emphasized with major prime contractors. Ways will be developed to reward contractors having effective competition management programs.

- Programs will be established at field activity level to:

  -- Better educate everyone involved in the acquisition process regarding the benefits of effective competition.

  -- Recognize competition lessons learned and significant achievements.

The importance of competition to the acquisition process is emphasized by General Marsh's letter and the policies that he has presented. What is significant about the three particular policy items is their underlying effect on the acquisition process. The intent is obvious: to give the field commanders some specific direction to encourage and promote more competition.

The purpose of this article is to review the types of competition available in defense acquisition and the current push behind the high level attention to increase competition, particularly during production. In addition, closely tied to the General Marsh's policies is a requirement for more early planning and market research to promote a truly competitive environment. This kind of activity, planning and market research, needs added attention to understand and promote competition in the defense marketplace.

TYPES OF COMPETITION

Competition is certainly nothing new to defense procurement. It has been around since the days of competitive prototyping and multiple-source production in World War II. Many differing approaches to competition have evolved over the years. Current statutory proposals described by Emanuel Kintisch point out three distinct types of competition: price, lowest total cost, and multiple factors.[2] Price competition is based upon the lowest price to the government and is used when the market analysis shows equal or similar products will satisfy the need. Evaluation will be made on price only or price related factors, and firm fixed-price contracts will be used. Contract awards will be made without discussion, similar to formal advertising procedures.

The second type of competition Mr. Kintisch describes is the lowest total cost. This type is based on the total cost to the government including not only price, but considerations for maintenance and operating costs over the useful life of the item or service. Lowest total cost competition is used when dissimilar characteristics of products or services are expected to affect cost of ownership. Factors include product performance, operating and maintenance costs, energy consumption, product life, reliability and safety. The ultimate criterion used is the lowest total cost since the requirement is reasonably firm and the cost of ownership can be quantified. A firm fixed-price contract can be used if no discussion is required to settle the evaluation criteria.

Finally, the multiple factors competition is based on price, cost and other factors such as design, performance capability, service, delivery, and technical and management capability. It is the most complex type in which

government needs cannot be precisely described, a well-defined solution does not exist, evaluation factors cannot be objectively measured, and technical and management performance is critical. This type of competition applies to the majority of major weapon acquisitions and research and development efforts.

An additional type of competition that Mr. Kintisch describes is "follow-on-to-competition." This type of competition refers to production competition described in a contract proposal once a competitive development contract has run its course. Leader/follower and other forms of second sourcing may fall in this category.

Another viewpoint of types of contracts is presented in Figure 1 where design and price are the major criteria. The various stages of the acquisition process are shown with the corresponding type of competitive activity. This depiction gives a broader view for the potential areas of defense competition, specifically out in the production and reprocurement stages.

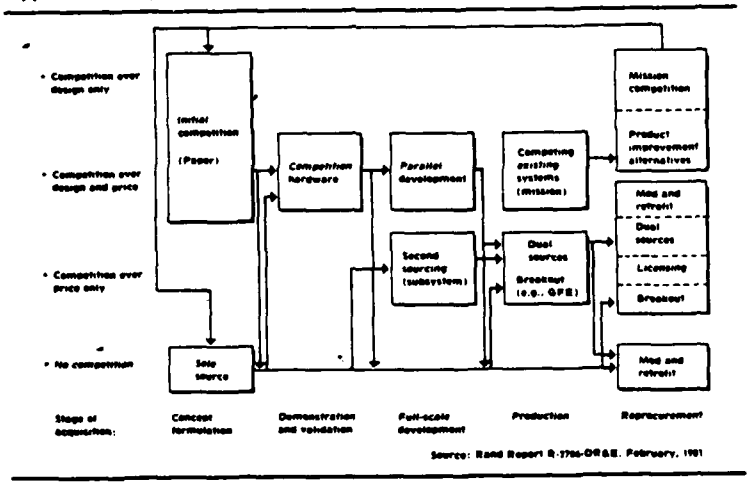
COMPETITION INITIATIVE

Increased interest in the use of competition in the acquisition process has been spearheaded by former Deputy Secretary of Defense Frank C. Carlucci. From his July 1981 memorandum, he stated: "We believe that it (competition) reduces the cost of needed supplies and services, improves contractor performance, helps to combat rising costs, increases the industrial base, and ensures fairness of opportunity for award of government contracts."[3] From General Marsh's letter, we can see the downstream effect. Prior to Mr. Carlucci's efforts, the 1972 report of the Commission on Government Procurement made a number of recommendations on competition. They were eventually incorporated in the Office of Management and Budget Circular A-109. The significance of this document was that it directed attention to using competition throughout the acquisition process ". . . depend on, whenever economically beneficial, competition between similar or differing system concepts throughout the acquisition process."[4] This direction is significant to defense procurement which historically has concentrated upon competition in the development phase and a winner-take-all situation in the production phase. Defense costs have shown drastic increases over the past twenty years due to programs, once won competitively by a contractor, that have shown tremendous cost growth during production. Excellent examples are the Air Force's C-5 Galaxy, the Army's M-1 tank, and the Navy's F-18 Hornet.

Competition in the production stage may not be feasible nor desirable for all major weapon systems involving multiple contractors; however, it does offer potential cost savings and should be examined on a case-by-case basis. Figure 2 presents some cost savings figures for the production stage.

A preplanned leader/follower competitive strategy or other methods of second sourcing are examples that have been used in production competition. In the Advanced Medium Range Air-to-Air Missile (AMRAAM) program, a leader/follower approach has been used from the initial planning stages as a competitive production strategy. Preplanning is the key to the potential success of production competition. The same type of strategy is being considered for the Low Altitude Navigation and Targeting Infrared for Night (LANTIRN) program, but without too much current success. The up front

FIGURE 1
Types of Competition



Source: Rand Report R-2786-DR&E, February, 1981

FIGURE 2 PRODUCTION COST SAVINGS FROM COMPETING PREVIOUSLY SOLE SOURCE CONTRACTS*

Programs	(%)	Programs	(%)
AN/APM-123	67.7	USM-181 Telephone Test Set	36.3
MK-980/PPS-5	66.5	Standard Missile, ER RIM 67A	34.0
AN/ARC-54	63.1	AN/SQS 23 208A Transducer	32.3
MK-48 Torpedo - Test Set	61.8	Tow Launcher	30.2
MK-48 Torpedo - Exploder	61.2	TD-660 Multiplexer	28.4
AN/GRC-103	60.1	BULLPUP 12B Missile	26.5
Standard Missile, MR RIM 66A	59.2	APX72 Airborne Transponder	25.3
AN/ARA-63 Radio Receiver	57.9	FAAR TADDS	18.2
TD-352 Multiplexer	55.6	FAAR Radar	16.6
AN/PRC-25 -	55.0	Dragon Tracker	12.3
60-6402 Electric Control	52.7	TOW Missile	12.3
MD-522 Modulator-Demodulator	51.9	UPM-98 Test Set	11.5
Hawk Motor Metal Parts	49.9	AN/ASN-43	10.7
MK-48 Torpedo - Warhead	48.6	SPA-25 Radar Indicator	10.7
MK-48 Torpedo - Electric Assembly	47.0	SHILLELAGH	9.4
CV-1548 Signal Converter	45.4	Dragon Round	2.8
AN/FYC-8X	43.2	Sidewinder AIM-9D/G	.7
TD-204 Cable Combiner	42.0	PP-4763/GRC Power Assembly	.5
AN/PRC-77 Radio	41.9	SPA-66 Radar Indicator	-3.4
AN/GRC-106	41.8	Rockeye Bomb	-4.5
TD-202 Radio Combiner	40.2	Sidewinder AIM-9B	-5.6
FGC-20 Teletype Set	39.9	AN/ARC-131 Radio	-16.1
TALOS Missile	39.8		

* AVERAGE PRODUCTION COST SAVINGS FOR 45 PROGRAMS: 33%

costs of initiating this type of "follow-on-to-competition" efforts were not preplanned for in LANTIRN's case. The additional funding at this stage of the program makes a leader/follower strategy for production competition less than desirable.

The use of more competition among subcontractors is an area where added defense attention is being placed. Depending upon quantities being procured and production rates, subcontractors offer a potential for increased production competition. In a recent speech by Secretary of Defense Weinberger, he squarely pointed out that "there is ample evidence that spare parts prices are excessive and that there is far too little competition in the buying of spares."[6] This area of procurement and its cost control deserve serious attention.

The potential for competition in the production phase of acquisition is shown by Air Force data. Defense acquisition regulations define five categories of competition:[7]

- Price competition
- Design, technical, or other competition
- Follow-on actions after price competition
- Follow-on actions after technical or other competition
- Other non-competitive actions

The first two are basically "pure" competition, whereas the "follow-on actions" are principally non-competitive and the final category is basically sole source. Figure 3 shows several important trends. First, there has been a definite reduction in sole source awards from FY 80 to FY 82. Secondly, there is an increasing amount of follow-on action, non-competitive contract awards. This trend is due to several large reprocurement efforts within the Air Force, i.e., B-1B, MX, F-16, C-5B. The reduction in sole source contracts shows the Air Force's emphasis over the past few years on competition. However, the second trend emphasizes a large potential for further competition.

FIGURE 3
AFSC Obligated Dollars

	FY 80	FY 81	FY 82
Competitive ($B)	36% 1.41	42.6% 2.404	34.8% 2.634
Follow-On ($B)	38% 1.529	45.1% 2.549	58.7% 4.441
Sole Source ($B)	25.1% .988	12.3% .694	6.5% .485

In a current article by Commander Ben Sellers, USN, he astutely recognizes that effective production competition requires early planning and effective use of second sourcing methods.[8]

"These and other problems have been raised, suggesting that effective production competition may not be feasible or desirable. In my opinion, however, in the vast majority of cases, the problems can be either eliminated or minimized by proper advance planning, early and forthright communication with the contractors, and effective implementation of an appropriate second-sourcing method."

The five methods of second-sourcing that Sellers describes are form-fit-function, technical data package, directed licensing, leader/follower, and contractor teams. These methods leave the government a flexible approach to finding a strategy for production competition.

PREPLANNING/MARKET RESEARCH

There is a definite need for a complete analysis prior to every defense procurement focusing on the competitive environment that exists in the marketplace. If the particular type of marketplace can be accurately identified, then the proper strategy for procurement can be applied. The types of marketplace that come to mind are: (1) pure competition, (2) monopoly, and (3) monopsony (one buyer-many sellers). If the marketplace is properly identified in the preplanning stage of the procurement process, competition can be used effectively. Sole source procurement, in certain cases, may be justified with proper research. Colonel G. Dana Brabson, USAF, makes a good case for this point. "The indiscriminate enforcement of competition leads to a waste of government funds. Thus, the program must use proper analysis to evaluate competition in terms of cost, potential for cost reduction, and risk reduction."[9] A recent GAO report, however, found that competition would have been feasible in many situations in which sole source selections have been made.[10] The report cited reasons for not competing that included lack of effective planning, inappropriate reliance on sole source justifications, insufficient knowledge of procurement, and a lack of commitment to competition by key personnel. This evidence points to the need for competition advocates and thorough market research for every kind of procurement effort.

Not only should the type of marketplace be identified and analyzed, determination should be made to whether several types of competitive environments exist simultaneously. A prime contractor may be selected as a sole source due to the market environment, but there may exist a very competitive market for subcontractors. With proper planning and research, the business community may be alerted to the government's impending need and more subcontractors can enter the market. This type of long range thinking and planning is apparently what defense procurement is sorely lacking. The astronomical cost increases for spare parts and bits and pieces of hardware must lead us to the conclusion that if the environment were more competitive, the costs could be controlled.

Another question that can be asked in the preplanning and market research stage is whether there is a correlation between the type of competitive environment and the type of government need. This need could be a system acquisition, a service need, a support requirement, or a supply issue. The correlation might lead to a business strategy less motivated to overall cost savings and more attuned to other factors, such as overall system performance, contractor's history, industrial base, or reliability and maintainability.

The Air Force has spent millions of dollars in its current effort with General Electric to develop the F110 engine as a competitor for the F100 Pratt and Whitney engine used in the F-15 and F-16. It may have been possible that with proper research and planning the Air Force might have anticipated the problems of having one high performance engine for their two current frontline fighters. A strategy which encouraged the development and procurement of two different engines would have maintained a competitive environment that the Air Force is now trying to correct. This observation is admittedly "Monday morning quarterbacking." But it is also a lesson learned. Both the fighter engine industrial base and the engine's reliability and maintainability should have been major factors in the procurement of such a vital subsystem to two major aircraft programs.

SUMMARY

The direction is clear to the Air Force. Competition must be used more effectively to control weapon system costs. Competition does not need to be limited to design only, winner-take-all thinking that has prevailed over the past years. Production follow-on competition, second sourcing, and subcontracting competition all need to be considered and used where beneficial. A key implication to this direction is thorough preplanning and market research early in the acquisition process to provide the basis for a sound business strategy. A strategy which understands the marketplace, promotes competition, and correlates the type of marketplace with the government's need is one which can better serve the total

acquisition process. Not in all cases will competition serve the government best. Complete planning and market research will always serve to promote effective procurement and a cost conscious business strategy.

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INCREASING SPARES COMPETITION IN AFLC

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ABSTRACT

This paper describes the results of a research effort sponsored by the Air Force Business Research Management Center at Wright Patterson AFB. The focus of the research was on the identification of the impediments to competitive spares acquisition and definition of those actions which can be taken to improve the capability of the Air Force to achieve competition on spare parts. The effort included an extensive search of the literature and field visits to Air Logistics Centers involved with the purchase of spare parts. The research was structured around analysis of the impact of the Procurement Method Code on the competitive activities.[1]

The results of the research is a set of recommendations covering systemic changes in the initial system acquisition process and in the procedures used at the Air Logistics Centers in item screening and contracting which should provide the capability to improve the degree of attained competition for Air Force spare parts.

INTRODUCTION

The cost of spare and repair parts represents a significant portion of the cost of supporting weapon systems within the Air Force inventory. This cost must be absorbed within a budget subject to many competing demands, and there is a subsequent need to minimize the cost of spares acquired. There have been a number of studies which have consistently demonstrated that spares (and normally most other equipments and supplies) can be purchased at a lower cost to the government if there is a competitive market in existence. The capability of the Air Force Logistics Command to competitively procure spare parts is heavily dependent upon the actions taken during the initial system acquisition effort to obtain the rights to the technical data required to support competitive action and the possession of that technical data.

There are other benefits which accrue to the Air Force from having the capability to competitively procure spare parts. Federal law (10 USC 2304) and DoD policy require that, insofar as practicable, all contracts should be let on a competitive basis. This direction and basic good business reasons dictate DoD's desire not to be limited to just one source. Consequently, the Air Force would prefer to have at least two sources of supply for every part and subsystem it must buy.

SCOPE OF THE AIR FORCE SPARES PROGRAM

Spare parts provide the Air Force capability to sustain the operation of weapon systems given the fact that parts wear out and fail in operation. Spare parts is a generic term that encompasses a wide variety of items with different end item application, different requirement calculations, different budgeting and programming approaches and different levels of management attention and review. Broadly speaking, there are two major categories of spare parts, reparables and nonreparables. Spares are classified as reparable if repair is economically feasible and a technically sound repair procedure has been developed. Nonreparables are those parts, normally lower in dollar value, which do not meet both of the above criteria. Figure 1 shows the relative distribution of parts within these two categories from both an item count and a dollar basis.[2]

	Reparable	Non-reparable
Percent of Items	32%	68%
Percent of Dollars	91%	9%
No. of Items (AF Managed)	265,600	568,900
Inventory Dollars	$34.8B	$3.4B

Figure 1 -- Distribution of Spares By Type

The nonreparable spares, also commonly called Economic Order Quantity (EOQ) or consumable items, are managed in the Air Force in the system support stock fund. Reparable spares, also commonly called investment spares, are funded by three separate appropriations and eight budget programs. In a typical fiscal year approximately 10 percent of the Air Force managed spares will come into a buy position. The dollar value of the Air Force program for fiscal years 82 through 84 is shown in Figure 2.

	FY82	FY83	FY84 (Projected)
Number of items bought	83,000	83,000	88,000
Dollar Value	$6.2B	$6.0B	$9.2B

Figure 2 -- Magnitude of AF Spares Buys

It is this multi-billion dollar program that offers the opportunity for savings from the introduction of competition. The perception of the Congress and the public, as reflected in

the press and electronic media, is that the Air Force, and in fact the entire DoD, has not attained the level of competition required. This lack of competition is seen as resulting in a cost for the spares program above that which is truly required. In dollar terms, the Air Force percentage of spare parts acquired under competitive procedures has dropped from 37.5% in fiscal year 1973 to 20.7% in fiscal year 1982.[3]

SPARE PARTS BREAKOUT PROGRAM

A major method for achieving increased spare parts competition is the item breakout process which is accomplished under DAR Supplement 6, DoD Replenishment Parts Breakout Program. Through this program, the Air Force works with the initial provider of major items to identify those parts which can be bought on a separate basis and in accordance with the quantities estimated. This identification requires information or data and data rights to completely define the physical and functional attributes of the subpart, its manufacturing techniques plus all other data that will permit the part to be provided by another competent source in the same physical or functional characteristics as that made by the original source. The basic steps to accomplish item breakout are:

a. Air Force satisfaction within the initial end item and the parts making up the end item.

b. Identification of those parts that will be needed as spare and repair parts during the life of the end item.

c. Obtaining complete and accurate descriptive information on the parts identified as spare and repair parts.

d. Identification of capable manufacturers to provide functionally and physically interchangeable parts.

The process for identifying and selecting items for competitive spare parts procurement is accomplished within the framework of the initial acquisition program. This process has been in effect for some time, but has not been totally successful in maximizing the amount of competition for spare parts within AFLC.[4]

The ability to reprocure spares competitively after transition of a system from AFSC to AFLC is determined early in the system acquisition process, and is a function of the specific contract clauses and terms included in system acquisition contracts and the effectiveness of the system for defining, obtaining and making data available for internal usage. Despite the general agreement that competitive reprocurement is beneficial, the realities of relative priorities, funds constraints, personnel motivational factors, and legal problems have often prevented the front-end actions being taken to permit successful reprocurement during the Operation and Support Phase.

Even when there are the best intentions on everyone's part, there is a certain amount of ambiguity or confusion in several areas, including:

a. Policy, regulations, and procedures.

b. Specific responsibility and accountability.

c. Inconsistency in definitions and terms relating to data among equally authoritative publications.

d. Application of appropriate DAR clauses and subsequent resolution of disputes.

e. Procedures for acquiring missing or inadequate data by the ALCs long after the original contracts have terminated.

IMPEDIMENTS TO COMPETITION

Air Force competition statistics and the PMC coding of parts currently in the inventory was reviewed to determine if there were patterns in the coding of the parts that would aid in focusing recommended improvements. There are six PMCs which describe the status of spare parts as shown in Figure 3. Each PMC also has an alpha suffix code which describes the basis for the assignment of the PMC.

PMC	Explanation
0	Not assigned
1	Already competitive
2	First time competitive
3	Procure from actual manufacturer
4	Procure from actual manufacturer, first time
5	Procure from prime contractor, not manufacturer

Figure 3 -- Procurement Method Codes

The primary impediments to competitive acquisition, as reflected in the assigned Procurement Method Suffix Codes (PMC) are:[5]

Suffix Code*	Description
C	Procurement from approved source
D	The data not available
H	Inadequate data
P	Rights to use data legally not available

*AFR 57-6 Suffix Codes

Three of these suffix codes, D, H, and P, directly reflect data or data rights issues. The other suffix code, Code C, often reflects an inability to adequately describe the item. Control of the quality of delivered items requires specific approval of the source by the agency having design control. This control is in contrast to the more typical situation of controlling quality through the medium of conformance to drawings and other technical data. When we are unable to give a technical description of the part and the manufacturing processes, control of the source of manufacture is a viable alternative.

Achieving improvements in obtaining competitive contracting for AFLC requires that two separate issues be addressed. The first issue involves definition of systemic changes required in the acquisition process to effect a long term solution for the causes of the problem. The second issue is the identification of near term actions which can be taken to improve the competitive posture of AFLC on systems which have been or are about to be transitioned.

In addition to the implement reflected in the PMC Suffix Codes, we also found that spare parts competition, and the actions necessary to create the environment for competition, were low priority efforts within the Air Force structure. Requirements generation processes, contracting procedures and time constraints, and resource commitments all operate to frustrate the goal of increasing competition.

SYSTEMIC CHANGES

System Acquisition. The capability for competitive purchase of spare parts is fundamentally a result of the actions taken during the initial system acquisition. Minimal attention is given to this subject during acquisition in light of the tremendous near term emphasis on program cost, schedule and system performance. Our research found few cases in which responsibility for spares competition and the data and rights necessary to support it was clearly established within the SPO. It is recommended that a number of systemic changes be made within the development process. Program managers should be required to develop a life cycle competition strategy for the system or equipment. This strategy would describe the program manager's assessment of the degree of competition attainable and the specific measures to be accomplished in each phase to maximize competition for both the system and its spare parts.

A major element of this strategy needs to deal with the issues of data and data rights. Our research indicated that, while Air Force contracts generally establish the rights of the Air Force in these areas, these rights were not exercised. The Air Force has not received all the data to which it is entitled, primarily due to failure to adequately specify the data to be received, inspect the data on receipt, and monitor contractor progress in delivery. It is recommended that a number of actions be taken to improve this process.

The DAR clauses providing for data and data rights need to be revised and included in all acquisition contracts covering:

a. Rights in data

b. Predetermination of rights

c. Notice of limited rights

d. Technical data warranty

The contract should also include identification of the specific data to be delivered and the date for delivery. The Air Force also needs to develop clear acceptance criteria for acquisition data packages. These packages are acquired for use in the competitive purchase of spare parts. Attention also needs to be directed to the issue of limited rights in data. Contract Administration Offices (CAOs) have a responsibility to review the process by which contractors determine that only limited rights accrue to the government. The aggressive exercise of this responsibility needs to be coupled with programs at the buying agencies to challenge inappropriate assertions of limited rights. Without changing the front end of the acquisition process, the Air Logistics Centers will continue to find themselves unable to compete spare parts procurements effectively.

Internal Data Management. Data received by the Air Force is stored and issued from an archaic system. Data is received in aperture card format and stored by drawing number in tub files until needed. The system is an open-loop people-dependent system in which the possibility of lost and misfiled data impedes effective competition. Action is needed to develop an effective automation strategy, perhaps following the on-going Tri Service/Joint Committee on Printing program.

The internal Air Force decisions on acquisition of data is also impeded by a general lack of hard information on what data "should" cost. Often acquisition of data is deleted from or deferred in acquisition programs due to its alleged high cost. Our research was unable to find any specific information on the cost of data to support competitive spa es buys. It is recommended that the Air Force require the cost of this data to be separately stated in proposals and that action be initiated to develop bases for the evaluation of these costs.

Screening for Breakout. DAR Supplement 6 and its predecessor in the Air Force, AFR 57-6, provides for an economic basis for the decision on method of spares acquisition. The approach is based on estimating the gross savings which would result from introducing competition. This savings can be estimated at 25% if local data does not indicate a different savings.[6] These gross savings are then offset by the government's nonrecurring and recurring cost to achieve breakout to competition. Our research indicated that these offsetting costs are not quantified and consequently a firm economic basis for the decision cannot be made. In addition, a number of potential costs are not considered under the current procedure. As part of this research effort, Analytics developed a revised economic model for the breakout decision, the Competitive Acquisition and Breakout of Spares (CABS) model.[7] It is recommended that this revised model be utilized and that the costs involved in breakout be tracked to provide a valid basis for breakout decisions.

Personnel Issues. There has been little motivation within the system acquisition, inventory management and contracting workforce to aggressively pursue competitive spares acquisition. For the system acquisition personnel, the issue was too remote to receive serious attention. As a result, the majority of the spare parts entering the supply system arrived as sole source parts. The emphasis within the item management community is on supporting the operating forces, a job done well in the face of many constraints. In this environment, efforts to cause the introduction of competition were often viewed as presenting a risk to the objective of supporting the Air Force mission due to longer administrative lead times and the possibility of part or delivery failures from the new source. If breakout to competition were successful, little reward was given to compensate for these risks.

This situation is compounded by increasing inventory management workload accompanied by decreases in the direct labor inventory manager authorizations. Consequently, organizational priorities were established which gave little resource commitment to spares breakout. The issue of personnel resources also impacted the spares contracting community. Within the Air Force Logistics Command, contracting workload measured in terms of Purchase Requests has increased 21% since 1977. In that same time period, personnel has increased only 10%. Based upon current requirements for personnel, the contracting function is authorized less than 72% of the personnel required.

In many ways, the contracting function is a captive of the actions which precede it. To accomplish a competitive spares purchase, the buyer must receive a purchase request that:

a. is accompanied by a data package which will support competitive buy,

b. has no restrictions on the use of that data package,

c. has sufficient lead time to allow for competitive purchasing,

d. gives sufficient description to allow for source identification, and

e. has sufficient quantity of items to motivate contractor interest.

Many AFLC buyers may have 100 or more separate Purchase Requests (PRs) assigned at any one time. The primary measure of performance applied to this workload is processing time from PR receipt to award. The high PR count is driven by the low consolidation level on the individual purchases. The average PR contains 1.5 line items and many items are bought a number of times during the year.

If the competitive level for spare parts is to be increased, the Air Force will need to establish motivational programs and reward structures which provide both positive and negative incentives to the workforce. In addition, organizational measures in contracting need to focus on quality of actions rather than quantity and flow times. In addition, consideration to changing organizational priorities, as reflected in personnel assignments, needs to be aggressively pursued.

Automated Data Processing (ADP). Contracting data systems in use today are inadequate and impair the Air Force's ability to effectively price and manage spare parts acquisition.

The magnitude of the spare parts contracting job is extremely large. The job could not be accomplished without extensive ADP support. Computers are used to calculate spare parts requirements, generate purchase requests, monitor the contracting process, track spare parts deliveries after contract award, accumulate historical data on spare parts purchases and perform other functions supporting the acquisition process. AFLC central procurement activities use six automated systems to manage the spare parts contracting process: J014, J023, J041, D016, E841 and AUPARS. The J014, Mechanized Bidders List System, provides buyers with a mechanized list of sources for acquiring supplies and services. The J023, Automated Purchase System, generates automated purchase requests (PRs) and automated delivery/orders that provides some relief from manual document preparation. The J041, Acquisition and Due-In System, has three distinct functions: preaward, postaward, and purchase history. The D016, Status of Present/Projected Backordered Items System, provides management

information used to correlate delinquency data to backorders and projected backordered items. The AUPARS, Automated Unpriced Action Reporting System, tracks and prepares reports concerning unpriced contractual actions.

The six systems support AFLC spare parts contracting operations at the five Air Logistics Centers. They operate in complex interrelationships with numerous other automated systems. These systems also are required to process large volumes of data . . . far greater than the largest commercial business. They also must be able to surge to support a wartime mission while generally operating in a relatively steady-state peacetime environment yet yearly manpower and budget constraints which limit the level of ADP support which can be provided.

The AFLC contracting data systems in use today do not supply the information or analytical tools buyers need to price and effectively manage spare parts acquisition. ADP support is accomplished through a series of batch-sequential computer programs with a number of time-consuming off-line interfaces. The hardware supporting these systems is near saturation. The computer programs have evolved and grown through a series of complex modifications which, in many cases, duplicate functions already performed in other systems. Consequently, the systems cannot be readily expanded. Further, they are basically off-line data tracking and management information systems which generate fixed (format cannot be varied), standard, hard-copy listings at specified intervals, i.e., daily, weekly, monthly. These system characteristics translate into a number of specific deficiencies.

a. Buyers must price the vast majority of spare parts manually without the aid of ADP tools. The current systems contain price data that would be very helpful in analysis, however, there are no terminals nor software which would enable buyers to access or analyze the data.

b. Data required for spare parts analysis is sometimes difficult to collect because it resides in multiple systems, and, in some cases, is not collected at all. This problem is further complicated because the systems reside on disimilar pieces of equipment which do not easily communicate with one another.

The deficiencies cited above have been recognized by the Air Force and efforts are planned or underway to address them. Some programs are directed specifically toward improving ADP support for pricing, while others address the spare parts acquisition process in general. Automated data systems supporting spare parts contracting activities must be upgraded and/or replaced as rapidly as possible. This is an absolute necessity if buyers are to have current, accurate data and the tools to access and analyze it. AFLC spare parts contracting activities need:

- Sufficient computer capacity to provide real time support to buyers.
- System software (data base management systems) that will support terminals, printers, plotters and will allow real-time access for research, trending and answering "what if" questions.
- Single point source data automation that will eliminate submissions of the same data for different systems applications/ requirements.
- Integration of the functions of the six contracting data systems to eliminate manual, labor intensive workload and to provide all the available information needed to intelligently price and manage spare parts.

AFLC is currently pursuing both near and long term programs to upgrade contracting data systems. These programs should be fully integrated into a single program and accelerated.

NEAR TERM ACTIONS

While the systemic changes discussed above can be expected to increase spares competition, these effects will be felt mainly on new systems. To impact the competition rate on the spares parts currently in the inventory, other actions may be appropriate.

Data and Data Rights. The largest single impediment to competitive spares purchase found in this research is missing or inadequate data. Without an ability to adequately describe the part, competition cannot occur. It is recommended that the Air Force initiate a serious effort to acquire this missing data from the contractors who committed to deliver it. Where data cannot be obtained, and the potential savings are large, efforts to independently develop acquisition descriptions suitable for competitive purchase should be developed. This approach could be applied to a select small number of parts to develop and proof a workable methodology which could then be applied to other high pay-off items.

It is also recommended that a system be established to challenge the assertion of limited rights on data currently in the Air Force system.

In today's high visibility environment, it may be reasonable to expect a higher degree of cooperation from prime contractors in assisting the Air Force effort to increase spares competition. Efforts to enlist this assistance could provide significant results. Air Force/Industry dialog on this subject needs to increase and formal mechanisms for the integration of Air Force and industry efforts should be established.

Personnel System. While major revisions within the personnel structure cannot be achieved quickly, recognition and award programs, such as the Zero Overpricing program, could be instituted. These types of programs would provide visible evidence of management commitment to increasing spares competition.

Organizational Focus. The responsibility for competitive spare parts acquisition at the ALC is spread across two major directorates, Material Management and Contracting and Manufacturing. In addition, each ALC has a Competition Advocate who is tasked with providing emphasis and management attention to the issue of spares competition. The ALC is also supported by representatives from the Small Business Administration who aid in the identification of sources within the small business community. The Air Force should consider augmenting and focusing the resources applied at the Air Logistics Centers for an interim period to deal with the large number of items currently in inventory which could be acquired competitively.

SUMMARY

There is no single cause for the current difficulties in obtaining competition and fair and reasonable prices for spare parts. The process by which the Air Force creates the capability to compete spares and performs up to that capability is complex and involves the entire Air Force structure. At each level, specific problems can be identified which contribute to the low level of competition for spare parts. The problem can be solved but its solution will require significant changes in resource commitment and organization behavior. Success in increasing competition is dependent upon a focused, integrated approach to curing long standing systemic problems -- but theyc an be solved.

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CONTRACTING METHODS

Panel Moderator: Brigadier General Donald J. Stukel
Commander, Air Force Contract
Management Division (AFSC)

Papers:

Award Fee Contract Provisions as a Program Management Tool
by Richard F. DeMong

Nailing Down the Liability Issue Once and For All
by William C. Pursch

Does the Prompt Payment Act Insure Timely Contract Payment?
by Michael E. Wilson

AWARD FEE CONTRACT PROVISIONS AS A PROGRAM MANAGEMENT TOOL

Major Richard F. DeMong, University of Virginia

ABSTRACT

Award fee contract provisions can be used as a program management tool. Award fee contracts have been found to be a cost effective means of encouraging contractors to surpass the specifications of the contract. Award fee contracting can be successfully used in the dynamic environment of R and D programs as well as full scale development programs. Award fee contracting relies on other forms of motivation than just the profit motive. The frequent evaluations used in award fee contracting give the contractor (including its managers and employees) timely feedback on its performance. These evaluations implicitly tell the contractor what the government's priorities are. This evaluation process also enables the government to better define its requirements. It serves as a motivation tool in that the managers will strive to make the evaluation look as good as possible. Timely and high level government involvement have been found to be important in the success of award fee contracting.

INTRODUCTION

The Department of Defense (DOD) has used award fee contracts effectively since their first use by the National Aeronautical and Space Administration (NASA) and the U.S. Navy in 1962 (36;37). The award fee is an incentive that can be paid by the government to a contractor. The objective of the award fee provision clause in a contract is to encourage the contractor to surpass the minimum acceptable performance established for certain performance areas that are described by the evaluation criteria. These incentives may encourage a firm to better meet the government's goals in such areas as acquiring a superior product for less money and in less time than called for in the contract. The level of specific payments made under the award fee provision is unilaterally set by the government and is not subject to the dispute clause in a contract.

The award fee contract is generally a cost reimbursement plus award fee (CPAF) type of contract. The CPAF contract reimburses the contractor for the allowable costs (as defined by the contract and the government) plus a base fee (which is a percentage of those estimated costs) in addition to the award fees which may be paid. Award fees are in addition to any base fees earned by the contractor. Both the base fee and the maximum fee (the total award fee plus base fee) are subject to a percentage of estimated cost limitation of the Defense Acquisition Regulation (DAR).

Award fee provisions offer the contracting parties a process that aids in the identification of areas in which significant technical or managerial efforts will be required to exceed the minimum acceptable performance requirements. To identify the important performance areas, and to establish the minimum acceptable performance levels considered achieveable, the DOD must first identify and then prepare a priority listing of the performance criteria appropriate for the program. When this step is complete, the performance areas which can be objectively specified and measured can be covered by objectively defined and measured incentives. The program requirement analysis required to isolate the performance areas appropriate to award fee incentive provisions initiates a process leading to improved requirement and program understanding by the government, and by the successful contractor(s) as well.

In addition, the requirement analysis process forces increased communication between the technical organization responsible for defining and programming the system acquisition and the contracting organization which must establish the administrative network with the successful contractor who will actually accomplish the program's objectives. With improved understanding of the total program, technical and contracting organizations are more likely to develop a productive, problem solving team approach to the process of contracting for requirements, and to the ongoing management effort required to achieve the desired acquisition goals. Thus, the award fee contract incentive also initiates a process that improves the managerial communication and control processes of both the government and the contractor. Throughout the contract the government will be evaluating the contractor's performance and giving feedback to the appropriate managers. This process should lead to further refinement of the program's requirements and superior performance based on the better understanding.

BACKGROUND

All the military services currently use award fee provisions for such varied areas as research and development (R&D), support services (from maintenance to technical

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support), design, development or production of major weapons systems. For example, the Air Force effectively used CPAF contracts in development of the F-15, AWACS and B-1 aircraft (2:5 and 3). The Army has effectively used them in the management of government-owned contractor-operated plants (26) and in the development of the XM712 laser guided artillery round (14). The Navy successfully used CFAF contracts in the full scale development phase of the F/A 18 attack aircraft (32).

CPAF contracts were used in one-half of one percent of all DOD contracts in excess of $10,000 in Fiscal Year (FY) 1982 (33:63). This represents 3.5 percent of net dollar value of FY 82 contracts (33:63). The difference between the two percentages indicates that the award fee contracts represented a larger dollar value than the average contract.

As can be seen in the chart, the use of CPAF contracts has generally been increasing, since its low point of 1.6 percent of the net dollar value of FY 75 DOD contracts. As more contract managers in the government become aware of the use of award fees as a management tool, this percentage may continue to climb.

As indicated earlier, the Navy has used CPAF contracts longer than the Air Force or Army. In FY 82 CPAF contracts represented 7.4 percent of the net dollar value of all Navy contracts as compared to 1.7 percent of the Army contracts and 1.7 percent of the Air Force contracts (33:63 to 64). CRAF contrasts as a percentage of total numbers of contracts in excess of $10,000 used by the Navy was 1.5 percent in FY 82 (33:64). In contrast, CPAF contracts were 0.2 percents of the total number of Army contracts was only 0.2 percent and 0.6 percent of Air Force contracts (33:63 to 64).

The difference in the use of award fee contracts may be attributed to the uniqueness of each Service's procurement activities. For example, the shipbuilding programs of the Navy may be inherently more conducive to award fee contracting than the Army's tank-building activities are. This may be partially true, but the large variance in the usage of the award fee contract suggests some other explanation. Perhaps the Navy's longer experience with the award fee contracting process may have convinced more of its acquisition personnel of its effectiveness as a management tool.

Award fee contracts are not the first type of incentive contracts that the military has ever used; other types of incentive contracts are fixed price plus incentive

CPAF AS A PERCENT OF THE NET VALUE OF DOD CONTRACTS**

**Prime Contract with a net value of $10,000 or more

*7t represents the transition quarter to current federal Fiscal Year that starts on October 1st of each year.

SOURCE: Department of Defense Prime Contract Awards:Fiscal Year 1982.

(FPI) and cost reimbursement plus incentive fee (CPIF). The FPI contract has fixed price plus an additional incentive fee which varies based on the contractor's ability to satisfy specific objectives. The CPIF contract has an incentive fee based on specific criteria and a fixed fee up to some specified ceiling. These traditional incentive contracts precisely define the factors that will be used to determine the incentive to be paid. Both the Monitor of the Civil War and the Wright Brothers' "heavier than air machine" were purchased with an incentive contract (1:8-9).

According to the DOD and NASA Incentive Contracting Guide, "the objective of an incentive contract is to motivate the contractor to earn more compensation by achieving better performance and controlling costs" (9:viii). FPI and CPIF contracts have not been found to be especially effective in reducing the project's costs, speeding up its delivery or enhancing its performance (1; 7; 17; 19; 22; 27; 38; 39).

Since incentive contracts began to be used more widely in the early 1960's, their influence on program performance outcomes has been subjected to extensive research. The findings reveal a remarkably consistent general pattern; incentives involving technical performance goals are usually earned while those dealing with cost or schedule goals of the program are missed. While the studies are individually criticizable on various methodological grounds, the unanimous direction of their findings cannot be ignored. From an operational viewpoint, therefore, the role of objective incentives in motivating contractors to reduce costs or improve schedule performance must be seriously questioned.

Programs contracted for using award fee provisions, however, have revealed nearly unanimous positive correlation between performance and fee earned. Indeed, all studies which have investigated the linkage between fee earned and performance realized, have found the award fee to be an effective incentive to improved contractor performance (2; 3; 4; 5; 6; 7; 11; 15; 16; 18; 24; 26; 27; 31;.32; 35; 36; 38; 39).

Again, it is the consistency of the direction of results that is operationally significant. The probabilities of such a large number of research efforts conducted independently on widely divergent business and technical requirements yielding such consistent results by chance must be regarded as being extremely remote. From an operational viewpoint, therefore, the evidence indicates that when properly employed, award fee contract provisions have a very high probability of positively influencing contractor performance.

AWARD FEE PROCESS

The award fees may be earned in whole, or in part, or may not be earned at all. The process of awarding fees based on the evaluation criteria of the contract gives the program manager additional leverage in the dynamic technical management of the program. A CPAF contract defines the general criteria that the government uses to establish the level of awarded fees. Examples of these criteria include the following: the contractor's effectiveness in controlling or reducing costs, his effectiveness in using his personnel, his effectiveness in managing his subcontractors, and his ability in making an attractive and reliable product (9:3-40 to 3-44; 12). These criteria are necessarily general. This generality allows the contract to adjust to any expected or unexpected changes that may develop during the life of the contract. In addition, the government can also adjust for any changes in it's priorities by adjusting the evaluation weights associated with each criterion. The reweighting of the importance of the criteria signals the contractor to the governments new priorities.

Thus, these criteria, and their inevitable trade-offs, concern performance areas that defy objective quantification. (If the criteria and the trade-offs are measurable, then a straight incentive contract should be used.) The award fee process, with its subjective awards and qualitative criteria, implicitly recognizes the increased complexity of many aspects of both today's weapon systems and, ultimately, today's contracts.

The award fee process generally requires periodic determination of the fees that will be awarded by the government. An award can be made as often as the government wants; however, the fees are generally awarded on a schedule ranging from quarterly to yearly. This requires the government to monitor, document, and recognize the performance of the contractor on an ongoing basis. DOD contract managers usually designate someone to monitor, the contractor's performance against the general cost, schedule or performance criteria established by the government. And, these monitors will periodically report to an advisory board. The advisory board will recommend the level of fees that should be awarded for that period, but the final decision is made by a higherlevel official called the Fee Determination Officer (FDO). Research into this process indicates that quarterly fee establishments meetings with high ranking FDD's yields in proved performance over less frequent meetings on lower ranking FDO's (35:52).

AWARD FEES AS A MANAGEMENT TOOL

Raymond G. Hunt, of the State University of New York at Buffalo, states that "award fee is best regarded as a method of management, not as a contract type" (17:164). As a management tool, the award fee allows the government to influence the contractor and the project more effectively during the contract period. Award fee contracting relies on more than just the profit motive. The profit motive as an effective incentive has been recently questioned by researchers (2; 8; 39). The award fee brings in the pride of the organization, the managers and the workers as an additional incentive (38;22). Periodically, the firm and its management are formally advised on the level of fees awarded and the reasons for the award or absence of award. These evaluations, commonly called "report cards," are, by themselves, either a positive reinforcement of the firm's performance or a penalty. Thus, without even considering the profit to the firm (the awarded fees), the evaluation can have a positive impact on the firm's managers and employees. Robert F. Trimble found that this can appeal to the pride of the employees at the working level (38:22). These employees are probably not directly motivated by increased profits to the firm, and would be therefore, relatively insensitive to a straight incentive contract.

In his research on the hierarchy of man's needs, Abraham Maslow found that the strongest motivation of man, after his more basic needs of food, shelter, and a sense of belonging to a group are satisfied, is a need for esteem (29). The award fee process satisfies this need through the feedback of an oral or written evaluation backed by the dollars of an award fee. Managers may not

receive a bonus from their employer (13:41), but the evaluation can be a non-cash reward or penalty which can either satisfy or frustrate a manager's need for ego satisfaction. The evaluation aspect of the award fee process can be a more powerful incentive than cash alone (20:64; 29). A formal presentation of the evaluation and determination of fees can increase their impact and make the award fee process a more effective management tool.

Effective use of the evaluation process can make the award fee contract a powerful tool by allowing the contractor's technical managers to perceive what the government most li es and most dislikes. It also gives the contractor an incentive to make the many complex and dynamic trade-offs and decisions in a way that is perceived as most beneficial to the evaluators. The frequent and timely evaluations may give the contractor's management enough time to make favorable changes in the project.

This ability to send a meaningful and timely signal to the contractor during the life of the project contrasts sharply with most incentive contracts, in which the rewards are given after the project is completed. The post-contract reward system of a traditional incentive contract does not give the managers any opportunity to correct the unfavorable aspects of the firm's performance, and the future reward may be discounted by the managers. In contrast to the effectiveness of timely rewards of the award fees, B. F. Skinner found that remote, ultimate consequences (incentives at the end of a contract) are especially weak motivators (37:147).

Trimble found that the award fee process not only appeals to the pride of the work-level employees, but it also reinforces the contractor's goals (38:22). Phillip E. Oppedahl and the International Technology Corporation found that corporations have a hierarchy of needs very similar to the personal needs found by Maslow (20; 34). Once the firm's lower-level needs of survival, profit, growth and market shares are satisfied, the primary motivation of the firm becomes prestige. The award fee will act as a corporate motivator to the extent that it is perceived by the firm to affect its prestige. Again, the award fee process may be enhanced as an organization motivator by a formal presentation of the awarded fees.

An early study of incentive contracting by Douglas Egan concluded that the major incentive in the award fee process may "arise from the fact that a formal record of evaluated performance is maintained," rather than from the fact that immediate fees are earned (11:24). The attention given to certain aspects of the contractor's performance is itself an incentive, and it also leads to a more focused communication between the government and the contractor. This process often defines for the contractor the government's goals and its priorities by communicating this information to the contractor (6; 18; 19; 23; 25). Thus, the award fee process enhances performances of the contractor through improved communication between the government and contractor.

If award fee is to be considered a management tool, then there should be a learning-curve effect over the life of the contract. That is, if partial awards are made, the contractor should be able to discern what is important to the government. In a study of 13 CPAF contracts, Mel D. Byers of the USAF found that the "percentage of award fees the contractor earned seemed to increase" as the contract progressed (4:86). Thus, the contractor seems to better meet the governments goals as the work continued.

Nonetheless, Byers found that the relative magnitude of the award fee or the size of the contract has no significant impact on the contractor's performance (4:81-8). An Army researcher, Shirley H. Carter, found that award fees are effective motivators of contractor performance; however, relatively large base fees of the contract diminished the effectiveness of the award fees (5:36-40).

The DOD has traditionally tied award fees to cost reimbursement contracts. However, with appropriate changes to the DAR, award fees could easily be combined with fixed-price contracts which could be more effective, in some situations, than cost reimbursement plus incentive contracts (18; 28; 30). Thus, the government could use this flexible management tool with almost any contractor and at any stage of development. Of course, award fee contracts would not be appropriate for the purchase of commercial items for which the schedule of delivery, product quality, and costs are predictable.

Award fee contracts are often superior to traditional incentive contracts in the dynamic and uncertain environment of R & D (34). The numerous trade-offs that must be made during the development stage of a product are often too vague, dynamic, and complex to quantify in a traditional contract. The award fee contract's subjective evaluations made shortly after completion of a phase of the contract, are very useful management tools in that type of environment. They are also very useful management tools in maintenance and service contracts where some criteria, like

courtesy and cooperative attitude, are important but not easily quantified.

DISADVANTAGES OF THE AWARD FEE PROCESS

The primary disadvantage of the award fee contracting process is the extra administrative workload of monitoring, documenting and evaluating the contractor's performance. This administrative process should be made efficient but cannot be eliminated since it is at the very heart of the award fee contract. That process identifies those factors that are important to the government and will be reinforced by the evaluations and award fees. Although the process may be administratively more difficult, the contract itself should be structurally simpler than a traditional incentive contract (19:158). Of course, an award fee contract should not be used where its effect will be minimal or on very small contracts where the administration costs outweigh the benefits. Nielsen found that the benefits of lower life cycle costs and better program milestone management in the Navy's F/A-18 program exceeded the administrative costs of the award fee process (32:103).

What is often considered another disadvantage of the award fee process is that the contractor is being paid extra for what the firm should have done in the first place. This, however is a misperception. The objective of the award fee clause is to give the contractor the incentive to make a superior product with less cost and in less time, and to make all the trade-offs in favor of the government. So, in reality, he is being paid extra for doing more than what was called for in the contract. If the contractor performs only to the minimal standards, then no award should be made. Finally, award fee contracting may not be an effective management tool if the goals are unattainable or if the evaluations process is neither consistent nor sound. Jerry V. Brown found that unobtainable goals tend to frustrate rather than motivate the contractor (2:28). He also found that the system will break down if the awards are capricious (2:42).

CONCLUSION

The award fee process is a flexible management tool which the government can use to motivate the contractor's firm, its managers, and its employees. Its effectiveness depends upon the subjective, but honest and consistent evaluation of the contractor's performance and subsequent award of fees. If criteria are constantly changed, the contractor may not be able to perceive the government's true goals or priorities.

The award fee process can be enhanced by formal presentations of the award fees and the government's evaluation of the contractor's performance. Such formalization should act as a motivator since it should satisfy the firm's need for prestige and the employees' ego needs of high esteem. The evaluations and awards should be frequent so that they are more closely tied with performance which the government wants to discourage or encourage. The process can also be enhanced with high-level government involvement, which may add credibility and consistency to the process. Lower base fees (the fixed fees that the contractor receives for completion of the contract) relative to the award fees should increase the effectiveness of the award fee process because of the greater impact of the award fees.

Award fee contracting has some inherent advantages as a management tool over the traditional incentive contracts. It does not rely solely on the profit margin, nor does it require pre-defined, quantifiable and measurable criteria. It is, therefore, a more flexible and effective motivator than the traditional incentive contracts. This flexibility and effectiveness are especially important to a dynamic, complex and uncertain contracting environment.

Properly administered, the award fee contract can be a very effective and efficient management tool. However, this management tool should not be used for all projects. It is only effective where the contractor's managers can make a difference and where there is some uncertainty inherent in the project. Finally, the award fee clause should be added to other forms of contracts besides costs reimbursement, thus making this powerful management tool available to many more projects.

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NAILING DOWN THE LIABILITY ISSUE ONCE AND FOR ALL

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ABSTRACT

This paper contrasts the present Defense Acquisition Regulation requirements for liability determinations for loss, damage, or destruction of government property in the hands of contractors, with new guidance in the Federal Acquisition Regulation for property administrators and administrative contracting officers. Discussion includes the cumbersome method of shifting the liability for loss, damage, or destruction of government property by disapproving the contractor's property control system, and the liability clauses used in government contracts. The rationale behind the government's position as a self-insurer is presented, along with the procedure to follow in making liability decisions. Finally, certain conclusions are drawn with respect to strengthening the function of the property administrator, and the need for the support of the administrative contracting officer.

INTRODUCTION

Liability for loss, damage, and destruction of government property has been a concern of administrative contracting officers, property administrators, and contractors since the Armed Services Procurement Regulation (ASPR), now the Defense Acquisition Regulation (DAR), provided for property administration. One of the difficulties in liability determinations is created by the necessity to look in several different sections of DAR to find the information required to make an intelligent decision. The purpose of this paper is to review the procedures that should be used by the Property Administrator in liability determinations; and to contrast the requirements of DAR with the new clauses in the Federal Acquisition Regulation (FAR) which will become effective following publication. It is important to remember that contracts written with DAR clauses will be administered using the guidance and policy in the DAR, even after the FAR becomes effective. Since it will take a few years to close out contracts written under DAR, the contracting professional will have to operate, for a while, under two systems: the DAR and the FAR. Who is liabile for loss, damage, or destruction of government property? The answer is: it depends! It depends on (1) the type of contract; (2) the government property clause cited in the contract; (3) the status of the contractor's property control system; and (4) the circumstances surrounding the loss, damage, or destruction of the government property.

GOVERNMENT PROPERTY

Before proceeding further, it is prudent to clarify what is government property? Immediately one thinks of that property furnished to the contractor by the government. But that is only half the answer. Government property also includes that property "procured or otherwise provided by the contractor for the performance of a contract, title to which is vested in the Government". So the term "government property" consists of both government-furnished property and contractor-acquired property (DAR B-102.2). Usually property is further defined into one of five types: Material, Special Tooling, Special Test Equipment, Facilities (Real Property, Industrial Plant Equipment, and Other Plant Equipment), and Military Property. Each of these types are defined in DAR B-102.

How does the contractor become involved with government property? Usually one of two ways. Many times, the decision to furnish government property is made by the requiring activity and included in the technical data package provided the procuring contracting officer (PCO). It is the responsibility of the PCO to include the correct government property clause in the contract. On the other hand, the decision to furnish government property is often made after award of the contract and at the request of the contractor. In these cases the administrative contracting officer (ACO) can modify the contract to incorporate into the contract the correct government property clause. Without the government property clause in the contract, the contractor is under little obligation to protect the government's interest and maintain an effective property control system.

TYPE OF CONTRACT

The type of contract is decided, prior to the time of award, by the purchasing contracting officer (PCO), and in some instances, can be subject to negotiation between the parties. The method of contracting, either formal advertising or negotiation, is also a factor in determining the type of contract. If government property is involved in the contract then a government property clause should be included in the contract.

PROPERTY CLAUSES

For contracts of the fixed price type the 7-104.24(a). For cost reimbursement type contracts asic government property clause used is DARthe basic government property clause used is DAR 7-203.21. Both clauses require the contractor to comply with the provisions of Appendix B of the DAR which is incorporated by reference and made a part of the contract. For the sake of comparison, both clauses are almost identical, sub-paragraph by sub-paragraph, with the exception of two significant sub-paragraphs -- (c) title and (g) risk of loss. Risk of loss is the issue of this paper and will be discussed in detail.

While there are two basic property clauses, there are three sub-paragraphs (g) Risk of Loss to be considered. Two of the sub-paragraphs (g) are for use with fixed-price type contracts and one is for use with cost reimbursement type contracts. Figure 1 shows the DAR and FAR clauses used for three contract types and indicates who is liable in case of loss, damage, or destruction of government property.

Property Clause	Type of Contract	Liability for Loss
DAR 7-104.24(a) Regulan (g)	Fixed Price Competitive	Contractor
FAR 52.245-2		
DAR 7-104.24(c) Alternate (g)	Fixed Price Non-Competitive	Government
FAR 52.245-2 Alternate I		
DAR 7-203.21	Cost-Reim-bursement	Gover.ment
FAR 52.245-4		

Figure 1

The basic government property clause for fixed price type contracts (DAR 7-103.24(a)) specifies in sub-paragraph (g) the "contractor assumes the risk of, and shall be responsible for, any loss of or damage to Government Property" except for reasonable wear and tear or authorized consumption in performance of the contract. However, when negotiated fixed price non-competitive contracts are awarded, an alternate paragraph (g) is used as set forth in DAR 7-104.24(c). The alternate paragraph (g) specifies "the contractor shall not be liable for loss or destruction of or damage to the Government Property" unless the loss results from willful misconduct or lack of good faith on the part of the contractor's managerial personnel or a failure to maintain and administer a system for control of government property. The risk of loss clause for cost reimbursement contracts (DAR 7-203.21) specifies the same criteria as the alternate (g) clause in DAR 7-104.24(c).

The contractor's managerial personnel, as defined in the risk of loss paragraphs, means the directors, officers, and top managers. Willful misconduct is defined in DAR S3-602.1(e) as "any intentional or deliberate act or failure to act which causes, or results in, the loss, damage, or destruction of Government property". Lack of good faith is defined in DAR S3-602.1(f) as "gross neglect or disregard of the terms of the contract or of appropriate directions of the contracting officer or his authorized representatives".

THE PROPERTY CONTROL SYSTEM

The DAR property clauses 7-104.24 and 7-203.21 incorporate by reference DAR Appendix B (DAR Appendix C for non-profit organizations). DAR Appendix B requires the contractor to "establish and maintain a system to control, protect, preserve, and maintain all government property". DAR Appendix B sets forth minimum criteria and guidelines to insure the contractor establishes an efficient and effective system. The property administrator has the responsibility to survey the contractor's property control system and either approve the system or recommend to the ACO the system be disapproved. In the case where the contractor has an approved system and the property administrator finds, during the annual system survey, deficiencies in the system, the ACO may be requested to withdraw the previous approval of the system. There are two major points to be emphasized here. First, nowhere in DAR does the government establish a standard system for property control for contractors that would be acceptable. The property administrator uses judgment, experience, and the guidelines set forth in DAR Supplement No. 3, to determine the acceptability of the contractors' property control system. Second, the property administrator has authority to approve the contractor's property control system but no authority to disapprove the property control system (only the ACO can take this adverse action). Such lack of authority weakens the position of the property administrators. If government quality assurance representatives have the authority to reject poor quality performance, then why not give the property administrator the authority to disapprove the property control system? Disapproving the property control system will not (contrary to some contractor claims) shut down the production line. In fact, such action should have no impact on performance. Then why get

excited about a disapproved property control system? A disapproved system is an indication that the contractor's top management is not placing proper emphasis on property control and the government's interest is not being protected. Failure to maintain an approved property control system is an indication of lack of good faith on the part of top management. If the system is disapproved, or a previous approval is withdrawn, the contractor may be liable for any loss, damage, or destruction of government property, even if the clauses in DAR 7-104.24(c) or DAR 7-203.21 are in the contract. If a causal relationship can be established between loss or damage of government property and the reason(s) for which the system was disapproved, or a previous approval is withdrawn, then the contractor should be liable for the loss or damage. The property administrator must convince the ACO that the contractors' procedures and property control system, because of serious deficiencies, merit this adverse action. The ACO is advised to seek government legal counsel to insure the governments' position is justified. If the contractor believes the ACO's action is inappropriate, the contractor can seek remedial action under the Disputes clause.

Failure to maintain an approved property control system is indicative of an irresponsible contractor. Contractor responsibility is a criteria the PCO uses to determine future contract awards.

DETERMINING LIABILITY

When the contractor discovers that government property has been lost, damaged, or destroyed, DAR B-203 requires the contractor to report all cases to the property administrator as soon as possible.

After receiving the contractor's report, the property administrator, using the guidelines in DAR S3-602.2, should first determine what type of contract is involved and what property clause is in the contract. If the clause in DAR 7-104.24(a) is used, then, depending on the contractor's report of loss, damage, or destruction, in all likelihood the contractor will probably be held liable. However, if the clause in DAR 7-104.24(c) or DAR 7-203.21 is used, and there is no evidence of willful misconduct or lack of good faith on the part of top management, then the government assumes the role of self insurer and the contractor is relieved of liability.

With over $35 Billion worth of government property in the system, it would be difficult and extremely costly to try to insure the property. If the government were to hold the contractors liable for all losses, then the contractors would take out insurance against the risk of loss and pass the cost of insurance on to the government as an allowable cost on the contract. So the government becomes a self-insurer and assumes the risk of loss. Figure 2 is the result of a review of the liability decisions in one Defense Contract Administration Services Region for FY 82.

LIABILITY DECISIONS - FY 82

Property under Administration	Relief Granted For Loss	Contractor Liability
$4,535,689,692.	$2,415,174.	$217,279

Figure 2

The amount of relief granted was ½ of 1% of the value of the property under administration, and the amount of loss the government recovered was .004 of 1% of the value of the property under administration. The dollar value of the property under administration is based on acquisition cost. Considering the rate of loss, the government is probably better off assuming a self-insurer position.

FAR IMPROVEMENTS ON LIABILITY

The Federal Acquisition Regulation (FAR), when issued, consolidates the policy and guidance found in four separate parts of DAR into one sub part. While the FAR property clauses (52.245-2, 52.245-2 alternate I, and 52.245-4) are similar to the DAR clauses (7-104.24(a), 7-104.24(c), and 7-203.21) with regard to contractor liability, the major change is the new direction given to the administrative contracting officer (ACO), when the property administrator is not successful in having the contractor correct deficiencies in the property control system. Under DAR 13-108, when the property administrator is not successful in obtaining compliance with the contract requirements, the ACO would be notified. If the ACO concurs with the property administrator, then the ACO would advise the contractor, in writing, of the changes necessary in the contractors' property control system. The ACO will also establish a schedule for completion and notify the contractor that his liability for loss, damage, or destruction may be increased.

The new guidance to ACO's is found in FAR 45.104 "Review and correction of contractors' property control systems". Under FAR, when the property administrator is unsuccessful in obtaining the contractors' correction of deficiencies, the property administrator shall request action by the ACO. FAR 45.104(c) specifies "the contracting officer shall:

(1) Notify the contractor in writing of any required corrections and establish a schedule for completion of actions;

(2) Caution the contractor that failure to take the required corrective actions within the time specified will result in withholding or withdrawal of system approval; and

(3) Advise the contractor that its liability for loss of, or damage to, Government property may increase if approval is withheld or withdrawn."

The FAR does not contain the requirement found in DAR 13-108 that the ACO must concur with the property administrator before he is required to take action. While this may have been an oversight on the part of the writers of the FAR, the author would like to believe that the intent is to give more support to the property administrator.

Property administrators need the support of the ACO in order to be effective in their job. Too many contractors treat the property control function lightly. When the contractor signs a government contract which contains the government property clause, he agrees to maintain control of the property and protect the government's interest. The cost to maintain control of the property should have been included in the contractor's bid. The government is paying for property control and the property administrator's function is to insure the government is getting its moneys worth. Without the ACO's support the property administrator is rendered ineffective.

CONCLUSION

The current DAR procedures for liability determinations are cumbersome and difficult to implement. Without the support of the administrative contracting officer, the property administrator can do little to motivate the contractor to maintain and administer an effective and efficient property control system.

Disapproval of a property control system, or withdrawing a previously approved system, establishes a potential shift in liability for loss, damage, or destruction of government property from the government to the contractor. The contractor's failure to maintain an approved property control system tends to establish a lack of good faith on the part of top management. Administrative contracting officers should not be reluctant to use this administrative remedy to motivate contractors to adequately manage government property.

While the DAR allows the ACO to override the recommendations of the property administrator, the FAR directs the ACO to take action upon receipt of the property administrator's recommendation. If the property administrator is to have any credibility at all, this is the kind of support needed. Let's get the FAR implemented!

NOTE:

THE VIEWS EXPRESSED HEREIN ARE THOSE OF THE AUTHOR AND DO NOT NECESSARILY REFLECT THE VIEWS OF THE AIR FORCE INSTITUTE OF TECHNOLOGY, THE AIR UNIVERSITY, THE UNITED STATES AIR FORCE, OR THE DEPARTMENT OF DEFENSE.

ADP002778

DOES THE PROMPT PAYMENT ACT INSURE TIMELY CONTRACT PAYMENT?

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ABSTRACT

On 21 May 1982, President Reagan signed Public Law 97-177, the Prompt Payment Act, which has an objective of timely contract payment. Since the Act was implemented nearly one year year ago, the question is: "Does the Prompt Payment Act Insure Timely Contract Payment?" The following paragraphs address this question. This report addresses this question.

WHAT IS TIMELY CONTRACT PAYMENT? There is no established standard for timeliness in which both government and industry agree. When contractor expectations about contract payment timeliness exceed Contract Payment Activity performance, complaints about untimely payments occur.

HOW HAS THE PROMPT PAYMENT ACT IMPACTED THE TIMELINESS OF CONTRACT PAYMENTS? The provisions of the Prompt Payment Act can, and when followed, do improve the timeliness of contract payments; however, given the contract payment process followed, the delays inherent in it and accidental to it, timely contract payment cannot be insured by the Act alone.

WHAT STRATEGY SHOULD BE FOLLOWED TO ENSURE TIMELY CONTRACT PAYMENT? A win-win strategy should be followed by government and industry.

WHAT SHOULD THIS STRATEGY INCLUDE? It should include both short-term and long-term actions, which attack the root causes of delays in contract payments.

INTRODUCTION

A senior DoD official has stated that a strong national defense depends upon a strong industrial base. [1] Following this thesis, one might ask "What are the factors which support a strong industrial base?" A strong case can be made for improving cash flow, which can be accomplished by timely contract payment to defense contractors.

On 21 May 1982, President Reagan signed Public Law 97-177, which is known as the Prompt Payment Act. One of the prime expectations of this law was timely contract payment. [2] Since this law was implemented with all contracts issued on or after 1 October 1982, nearly one year ago, the question is: "Does the Prompt Payment Act insure timely contract payment?" In answering this question the following points will be addressed:

- What is timely contract payment?
- How has the Prompt Payment Act impacted the timeliness of contract payments?
- What strategy should be followed to insure timely contract payments, and what should this strategy include?

WHAT IS TIMELY CONTRACT PAYMENT?

In answering this question, the following points will be covered: contract payment process, contract payment terms, contractor payment expectations, contract payment activity priorities/experience and contract payment delays.

CONTRACT PAYMENT PROCESS MODEL

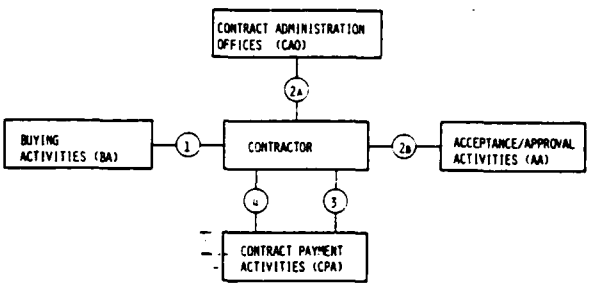

Figure 1

The contract payment process begins when the contract is negotiated and/or awarded by the buying activity to the contractor. This represents the first of four basic steps in the contract payment process (Figure 1, Step 1). Since this step "sets the stage" by identifying type and frequency of contract payment and conditions precedent for contract payment, it cannot be overemphasized. Depending upon the type of contract and the clauses included in it, the second step occurs when government representatives accept the goods/services or approve the contractor costs for reimbursement. If the contract clause specifies source acceptance, the Quality Assurance Representative from the Contract Administration Office (CAO) accepts the goods/services (Figure 1, Step 2a). If the contract clause specifies destination acceptance, the Government Receiving Activity accepts the goods/services (Figure 1, Step 2b). If the contract type is cost, the contractor forwards his voucher through the Defense Contract Audit Agency representative for provisional approval (Figure 1, Step 2b). If the contract contains a progress payment clause or requires approval by the Administrative Contracting Officer, the contractor billing is sent to the CAO for approval (Figure 1, Step 2a). Some contractors erroneously believe that the contract payment process begins when the billing/voucher is forwarded to the Contract Payment Activity (CPA), (Figure 1, Step 3) without regard

for the other steps; this may result in the contractor's billing being returned for correction. When a correct billing is received by the CPA designated in the contract, payment entitlement is determined. When all the necessary documentation is received and various contract clauses satisfied, the CPA disburses funds to the contractor (Figure 1, Step 4). It is important to keep these four contract payment steps in mind while examining the issue of timeliness.

Currently, there is no specific clause in the Defense Acquisition Regulation, which defines what constitutes timely contract payment. Notwithstanding this fact, contractors can negotiate specific payment due dates and can offer prompt payment discounts to expedite their contract payments. In the absence of these specific contract payment terms, 30 days after receipt of a correct invoice by the designated CPA had been the standard for contract payment timeliness within the Defense Logistics Agency (DLA).

Contractor expectations with regard to contract payment timeliness vary depending upon several factors; some of these factors include: their cost of money, the availability of credit to them, their current cash position and their year-end closing date. Generally, the contractors "bottom line" on contract payments is regularity within contract payment terms.

CPAs within the DLA have established priorities and goals for processing contractor billings/vouchers; these include: earning all prompt payment discounts that meet the Treasury Cash Management rate (11% from 1 July to 30 September, 1983), paying all progress payments within an average of 4 work days, paying all cost reimbursement vouchers within an average of 14 calendar days and having no more than 16% of total invoices on-hand over 30 days old. [3] Notwithstanding these priorities and goals, individual CPAs actual experience may vary depending upon several factors (such as, workload peaks and available resources).

Problems in contract payment timeliness can originate in any of the four steps of the contract payment process. Generally, these problems can be categorized into three groups: expected delays, unexpected delays and a combintions of both expected and unexpected. These problems can be further identified to each of the participants in the contract payment process and by type of delays. The contract paycontract payment delay matrix (figure 2) summarizes the most common problems, associated with contract payment timeliness. When contractor payment expectations exceed CPA performance, contractors complain about untimely contract payment, which disrupts their cash their cash flow. The question that "begs" an answer is: How can these delays be overcome, insuring timely contract payments? Since one of the Prompt Payment Act's objectives was timely contract payment, its impact must be considered.

CONTRACT PAYMENT DELAY MATRIX

DELAYS	BUYING ACTIVITIES	CONTRACTOR COMMUNITY	CONTR ADM OFC	CONTRACT PAYMENT ACTIVITIES	ACCEPT/ APPROVAL ACTIVITIES
CLERICAL ERRORS	Y	Y	Y	Y	Y
DOCUMENT DISTRIBUTION	Z	X	Z		Z
CONTRACT CLAUSES	X	X	X	X	
CONTRACT FUNDING	X		X		
ACCEPTANCE/APPROVAL POINTS	Z		Z		Z
PAYMENT PRIORITIES		X		X	
OTHER DELAYS				Z	

X = EXPECTED DELAY Y = UNEXPECTED DELAY Z = EXPECTED AND/OR UNEXPECTED DELAY

Figure 2

HOW HAS THE PROMPT PAYMENT ACT IMPACTED THE TIMELINESS OF CONTRACT PAYMENTS?

In answering this question, the following points will be covered: background of the Act, implementing guidance and several key provisions of the Act.

One of the driving forces behind the Act was a 1978 General Accounting Office (GAO) report, which concluded that the Federal Government was not paying its bills as timely as they should: 45% were paid too early; 25% were paid on time; and 30% were paid late.[4] In October, 1981, the GAO completed a follow-up review, concluding that no substantive improvement had been made. Congress then convened a committee to determine the costs and hardship imposed on contractors doing business with the Federal Government. After much testimony, the House drafted and passed H.R. 4709 and then adopted Senate Bill 1131 with Amendments. Section 2 (a) (1) of the Act [5] directed the Office of Management and Budget (OMB) to issue an implementing regulation, which was accomplished with the issuance of OMB Circular A-125, titled "Prompt Payment" dated August 19, 1982. DAR clause 7-103.30, titled "Invoices" dated October 1982 implemented the Prompt Payment Act.

While the Prompt Payment Act covers many requirements, only those impacting the timeliness of contract payments will be covered. Furthermore, these impacts are based upon the first ten months of experience under the Act at the Defense Contract Administration Services Region, Los Angeles (DCASR, LA).

PAYMENT OF AN INTEREST PENALTY: This applies when payment is made more than 15 days (3 days for meat and 5 days for perishable agricultural commodities) after the "due date". It also applies when a discount is taken after the discount period has expired.

[2] Interest rates are published in the Federal Register on a semi-annual basis. The rate for 1 July to 31 December 1983 is 11.5%. Because interest payments are funded out of the operating budget of Contract Payment Activities, there is a very strong incentive to pay contractor billings in the allowable timeframe; consequently, this feature of the Act improves the timeliness of contract payments.

INVOICES RETURNED FOR CORRECTION: Notice of an apparent error, defect or impropriety in an invoice will be given to a business concern within 15 days (3 days for meat and 5 days for perishable agricultural commodities) and suitably documented. Failure by contract payment activities to follow this feature of the Act allows contractors to subtract any days in excess of 15 days from their payment "due dates". [2] Because this feature insures that contractors will not be unduly penalized for incorrect invoice submissions, it also improves the timeliness of contract payments.

DEFINITION OF A PROPER INVOICE: Invoice date; name of contractor; contract number (including order number, if any), contract line item number, contract description of supplies or services, quantity, contract unit of measure and unit price, and extended total; shipment number and date of shipment (Bill of Lading number and weight of shipment will be shown for shipment on Government Bills of Lading); name and address to which payment is to be sent (which must be the same as that in the contract oron a proper notice of assignment); name (where practicable), title, phone number and mailing address of person to be notified in event of a defective invoice; and any other information or documentation required by other provisions of the contract (such as, evidence of shipment). [6] Because this definition is an improvement over the previous contract invoice instruction, contractors will not have as many difficulties determining "proper invoice" requirements, which aids the Contract Payment Activity in processing; consequently, it also improves the timeliness of contract payments.

DEFINITION FOR "RECEIPT OF INVOICE": This is based upon the later of the date a proper invoice is actually received in the designated payment office, or the date on which the agency accepts the property or service. [6] Because many contractors start their collection clock based upon the date that they prepare an invoice or ship the material, this creates confusion and has caused contract payment activities to spend much time correcting it. When this definition becomes fully understood, contract payment activities can better use this time paying invoices, thereby improving contract payment timeliness.

THE PAY WHEN DUE CONCEPT (also known as the Treasury Cash Management Policy): This means that if a contract specified a "due date" (not to be confused with discount provisions or delivery terms), payments will be made as close as possible to the due date. [2] If a due date is not specified, the due date will be the 30th day from the receipt of a proper invoice. [7] Contracts with advanced payments, progress payments and cost reimbursement payments are currently excluded from the pay whendue concept. Because this feature of the Prompt Payment Act has not yet been fully implememted, its impact on the timeliness of contract payments cannot be totally assessed; however, several segments of our contractor community have expressed major concern about the potential negative impact of this feature on their cash flow and interest costs.

The provisions of the Prompt Payment Act can, and when followed, do improve the timeliness of contract payments; however, given the contract payment process that is currently followed and the potential delays inherent in it and accidental to it, timely contract payment cannot be insured by the Act alone. The point is that the Prompt Payment Act is not a panacea for the sometimes elongated and complicated contract payment process and occasional delays.

WHAT STRATEGY SHOULD BE FOLLOWED TO INSURE TIMELY CONTRACT PAYMENT?

Before this question can be answered, two of the primary root causes of delays in contract payments must be examined; they are: (1) government and industry's mutual understanding of the contract payment process and (2) government and industry's perception of their relationship.

In trying to understand the Prompt Payment Act, for example, and all the follow-on guidance from various echelons of government, it is recognized that government personnel have an advantage in receiving and understanding this information over many of their industry counterparts. It is also recognized that many small business contractors do not have staffs to track new laws, like the Prompt Payment Act. This is just part of the problem in achieving a mutual understanding between government and industry. Basically, there are other parts to this problem.

First, the contract payment process with various clauses is very complex, and it is not necessarily standard for all Department of Defense contract payment offices. Furthermore, the variety of government terminology/jargon further confuses and frustrates the mutual understanding of the contract payment process.

Second, there are literally thousands of "players" dealing with some contract payment

offices. For example, there are nearly 2,500 government personnel in the DCASR, Los Angeles Region, 4,500 different contractors and hundreds of other government buying activities, material acceptance activities and DCAA activities, participating in the contract payment process.

The third and final part of this problem is the communication limitations that exist among all the "players" in the contract payment process. To illustrate these communication limitations, consider the following scenario: Picture a series of gears, very large to very small, which represent various levels of government from top to bottom. Turn the very big top gear and the very little gear at the bottom really spins--that represents perfect communication! By taking some teeth out of various gears, reality can be demonstrated in the communication process--that is, different people tend to interpret information in different ways. Now turn the very big top gear, and there is less movement, if any at all, by the lower level gears. The point is that the more links in any communication "chain" less chance there is for pure communication.

Add all of these factors (contract payment process complexities, thousands of participants and communication limitations) plus a measure of turnover among the information and participants in the contract payment process and the result is generally a very big and continuous learning curve.

The other root cause of delays in the contract payment process is government and industry perception of their relationship. Figure 3 i a perception problem, which many people have difficulty understanding. The reason for their difficulty is that they were taught to read black on white, and the images make no sense to them. If they change their perception to white on black, they can see the word "FLY" on Figure 3. Similarly, how government and industry perceive each other affects their understanding and can inhibit their ability to learn from one another. If government and industry perceive each other as adversaries, there is obviously a lack of trust.

PERCEPTION PROBLEM

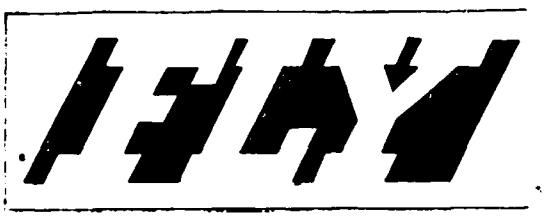

Figure 3

The gaming theory explains the four basic positions that can exist between government and industry (Figure 4). Three of these positions are adversarial, and one of these positions represents common failure, that is, lose-lose; This is the case where a mutual lack of understanding and trust destroy both government and industry. Obviously, the best position is win-win, which can be attained with mutual trust and understanding. This is the strategy that should be followed to insure timely contract payment.

GAMING THEORY

POSITIONS:
1. WIN/WIN - BEST
2. WIN/LOSE - ADVERSARIAL
3. LOSE/WIN - ADVERSARIAL
4. LOSE/LOSE - ADVERSARIAL

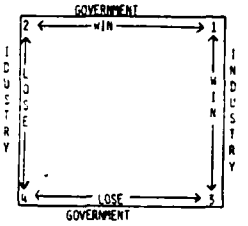

Figure 4

WHAT SHOULD THIS STRATEGY INCLUDE?

The win-win strategy should be directed at the root causes (i.e., lack of mutual understanding and trust) of delays in contract payments. This strategy should include both short-term and long-term actions. The following are only a few examples of what can be, using the win-win strategy.

The short-term actions that can be taken to insure timely contract payment are: First, understand the delays inherent in contract clauses, funding, acceptance/approvals, document distributions and various payment office priorities before the contract is accepted and/or signed; once the contract is signed, changes to terms and conditions may either be impossible or contribute to additional contract payment delays. To help contractors understand these matters and thus gain their trust, Contract Administration and Invoice Payment Seminars are held annually at each Defense Contract Administration Services Management Area (DCASMA) within the DCASR, Los Angeles Region. Second, set-up a quality control check to eliminate clerical errors over all contract payment documents before they are mailed to a contract payment activity. DCASR, Los Angeles provides its contractors a handy check list, which facilitates this quality control process. Third, take advantage of any check pick-up service offered by the contract payment activity. At DCASR, Los Angeles, this check pick-up service is provided through the bank messengers, who pick up checks daily for their customers. Finally, if problems do develop, know who to call for help within the contract payment activity. At least once a

year, DCASR, Los Angeles publishes a letter for all of its contractors, informing them of their chain-of-command.

The long-term actions that should be taken to insure timely contract payment may not happen in one year, in the present administration or in this decade, but this should not delay the quest. The direction that these actions should take are: standardization, simplification and education. One procurement regulation called the Federal Acquisition Regulation is definitely a step in the direction of standardization; another step is the effort to have one basic contract format, which will help everyone find contract data easier and faster--and hopefully with less error. Some of the projects under "Reform 88" hold great promise to simplify government [8]; other efforts to "sunset review" government regulation and related paperwork can reduce, if not simplify, the burden of "red tape". Finally, there is a need for more mutual education programs, where both government and industry can share creative ideas; this is an area where academe and professional associations (e.g., NCMA, AICPA, ASMC and Small Business Councils) can provide a great service by bringing government and industry together in a common cause--achieving win-win!

CONCLUSION

In closing, the senior DoD official that was referenced in the introduction was the former Deputy Secretary of Defense, Frank C. Carlucci who stated that a strong national defense depends upon a strong industrial base. He also stated in his initiative number one, Management Principles, that the proper "arms-length" buyer-seller relationship should not be interrupted by government or industry as adversarial.[1] In applying this to timely contract payments, government and industry have a shared responsibility to follow win-win strategies, which will allow them to achieve together what they cannot achieve apart--a *strong national defense*!

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[1] Deputy Secretary of Defense, Memorandum for Secretaries of the Departments, subject: "Improving the Acquisition Process", April 30, 1981.

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[3] Defense Logistics Agency Manual, Chapter 5 "Contract Administration Services Accounting Procedures", April 1980.

[4] Army Financial Management Newsletter, All Points Bulletin, High-Lights on the Prompt Payment Act, August 1982.

[5] Prompt Payment Act, Public Law 97-177, May 21, 1982.

[6] Defense Acquisition Regulation, 7-103.30 "Invoices", October 1982.

[7] Defense Logistics Agency letter, subject: "Advance Copy of Change" on Prompt Payment and Cash Management, December 20, 1982.

[8] Government Executive, "Reform 88" - Progress to Date, June 1983.

CONTRACTING STRATEGY

Panel Moderator: Rear Admiral Joseph S. Sansone
Deputy Chief of Naval Material for
Contracts and Business Management
Headquarters Naval Material Command

Papers:

The Make or Buy Decision--Its Nature and Impact
by John G. Beverly, Frank J. Bonello, James M. Daschbach, and William I. Davisson

Multi-Year Procurement A "Team Approach"
by Harvey S. Fromer and John L. Sweeney

Cost Risk and Contract Type: A Normative Model
by Richard L. Murphy

Contracting Initiative: Best Proposal for Price
by Barbara Rose

ADP002779

THE MAKE OR BUY DECISION--ITS NATURE AND IMPACT*

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University of Notre Dame

There is no contractor at this time, in this Nation who can fabricate all the components needed for a major weapons system and deliver it in the time required and within cost limits. Therefore, the prime contractor must subcontract out certain of the components and parts needed for the system assembly. How do contractors make this division regarding the components and parts to be made versus those to be bought? This paper reviews the background for this area providing the theory and the practices as found during a recent study for the Air Force Business Research Management Center.

Essentially, the basis for the make-buy decision is the same today as the appropriate textbooks of a quarter century ago suggest (i.e., a cost orientation). However, a delineation of the many modern day pressures on the make-buy committee indicates a surprising consensus, by the contractors' perceptions of the system, for making or buying products and components. Though the United States Air Force personnel contacted see the function somewhat differently, the basic pressures on the contractor committee are built on a cost concern. Further aspects, however, include the survival of the contractor, its skill level, its reputation, satisfaction of the customer (i.e., in this case the Federal Government and the Air Force), past experiences with a component similar to the one in question, and other significant areas of cost impact. The remainder of this paper expands on the nature of the make-buy decision as seen principally by the contractors.

Textbooks of yesteryear (1, 2) suggest that the make-buy arena is a means primarily to assure the lowest level of manufacturing costs of a product. Alternative suppliers are typically a concern of the production control function in that a second source for parts and components of a product provide good cost analysis for one's own manufacturing system. Thus, if the product cost is subcontracted out to the level of about fifty percent of the dollar, the subcontractors will provide off-the-shelf items which the "prime" contractor does not wish to make. The dual sourcing part of the fifty percent will provide a good basis for study of the local manufacturing effort from the cost perspective.

Based on this sketch of the textbook approach, a simple set of interviews of a representative sample of the prime and subcontractors for the United States Air Force was set up during the spring and summer months of 1983. The contract by which this perspective of the make-buy analysis arose centered on the development of the availability of subcontractor information in commercially available databases (e.g., the Dun & Bradstreet and Standard and Poor's databases). Each database reviewed covers specific aspects of certain corporations. The efforts involved in the database availability analysis showed that the make-buy decision has a significant impact on contractor relationships. The nature of this decision then becomes an important aspect of the relationships between the Department of Defense and any one of the prime or subcontractors. The relationships between the prime and subcontractor provides an additional complication as the entire system of subcontractor selection is of interest to the Government program of weapons system acquisition.

As these relationships become responsive to further scrutiny and possible regulation based on the need of the customer to better control the costs, the nature of the make-buy analysis by the contractor is of interest to the DOD.

There appears to be a surprising consensus of opinion on the part of the major contractors and subcontractors as they perceive the make-buy decision. The traditional use of a committee make-up of skills from Production Control, Quality Control, and other manufacturing and purchasing functions still forms the basis for the committee. In addition, however, the Chairman of the Committee is typically a highly placed staff member or Vice President for Operations or Production. Thus the whole area has been raised to a greater level of management attention than has been traditionally the case. The reason is, of course, that manufacturing costs have become inordinately high, the risks of failure great, the concerns of the company greater in subcontracting products of high technical content, and the penalties for not producing the right product on time have been increasing as the Federal Government concern becomes more focused.

What then are the forces that focus management concern on the portion of production that

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subcontracts selected parts and components? The basic philosophy of the contracting group has a dual focus: the ever-present need to keep facilities and skills owned and operated by the contractor busy and productive plus the need for effective and economic equipment during its life cycle by the Air Force. These are the two main focuses of the decision environment. Complementing these are the detail issues.

A company that has been known for and made its reputation on the operation of a given product will not subcontract that component out for others to make. Thus considering a component in the avionics or engine area where the prime or sub-prime has won a contract, the basis of the company's policies will be to manufacture what it knows best and on which it has built its past history. In this area the make-buy decision seems appropriately isolated. If, however, the facilities and skilled personnel are a force, either negatively or positively, this policy may be modified. For example, one contractor has a policy that the facilities will be concentrated on the prototype and development stages of a system rather than the production phase. In this manner the entire product will be the responsibility of the contractor and all the problems encountered in the engineering phases will be solved before sending the product out to others on a production quantity contract. Control of the design and the quality are maintained but the high level of capital needed will be spread among subcontractors. The counter view of this is, of course, that the company wishes to have on the basis of inherited or already available facilities and skills the responsibility for the entire prototype, development, and production phases of the system.

As the facilities are loaded with economic effort and the skills are being used at a satisfactory level, contracts that are made available during a contract period may force a desire to change the number of subcontracted dollars. The best example of this is, of course, the Lockheed Aircraft Company in its need to drop the manufacture of the commercial line of L-1011 aircraft. When that line phased out, the manufacturing of the Air Force's C-130, which had been almost totally subcontracted out for several years, was effectively brought back to the Lockheed facilities. This was, in eesence, a facilities loading decision on the basis of available space and equipment and skills that were not going to be effectively used unless an aircraft was produced at the Lockheed facilities.

Several of the companies involved in the aerospace manufacturing functions face a substantial pressure to make foreign offsets a significant aspect of the contract dollar. This program can be a substantial percentage of the sales dollar or can be, in effect, no percentage at all. A company engaged in highly classified high technology and space oriented activities will probably have no interest in the foreign offsets problem where the company with a large amount of tactical systems manufacturing responsibility will have a corresponding large amount of foreign effort.

A complementary problem here is the minority and women-owned contract regulations that represent the Government's interest in the setting of policies which affect a social policy implementation for the Nation. The contractual impact regulations imposed regarding minority and women-owned subcontracting typically amounts to about ten percent of a contract. This percentage from a dollar amount perspective does not adequately represent the managerial effort needed. Again, the consensus is that the managerial need for this small percentage of the contract is high. Typically, the minority small business has not had the history of problem solving that longer experience alone has given a competitor. Thus the contractor must aid the smaller firm with engineering, production, and other managerial effort that, though given willingly, is nonetheless recognized as being a costly item.

Figure 1

KEY ELEMENTS IN THE MAKE-BUY ANALYSIS

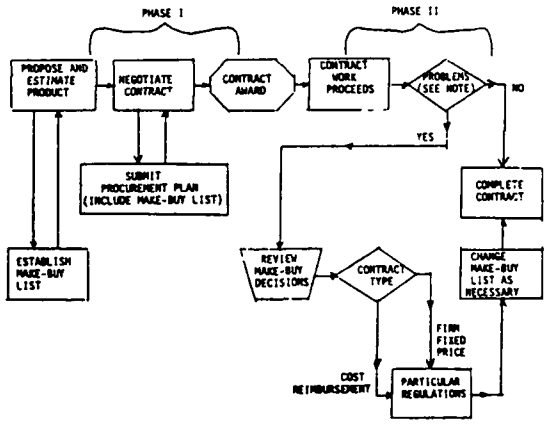

Figure 1 shows a basic block diagram of events specific to the decision. As can be seen by the diagram there are basically two phases of the make-buy function dealing with the pre-award phase of the contract and the post-award phase. The pre-award phase is oriented to the assembling of the list of components for make-buy. The Department of Defense requires a procurement plan which includes this list as a part of the negotiations. During this phase the various subcontractors will bid on the components necessary to the system. The engineering design and the fabrication capabilities for the various elements of the system are, of course, dealt with in great detail. Once the procurement

plan has been completed and the contract awarded, the necessary subcontracts are let and the work proceeds.

An interesting element enters the problem at this point keyed by the extended supply problems being encountered by the Department of Defense and its contractors. As the lead times for delivery of the product, be it raw material or component, become longer and the risk of the company in subcontracting out parts and components increases, the risk of the subcontractor being in business, being interested in the defense oriented produets business, and having the facilities and skills needed at the time in the future that they are needed all become a force to be reckoned with as an element for the make-buy committee to consider.

As the contract enters the working phase, sketched as Phase II in Figure 1, the problems of the subcontractors become an essential background to the make-buy list. If the component design encounters few and resolvable problems, then the list remains as negotiated. As problems are encountered during the system development and fabrication, changes to the subcontractor list may be considered. If quality problems or delivery problems are encountered, the "prime" contractor may wish to take over the product itself or transfer the contract to another division of the same or another company altogether. The thrust here is on delivery of the product at the quality level contracted for and at the price negotiated. The customer needs then become the foremost of the pressures involved.

The final result then is that the make-buy decision provides an important part of the contracting for weapons systems and a significant aspect of the contractor's relationships with each other as well as with the Department of Defense. The decision itself is normally an easy one if the pressures or forces driving the area are properly available and described for the committee to evaluate. This is the main reason why top management exposure is now typical for the contractors who are a part of this decision. At no time has the system of make-buy been challenged as a fundamental part of the system of weapons systems manufacturing. The entire area is looked upon by the contractors as a business function that at times raises problems oriented towards delivery or design problems not considered during the pre-contract stages.

The Air Force personnel and Department of Defense personnel contacted seemed to view this make-buy area as one that requires further control measures to be regulated by the Department of Defense but there is very little hard evidence that proves or disproves this need for regulatory control.

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ADP002780

MULTI-YEAR PROCUREMENT A "TEAM APPROACH"

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John L. Sweeney, Naval Air Systems Command

ABSTRACT

Although the multi-year concept has been on the scene for many years, the associated regulations (e.g., DAR 1-322) had severly limited its application to major acquisition programs. The prominence of Multi-Year Procurement in the Department of Defense Acquisition Improvement Program of 1981 (Initiative #3), coupled with the alterations included in the fiscal 1982 Defense Authorization Act, signaled a serious attempt by the government to make Multi-Year Procurement a viable acquisition strategy for major defense procurements.

The specific example of the Navy C-2A Aircraft Reprocurement demonstrates that the successful application of multi-year to major systems acquisitions requires a team effort by government, the prime contractor and his subcontractors. Since Multi-Year Procurement essentially represents an investment decision on the part of the government, it became apparent that the relative "goodness" of the multi-year proposition, would be founded on the most judicious application of the "expanded advance procurement" funding made available to the prime contractor by the government and by the development of additional sources of savings such as: capital equipment investments to improve producibility, risk assumption by the prime contractor, risk assumption by the subcontractors, make/buy decisions and increased competition.

In the case of the Reprocured C-2A, the aggressive application of the above policies has increased the initial program savings estimates by a factor of over 50% (program savings of $58M have grown to $89M). Multi-Year Procurement, the 1980's version, is providing all the benefits of a bigger bang for the defense dollar while improving the defense industrial base, filling idle capacity and putting people back to work.

INTRODUCTION

This paper will provide insight into the lessons learned during the conduct of the first two years of the Reprocured C-2A Program, the Navy's first major multi-year aircraft acquisition. The "team attitude" which developed between all the players: Congress, OSD, Navy, Grumman and Grumman's suppliers will be emphasized. Data will be presented which will demonstrate the value of Multi-Year Procurement in today's economy. A classical mathematical approach will be offered, for use by multi-year planners when considering alternatives leading to the optimization of a given multi-year program. In addition, specific C-2A data will be provided to show the actual results when the optimization techniques are aggressively applied and when the subcontractor organizations are fully informed and motivated to participate in a multi-year program that is beneficial to all participants.

Inherent in this paper is the assumption that a program cannot be designated a multi-year candidate unless it fully conforms to the "footprint" stipulated in Public Law 97-86. These criteria are fundamental to the basic concept of Multi-Year Procurement and include:

- That the minimum need will remain in effect during the course of the contract.

- That there is a reasonable expectation that DOD will continue to sequentially fund the program.

- That the program will promote the national security while reducing total cost.

- That the cost estimates are realistic (annual and multi-year).

- That there is a stable design.

The final item, design stability, is probably the most difficult to judge and the one most likely to create havoc with a multi-year plan. It shall be assumed for the context of this paper that some very rigorous configuration control rules have been agreed upon, between the government and the prime contractor, and that an "environment for no change" has been created on the program. This can be accomplished by:

- Preparing an extremely detailed analysis of the requirement before the design specification is finalized with the government and translating that detail into the subcontractor specifications.

- Staying away from items of an R&D nature. (Utilize field proven off-the-shelf hardware and software.)

- Avoiding complex packaging techniques that require latest state of the art semiconductors or that require special cooling techniques.

- Eliminating items that require RDT&E and steering clear of concurrency.

- Avoiding technologies that become obsolete quickly.

Having carefully selected our multi-year candidates to the aforementioned criteria, we are now ready to discuss the techniques that can be utilized to optimize and enchance a multi-year from the standpoint of an investment decision.

THE NEW SYNERGISM IN DEFENSE ACQUISITION

Achievement of the goals of the DOD Acquisition Improvement Program requires a coordinated effort by DOD, the Congress and industry. Perhaps the best example of the new synergism fostered by these initiatives is represented in the application of the multi-year concept to major defense acquisitions. The Congress led the way by encouraging the judicious use of multi-year acquisition and by clearing the legal roadblocks to its implimentation; specifically by allowing for an expanded advanced procurement cancellation ceiling ($100M vice $5M without Congressional approval), and by permitting the use of unfunded ceilings for recurring costs as well as nonrecurring costs. Contracting authorities have moved to bring contracts into conformance with the new laws by:

(a) Eliminating the mandatory level pricing requirements stipulated in DAR 1-322.

(b) Providing provisions for expeditious progress payments when contractors demonstrate that multi-year advanced procurement creates additional inventory carrying costs.

(c) Allowing indemnification (cancellation ceiling coverage) for capital equipment investments that generate savings to the government, in accordance with DAR 3-815, along with added profit potential for contractors and subcontractors that take risks to develop savings through improved productivity.

Industry has replied in kind with a willingness to invest in some badly needed capital equipment improvements, to spend the nonrecurring to develop the required rate tooling, and to absorb some of the termination liability necessary to make Multi-Year Procurement attractive from a cost savings/up-front investment standpoint.

THE MULTI-YEAR GAME PLAN

The "bedrock" of all multi-year efforts are the scenarios picked early in the game for the procurement of material and equipment (subcontractors) and for the manufacture of parts and sub-assemblies within the prime contractor's facilities. These two scenarios determine the eventual success of the multi-year. Therefore, extra time and effort should be expended performing a full and complete analysis prior to firming up the final scenarios. A typical procurement scenario for an aircraft program is presented in Figure 1. Key factors that must be evaluated in determining the final scenario are: design stability of each subsystem (note that the power supply and weapons delivery systems are not aggressively multi-year procured in our sample because they have a history of configuration instability), subcontractor capacity (note that the APU and engines are not being aggressively multi-yeared in our example because the supplier has reached his plant limits for all the engines he delivers), shelf life of the equipment, storage availability and the amount of up front termination liability required to advance procure the material. Given the complexity of the equipment and the multiplicity of the factors involved, determining an optimum procurement scenario will require a series of iterations and an extensive amount of information exchange with the suppliers. However, it should be noted at this point that substantial flexibility exists at the prime contractor level to select the components to be aggressively multi-yeared so that the Congressional footprint for multi-year candidates is not violated and the risk of change is greatly reduced.

TYPICAL MULTI-YEAR SUBCONTRACTOR PROCUREMENT SCENARIO FOR AN AIRCRAFT PROGRAM

ITEM	QUANTITIES					TOTAL SHIP SETS	% OF TOTAL COST
	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5		
RAW MATL	480	-	-	-	-	480	3
CASTINGS	240	240	-	-	-	480	5
FORGINGS	240	240	-	-	-	480	4
ELECTRICAL	360	120	-	-	-	480	3
HYDRAULICS	240	240	-	-	-	480	6
ANTENNAS & WAVEGUIDES	480	-	-	-	-	480	4
ENVIRONMENTAL SYSTEM	240	120	120	-	-	480	7
FUEL SYSTEM	120	120	120	120	-	480	3
LANDING GEAR	200	140	140	-	-	480	10
INSTRUMENTS	240	240	-	-	-	480	2
MACHINED PARTS	120	120	120	120	-	480	10
COMM SYSTEM	480	-	-	-	-	480	2
NAV SYSTEM	480	-	-	-	-	480	2
WEAPONS DELIVERY	96	96	96	96	96	480	15
POWER SUPPLY	96	96	96	96	96	480	3
FLIGHT CONTROLS	480	-	-	-	-	480	2
SEATS	480	-	-	-	-	480	1
CANOPYS	480	-	-	-	-	480	2
APU & ENGINES	120	120	120	120	-	480	20
							100

Figure 1

Step II of the scenario generation process is the selection of a manufacturing plan that is achievable, fits well with the rest of the work being performed within the shop and provides the savings desired. Figure 2 represents a typical example of a multi-year manufacturing scenario for an aircraft program. Key factors that determine the individual elements of this scenario are: nonrecurring required to achieve the increased rates, manpower loading in the shop, machine capacity, storage life, storage availability and the amount of up front cash flow required to support the advance manufacture of equipment. Most multi-year practitioners have found it advantageous to schedule their multi-year build cycles around the other efforts within the shop, thereby, increasing the efficiency of the entire shop, while maintaining employment levels, thus improving the profit achieved across the board. The flex-

ibility of the multi-year advance manufacturing plan clearly has beneficial effects on the entire shop when care is taken to schedule the multi-year release plan to "level load" the shop's efforts.

TYPICAL MULTI-YEAR MANUFACTURING SCENARIO FOR AN AIRCRAFT PROGRAM

ITEMS	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	TOTAL SHIP SETS
		QUANTITIES				
DETAIL PARTS	240	120	120	–	–	480
MINOR SUBS	205	100	100	80	–	480
MAJOR SUBS	96	96	96	96	96	480
FINAL ASSY	96	96	96	96	96	480

Figure 2

THE UP FRONT FUNDING/SAVINGS DILEMMA

Since multi-year savings are directly dependent on the number and kind of front end commitments made, it became obvious that success would be a function of the judicious application of the additional advance procurement funding provided by Congress, as well as the added "leverage" that could be generated thru the assumption of risk by contractors and sub-contractors. Contractor and sub-contractor risk assumption, known as the "stretch" factor, has become increasingly critical as a result of the DOD multi-year policy of funding to the termination liability level and the Congressional desire to limit the funding provided in the initial years of the multi-year profile. The folloiwng equations represent in mathematical form the management problem facing a multi-year planner:

(1) Multi-Year Savings ~ Up Front Economic Order Quantities

(2) Total Termination Liability (TTL) = Long Lead Termination Liability (LLTL)

↑ (to protect schedule)

+ Economic Ordering Quantity Termination Liability (EOQTL)

↑ (to generate savings)

(3) Savings Leverage = Expanded Advanced Procurement Funding Provided by the Government

"Stretch Factor" { + Contractor absorbed EOQ T.L. + Sub-Contractor absorbed EOQ T.L.

Creative application of the limited amount of government provided funding as well as a program to encourage self commitments within industry is the foundation of the challenge in optimizing a given multi-year program. In planning and implementing the Reprocured C-2A, Grumman and the Navy have recognized the importance of these factors by designating termination liability as the "perishable commodity" and competing all sub-contractors against each other for the privilege of receiving an aggressive multi-year sub-contract. Once again, a formula was developed to assure maximization of savings utilizing the limited budget. As shown below, each sub-contractor's multi-year proposal was measured from the standpoint of savings offered (the good news) and the additional termination liability (the bad news) needed in the initial fiscal years.

$$\text{Figure of Merit} = fm = \frac{\Delta \text{ Savings}}{\Delta \text{ Termination Liability}}$$

Those sub-contractors responding with proposals where extra savings were derived as a result of capital equipment investments or as a result of absorption of risk were rewarded with more aggressive multi-year sub-contracts (additional profit collection in the early years) and an increase in profit percentage. An interesting example of the results generated by this type of an effort is shown in Figure 3. Note that the supplier has provided a proposal that offers almost $1M in savings (25%) but has actually reduced his request for termination liability and cash flow in the first year of the contract.

MULTI-YEAR VS ANNUAL BUY TYPICAL ENGINE ASSEMBLY

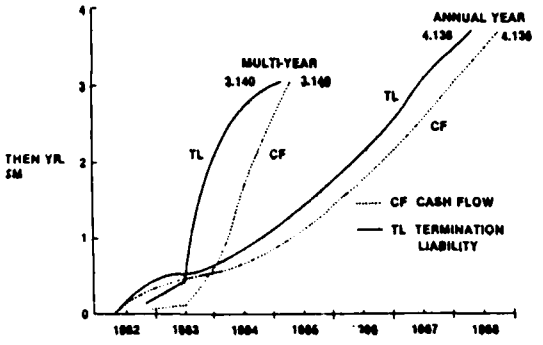

Figure 3

Since we know that he is pursuing an aggressive multi-year policy, we have to assume that his actual multi-year bills and commitments will far exceed the annual year quantities in that

time period. However, he has decided to absorb some of the risk in the early stages in return for a shortened period of performance (3 years versus 6) and additional profit recognition in his fixed price contract. This supplier's Figure of Merit would, obviously, place him high on the list for receiving the most aggressive multi-year contract possible.

SAVINGS CREDIBILITY AND THE INVESTMENT ANALYSIS

Incumbent in the preparation of any multi-year proposal is the development of a cost estimate based on the standard annual year approach. Since a contract will be signed for the multi-year value, the credibility of the savings will be specifically dependent on the veracity of the annual year number. Therefore, it is extremely important that a procedure be developed for calculating and verifying the annual year estimate. To successfully accomplish this on the C-2A Program, it was agreed at an early date to require two fully auditable cost proposals. A single year firm proposal on an annual year basis plus an estimate for four additional years on a budgetary basis made up the five year annual estimate. This was compared with the five year multi-year proposal to determine savings., Figure 4 represents the logic process flow utilized to develop savings credibility for the C-2A. Note that, although the annual year contract was not negotiated, a negotiation decrement similar to the multi-year negotiation result was taken. Another key factor was the selection of an escalation index that would best represent the average inflation rate over the extended period of performance.

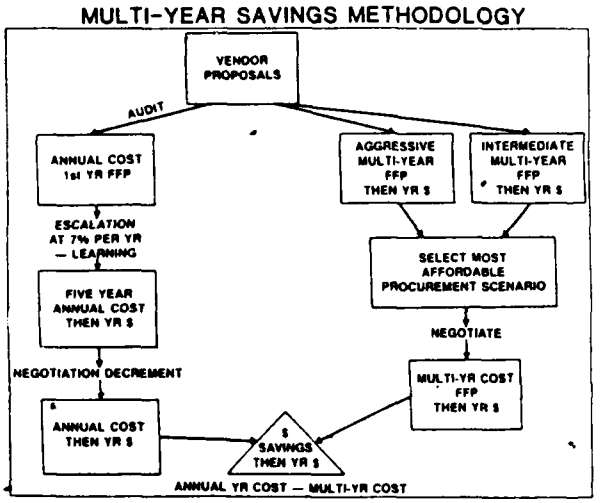

Figure 4

For the C-2A example, Grumman and the Navy selected 7% as a reasonably conservative guess. Savings were then calculated on a then year dollar basis with the percentage saved being determined by ratioing the dollar savings to the annual year contract value.

Since the basis of the Congressional and DOD action was to obtain increasing numbers of defense products for less money by investing more money up front, a requirement was generated to justify each multi-year on the basis of a "real value of money" financial analysis. To accomplish this, the government turned to the Discounted Cash Flow techniques developed by the academic community. This technique was evolved to provide a means for business people to make investment judgements during periods of high inflation and high interest rates. In the business world this analysis approach provides comparative assessments for varying propositions by measuring the investment costs (including loss of opportunity) against the time value of the profits they generate. By discounting the values of the cash flows back to the initial date, monetary values can be added and subtracted arithmetically and a resultant Net Present Value can be determined. For a multi-year analysis, the outlays for each fiscal year would be determined for the annual and multi-year programs, subtracted on yearly basis, and the resultant cash flows discounted to year one and added to determine the net present value. In all cases, multi-year will cause increased outlays up front and decreased outlays in the latter years. Thus, the determining factors in the relative "goodness" of the multi-year will be the limiting of additional expenditures early in the game, while at the same time generating the maximum savings at the earliest point in the program. Inherent in this analysis is the necessity to select a discount rate (expected average interest rate). At the present time, OMB and DOD guidance requires that a discount rate of 10% be employed when calculating the net present value. Obviously, the higher the net present value the more likely the multi-year program will be approved by the government.

INITIAL RESULTS FOR THE REPROCURED C-2A

In October of 1981, Grumman Aerospace submitted its initial Multi-Year Proposal to the Navy for 39 Reprocured C-2As to be delivered over a five year period. Multi-Year savings, at that point, were estimated at $58M or just under 8% of the total contract cost. This estimate was founded solely on budgetary proposals submitted from the major suppliers. On December 3, 1981, Grumman and the Navy held a multi-year get acquainted session for approximately 50 sub-contractors, representing

85% of the procurement cost for the C-2A. In this session, the multi-year concept was presented from the standpoint of the benefits that would be accrued to each sub-contractor and incentives were offered to those that were willing to aggressively participate. Everyone was told that they were competing against each other for the limited amount of available termination liability and that the suppliers desiring additional profit and shorter performance periods would have to improve their proposals to create an attractive Figure of Merit (fm). The response was dramatic and fortuitous, as can be seen in Figure 5. Multi-Year savings continued to grow and reached $89M (11.6% of contract cost) at the time of the formal contract signing between Grumman and the Navy. The suspected causes for the increase are also listed in Figure 5 and those which have not yet been discussed merit some attention.

REPROCURED C-2A MULTI-YEAR SAVINGS ESTIMATE, HISTOGRAM

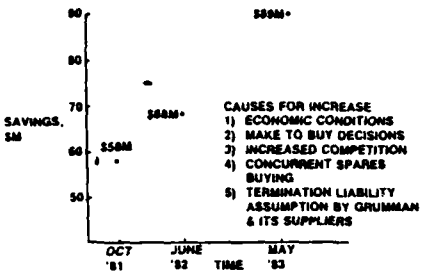

Figure 5

The economic environment in the United States during the period of time depicted was recessionary, thereby leading to a situation where most manufacturing facilities were substantially under capacity with a work force that was under-utilized. Thus, multi-year offerings were seen as an opportunity to fill idle capacity, improve the efficiency of the workforce and provide the business base needed to upgrade the capital equipment. Once the education process had been completed, many suppliers saw multi-year as the opportunity of a lifetime and were willing to take on risks or bid at lower profit levels, safe in the knowledge that additional profits would be generated on other efforts as a result of the manufacturing efficiencies created by the flexibility of the multi-year work. This situation was further enhanced by the concurrent ordering of the initial spares increment with the aircraft orders. Increased quantities were generated, resulting in a 25% savings on the spares buy and additional reductions on the unit cost of the aircraft buy. In combination, the cooperative effort by Grumman and the Navy, produced a subcontractor response that far exceeded all expectations. The data shown in Figure 6 represents the subcontractor results to date and indicates a 10% improvement over the initial 20% savings prediction. Included within these subcontractor figures are a number of assemblies which were originally designated as in-house make items. However, the increased quantities engendered by the aggressive multi-year aspect of the program fostered a revisitation of the make-buy profile and resulted in a number of items being redesignated to the "buy" category due to limitations in capacity. This action resulted in additional competitions and further reduced the unit cost of each C-2A aircraft.

MULTI-YEAR SAVINGS — C-2A DATA FIRM CONTRACTS IN FORCE

	ANNUAL YR	MULTI-YEAR	SAVINGS $M	SAVINGS %
ELECTRO-MECHANICAL SYSTEMS	$17.8M	$12.1M	$5.7M	32
MECHANICAL SYSTEMS	$53.2M	$38.8M	$14.4M	27
ELECTRONICS	$12.6M	$7.7M	$4.9M	39
TOTALS	$83.6M	$58.6	$25.0M	30

Figure 6

CONCLUSIONS/SUMMARY

Teamwork, as demonstrated by Congressional actions to alter the laws, DOD's management and policy initiatives, the services requirements and funding planning and contractors and subcontractors producivity and risk assumption efforts has yielded better than expected results in the application of the Multi-Year Procurement Initiative. Government, while recognizing that multi-year does not fit all programs, is realizing better than projected savings on the programs that have been selected for multi-year. Industry has found that an aggressive multi-year approach can stabilize employment, aid in their modernization programs and increase the efficiency of their existing operations. Everyone has found that the rewards have far exceeded the risks and it remains for Congress to determine whether it can overcome its penchant for year to year adjustments and take a long term view of defense procurement so that the scope of the multi-year application can grow beyond its present foothold. Meanwhile, Multi-Year Procurement, the 1980's version, is providing all the expected benefits by driving unit costs down, while improving our defense industrial base and putting people back to work, truly an initiative for our times.

COST RISK AND CONTRACT TYPE: A NORMATIVE MODEL

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AD P010 274

ABSTRACT

This article presents a model which describes the relationships among the cost risk inherent in a particular procurement situation, the degree to which that cost risk is shared between the government and the contractor, and the risk premium awarded to the contractor for assuming his share of the cost risk. The model is normative in that it provides a framework for analyzing the possible combinations of risk assumption on the part of the government and risk premiums which are logically consistent. The model requires that the price analyst estimate the cost of contract performance, the general shape of the distribution of probable costs, and the standard deviation of that distribution. In addition, a policy decision is required concerning what constitutes a reasonable probability that the contractor would incur a loss.

INTRODUCTION

Section 3-806.6(b)(5) of the Defense Acquisition Regulation (DAR) states in part that, "Contractors are likely to assume greater cost risk only if contracting officers objectively analyze the risk incident to proposed contracts and are willing to compensate contractors for it."[2] The "compensation" is in the form of a profit factor assigned as part of the weighted guidelines analysis of profit. This profit factor, which I will refer to as a risk premium, is based primarily on the type of contract selected. The DAR lists suggested ranges for the assignment of risk premiums based on contract type and category of procurement. Any additional guidance regarding how the contracting officer is to "objectively analyze the risk incident to proposed contracts" is both circular and ambiguous.

Section 3-808.6(b)(1) of the DAR states, "Evaluation of risk requires a determination of (i) the degree of cost responsibility the contractor assumes, (ii) the reliability of the cost estimates in relation to the task assumed, and (iii) the complexity of the task assumed by the contractor."[2] DAR section 3-806.6(b)(2) further states, "The first and basic determination of the degree of cost responsibility assumed by the contractor is related to the sharing of total risk of contract cost by the Government and the contractor through the selection of contract type."[2] Section 3-806.6(b)(3) states, "The second determination is that of the reliability of the cost estimates."[2]

When we look at what the DAR has to say about selecting the type of contract, we find the following. DAR Section 3-401(a)(1) states, "The specific type of contract should be determined by the degree of risk in contract performance. When risk is minimal or can be predicted with an acceptable degree of certainty, a firm-fixed-price contract is preferred. However, as the uncertainties become more significant, other fixed price or cost-type contracts should be employed to accommodate these uncertainties and to avoid placing too great a cost risk on the contractor."[2]

What does the DAR have to say about the negotiation of contract type? Section 3-402(a)(2) of the DAR states, "As a minimum, the uncertainties involved in performing at the cost estimate, and their possible impact on costs, must be identified and evaluated so that a pricing arrangement can be negotiated which imposes a reasonable degree of cost responsibility upon the contractor."[2] DAR Section 3-402.2(b) states in part, "The firm fixed-price contract is suitable for use in procurements when reasonably definite design or performance specifications are available and whenever fair and reasonable prices can be established at the outset,.."[2] Section 3-404.4(b)(1) states in part, "Fixed-price incentive contracts are appropriate when use of the firm-fixed-price contract is inappropriate,....."[2] Section 3-405.1(b) states, "The cost-reimbursement type of contract is suitable for use only when the uncertainties involved in contract performance are of such magnitude that cost of performance cannot be estimated with sufficient reasonableness to permit use of any type of fixed-price contract."[2]

Given the above guidance, no one should expect the contracting officer to "objectively analyze the risk." The guidance offered talks completely around the problem of objectively analyzing the relationship between contract type and the risk premium in a given procurement situation. The guidance is so nebuleous that it offers no standard by which to judge the reasonableness of the the decisions made by the contracting officer.

There is a three way interaction among cost risk, contract type, and the risk premium. The determination of contract type and the risk premium must be made simultaneously based on an analysis of cost risk. What I am proposing is a simple model that is both logical and practical to analyze the relationships among those factors which determine the appropriate combination of contract type and risk premium.

THE BASIC MODEL

Cost risk is a function of the probability distribution of possible cost outcomes. This distribution is a direct reflection of the ability of analysts for both the contractor and the government to accurately predict cost. There are many sources of uncertainty which impact on our ability to develop accurate cost estimates, and these uncertainties will certainly exert an influence over our determination of the general shape of the distribution. However, the function of the risk premium is to only compensate the contractor for assuming cost risk. Therefore, other sources of risk are not at issue here.

Let us define the following variables:

C_a = actual cost of performance

C_p = contract price

P_1 = probability that the actual cost of performance will exceed the contract price

We can now define what we mean by a "reasonable" assumption of cost risk. The selection of a value for P_1 is a policy question, and the answer will reflect the policy maker's perception of what is reasonable. Once a value for P_1 has been selected, the contract price should be set such that:

$$P[\, C_a > C_p \,] = P_1$$

If the contract price is set too low, the contractor will be faced with a higher probability of incurring a loss than is reasonable from the policy maker's perspective. If the contract price is set too high, the government will have unnecessarily paid money to reduce the probability of incurring a loss below what is reasonable.

The actual cost of performance should include not only the dollar cost of the resources used, but also the opportunity costs associated with investing resources to supply goods and services to the government. These opportunity costs are particularly relevant when the goods and services are being supplied to satisfy unique government requirements. I would define the actual cost of performance as follows:

$$C_a = \sum_j \sum_k R_{jk} (1 + i + l_j)^k$$

R_{jk} is the cost of resource j employed in time period k. If the contractor must invest in n different categories of resources to meet contract requirements, R_{jk} would be summed over j = 1 to n. If the time required to meet contract requirements is t periods, R_{jk} would be summed over k = 1 to t. R_j is the total amount of resource j required over the life of the contract, where

$$R_j = \sum_k R_{jk}$$

and R_k is the total amount of resources required in time period k, where

$$R_k = \sum_j R_{jk}$$

It is interesting to note that if you omit the the time variable from the equation, then

$$C_a = \sum_j R_j (i + l_j)$$

This is analogous to the procedure for assigning weights to individual cost elements under a weighted-guidelines analysis of profit, where the weight assigned to each category of resources would equal $(i + l_j)$.

$(i + l_j)^k$ represents the opportunity cost of diverting resources from other alternative uses in order to satisfy government requirements.

"i" is the current rate of return available on an investment that is both risk free and easily converted back into cash. A common standard used to measure i is the rate of return on a 30-day U.S. Treasury bill. Furthermore, it is obvious that if an investor has a choice between two investments which are both risk free and both offer the same rate of return, but one of which offers a greated degree of liquidity, he would chose the more liquid investment. The ability to quickly convert the market value of an investment back into cash has value, and any investor would expect to receive a return in excess of the risk free rate if the investment results in a loss of liquidity. A contractor who invests in resources for the purpose of satisfying government requirements suffers a loss of liquidity. Once he has made the commitment to this particular market, he no longer has the option to easily convert his investment into alternative uses. Therefore, he deserves compensation for this loss in the form of a liquidity premium. This liquidity premium is represented in the above equation by the variable l_j.

There are two factors which determine the liquidity of an investment in a resource. First, the contractor must have access to a market which would be willing to accept the resources at a reasonable price should the contractor decided to dispose of them. The ability to dispose of materials without suffering a major lose is also critical. If the market is willing to reabsorb resources, but only at a reduced price, the suppliers liquidity is still adversly affected. Second, if the disposal of the resources would have an adverse economic impact, there must be alternative uses available toward which the resources can be easily directed without incurring significant additional costs. The presence of either one of these factors can be measured on a continuum. If either one of these two factors are present, the liquidity premium associated with

that resource would be low. If neither one of the factors are present, the liquidity premium associated with that resource would be high. For analytical purposes, resources which would earn similar liquidity premiums could be aggregated into single categories.

For example, in the case of raw materials there may exist a market in which to dispose of excess materials at a reasonable price. Furthermore, disposal of excess materials would probably have no adverse economic impact on the operations of the firm. Conversely, there may be some resources for which a ready market exists, but for which disposal is not economically feasible. For example, a contactor may have excess engineering labor. However, it may be essential that the contractor maintain an engineering capacity in order to remain competitive. Furthermore, once resources are released, they may not be easily reacquired. It takes time, energy and money to build an effective engineering team. In this case, in spite of the existance of a ready market for engineers, the engineering staff of the firm may be viewed as an investment which lacks liquidity. The actual liquidity of the engineering staff also depends on the alternatives available for their use and the expense of pursuing those alternatives. If the contractor has feasible alternative uses available, then in terms of choice, the assets take on a degree of liquidity even though they may never be actually liquidated.

The liquidity premium may operate as a two-edged sword. In the short run, a contractor may be locked into the business of satisfying government requirements. If the balance of power in a negotiation favors the government, the contractor may be forced to accept a rate of return which implies a negative liquidity premium because he has no where else to go. The absence of liquidity becomes a weapon which the government is able to use against the contractor. Unfortunately, use of this weapon transmits a signal to all potential contractors that a sacrifice of liquidity for the sake of servicing the government market will not be adequately rewarded. The expected results should be that the entrance of new contractors will be substantially curtailed, and the exit of existing contractors would be accelerated. Penalizing current contractors because of their lack of liquidity is a short term decision which operates in direct opposition to the policy of developing and maintaining a healthy defense industrial base.

The presence of a negative liquidity premium does not necessarily imply that the government is abusing its market power. When economic conditions are unfavorable, the liquidity premium may also be negative even in competitive markets. Businesses committed to serving particular markets may have to accept this condition in the short run because they do not consider the option of liquidation to be a feasible choice. When this occurs, the government may consider a negative liquidity premium to be a reflection of current market conditions and not a penalty imposed on contractors. However, even for competitive markets, the consequence of a negative liquidity premium would probably be an absence of new entries into the market.

The presence of k in our equation accounts for the time value of money. One dollar invested in resources for a period of three years certainly deserves a high overall return than one dollar invested for only one year. The fact that k is an exponent in the equation allows for the time value of money to be calculated on the basis of compounding. As we have seen, $(i + l_j)$ represents the opportunity cost of diverting resources from other alternative uses in order to satisfy government requirements. Theoretically, $(i + l_j)$ should represent the rate of return that contractors would earn on the next best alternative risk-free investment of like liquidity. Therefore, the only factor remaining to be incorporated into the model is risk.

The contract price consists of our best estimate of the actual cost of performance plus a risk premium to account for the fact that future costs are never known with certainty. We can define the estimated cost of performance as:

$$C_e = \sum_j \sum_h C_{jk}(1 + i + l_j)^k$$

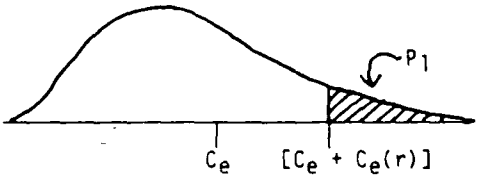
where C_{jk} is our best estimate of R_{jk}. Then the contract price becomes:

$$C_p = C_e(1 + r)$$

where r is the risk premium. We can now define the probability of incurring a loss as:

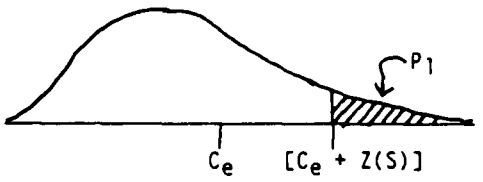
$$P[\, C_a > C_e(1 + r)] = P_l$$

As we saw, P_l represents the policy maker's evaluation of what constitutes a reasonable risk of loss for the contractor. The function of the risk premium is to move C_e to a point on the probability distribution where the probability of a loss equals P_l.



Given a distribution of probable costs, a confidence interval estimate can be writen as follows:

$$P[C_a > C_e + Z(S)] = P_1$$



where S equals the standard deviation of the distribution of probable costs, and Z is the number of standard deviations you must move to the right of C_e to generate a probability P_1 that the contractor will loose money.[1][2] The value of Z is determined by the particular shape of the distribution, the location of C_e with respect to the distribution, and the value of P_1.

By comparing the two probability statements, it is apparent that for both statements to be true, $C_e(r)$ must equal Z(S). By solving for the risk premimum, the following relationship can be derived:

$$r = Z(S)/C_e = Z(S/C_e)$$

Therefore, in order to determine the correct risk premium you must know four things: (1) the general shape of the distribution of probable costs, (2) the standard deviation of the distribution, (3) the estimated cost of performance and where that cost falls within the distribution, and (4) the value of P_1.

The equation expresses what appears to be logical relationships. All other things being held constant, as you increase the cost estimate you reduce the contractor's risk of incurring a loss, and therefore you reduce the risk premium. Likewise, with all other things being held constant, if you can increase the reliability of your cost estimate by reducing S, you reduce the required risk premium. Finally, again with all other things being held constant, if you increase the probablity of the contractor incurring a loss by decreasing Z, you reduce the required risk premium.

What this relationship also tells us is that no matter what the particular situation, there is a risk premium which adequately compensates the contractor for assuming total cost risk, provided both parties agree on the values of C_e, S, P_1, and the general shape of the probability distribution. However, it may turn out that the required risk premium is higher than some maximum which has been set by policy. In this case, there is only one legitimate possible course of action available for reducing the risk premium, and that is to increase the reliability of the cost estimate and thereby reduce S.

Two other apparent choices are to increase C_e or to increase P_1. However, these two values should be based on a consist policy regarding their determination. For example, it may be the policy that C_e should be our best estimate of the mean of the distribution. Changing the values to reduce the risk premium, therefore, would mean that each contractual arrangement would be based on a different set of criteria selected soley to create the illusion of reduced risk.

THE MODEL WITH RISK SHARING

If a more reliable cost estimate cannot be developed, there is only one other may to reduce the risk premium. The government must absorb all or part of the potential loss on the contract in order to reduce the contractor's exposure. Let G be the government's share in the loss. Then (1 - G) will be the contractor's share in the loss, and the contractor's actual cost of performance will be:

$$C_a = C_e + (1 - G)(C_a - C_e)$$

Note, if G = 0, you get the identity $C_a = C_a$. The contractor is liable for all his costs, and the government assumes no responsibility for any loss. If G = 1, $C_a = C_e$. The contractor's liability is limited to the initial cost estimate, and the government absorbs all of the loss. For values of G between 0 and 1, the government and the contractor each absorb part of the loss. G and (1 - G) correspond to the share ratios in an incentive contract. Our original definition of reasonable cost risk was:

$$P[C_a > C_e(1 + r)] = P_1$$

By substituting our definition of actual cost under a risk sharing arrangement into the above equation, the equation becomes:

$$P[C_a > C_e + C_e(r)/(1 - G)] = P_1$$

By comparing this probability statement to a confidence interval statement as before, we can derive the following relationship:

$$C_e(r)/(1 - G) = Z(S)$$

This equation can be solved in two different ways.

$$r = Z(S)(1 - G)/C_e$$

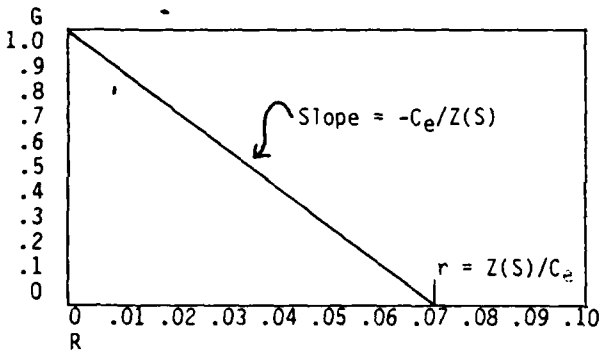
If we let G = 0, our equation for r is identical to the equation developed under the assumption that the contractor assumed all of the risk of loss. If we let G = 1, then r = 0. If the government assumes all of the cost risk, the contractor earns no risk premium. We can also solve the relationship for G.

$$G = 1 - [C_e(r)/Z(S)]$$

If we let r = 0, then G = 1. The goverment must assume all of the risk of loss. Furthermore, since G cannot be less than zero, there is an upper limit to the value of r at which it becomes reasonable for the government to assume none of the cost risk.

It is important to note that once C_e and S have been estimated and Z has been determined, the choice of risk premium and the government's share in any potential loss must be determined simultaneously. Once you select a value for r, G becomes a given, and vica versa. The issue of cost risk and risk sharing can now be approached as a problem involving the simultaneous solution of both variables.

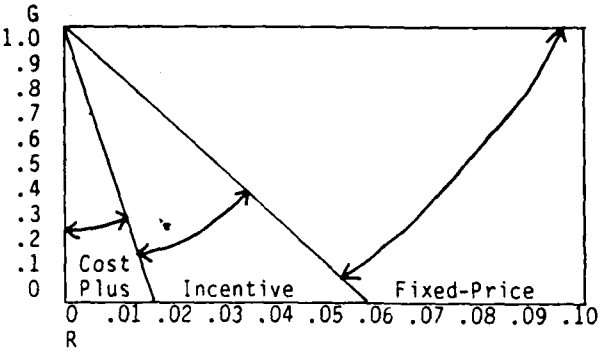
The relationship between r and G can be easily represented on a graph. Recognizing that the choice is arbitrary, let r be the independent variable and G be the dependent variable. Since $G = 1 - [C_e(r)/Z(S)]$, the equation for G would be a straight line with an intercept at G = 1 and a slope equal to $-C_e/Z(S)$. All that is needed to plot the line is two points. One obvious point is r=0 and G = 1. A second point would be to let G = 0 and $r = Z(S)/C_e$. The graph would appear as follows:



As you can see from the graph, the point r = 0 and G = 1 is always a point on the line regardless of the values of Z, S, and C_e. The government always has the option of assuming all of the risk of loss and awarding no risk premium.

When $Z(S)/C_e = 0$, G would equal 1 for all values of r. The only case where this could occur is when S = 0, which occurs only when costs can be estimated with absolute certainty. [Note, Z is determined, in part, by P_1. Z would equal zero only if $P_1 = 0$.] As the line rotates counterclockwise the potential risk of loss given that G = 0 decreases.

It would be possible to establish boundaries which delineate sectors within which certain contract types would be appropriate. Furthermore, within the range specified for incentive contracts, the graph would reveal which risk premiums are consistent with different levels of risk sharing. Within the range where the contractor assumes all risk of loss, the graph would also reveal the risk premium consistent with the cost risk inherent in that particular procurement situation.



CONCLUSION

Hopefully, what I have accomplished is to develop a framework for analyzing the relationship between the allocation of cost risk and the determination of a risk premium which are logically consistent. I realize that for the model to work, the price analyst must expand his efforts into the area of estimating probability distributions and their standard deviations. I would fully expect that many of these estimates would be completely subjective. However, that is exactly what we are now doing when we choose a particular contract type and risk premium, only the process has never been made explicit. By creating visibility for those factors which influence our choice and imposing logical relationships which must be adhered to, our decisions should began to better reflect the realities of the procurement situation with which we are dealing.

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ADP002782

CONTRACTING INITIATIVE: BEST PROPOSAL FOR PRICE

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ABSTRACT

With ever increasing emphasis being placed on Department of Defense acquisition improvements and reduction of acquisition lead time, the Air Force Systems Command, Armament Division, has developed and is testing a contracting initiative referred to as "Best Proposal for Price." This concept is intended to significantly reduce efforts by government and contractor personnel and thereby reduce acquisition lead time while maintaining the integrity of competitions that are limited by funds.

Best Proposal for Price contemplates award without negotiation, if possible. The main thrust of this acquisition concept is to identify the government's maximum contract dollar amount in the solicitation thus minimizing the negotiation processing time and yet insure technical performance.

Offering potential for improving present negotiation contracting procedures, the very nature and structure of Best Proposal for Price lends itself to some controversy. Nevertheless, Best Proposal for Price has the intrinsic momentum to be highly contributory in government contracting strategy.

INTRODUCTION

Utilizing present negotiation acquisition procedures, award of contracts is sometimes delayed because initial proposals submitted by industry exceed available government funds. This usually results in restructuring of government requirements, resubmittal of proposals by industry, and new rounds of discussions/negotiations. Application of these present procedures can prove to be costly to the government and industry alike, while greatly extending the acquisition lead time.

Many of these government efforts are designed to obtain the greatest technology advance or effort toward solving a particular technical problem but funds are limited. By providing the maximum price up-front, a more open and meaningful competitive environment is provided, gamesmanship and waste involved in soliciting and amending proposals is reduced, and contractors are enabled to concentrate their efforts on structuring initial proposals which are acceptable with little or no discussions.

Best Proposal for Price is aimed at significantly reducing nonproductive manpower expenditures and acquisition lead time while maintaining the integrity of competition and performance. The main thrust of this acquisition approach is to minimize the contract negotiation process and processing time and of key importance is thorough, realistic evaluation of technical proposals.

CONCEPT APPLICATION IN THE ACQUISITION PROCESS

Application of Best Proposal for Price is directed toward competitive development, prototype, demonstration or study efforts. It is recommended for use in research or development type efforts. The validation of the technique is presently limited to fixed price/fixed price level-of-effort type contracts. These type contracts help preclude a situation whereby contractors may be tempted to promise more than they can deliver. There is no dollar threshold for use of Best Proposal for Price.

The maximum dollar amount the government intends to obligate on the contract is stipulated in the request for proposal. If incrementally funded, the government's spend plan is set forth in the solicitation to the extent possible to guide the contractor's planned expenditures. The maximum dollar amount does not restrict submittal of proposals at a lower price.

Government requirements are stated as minimum needs and desired goals. It must be completely understood by the offeror what is absolutely needed. A pre-proposal conference should be considered, depending upon the complexity of the program, to insure complete understanding by the contractors of the government's baseline needs. To maximize performance, the successful offeror's proposal/contractor prepared statement of work is incorporated by reference into the contract. A special order of precedence provision is developed for making the contractor proposal/statement of work a part of the contract.

The criteria for award is the best proposal for the amount proposed within the stated maximum contract price. Best Proposal for Price is essentially a technical decision employing design-to-cost philosophy. Very specific technical evaluation criteria is an absolute necessity to insure receipt of complete proposals and fair and impartial evaluations. Also, some form of price or cost analysis is performed to the extent necessary to assure reasonableness of the price proposed when compared to the contractor's proposal. Audit reports generally are not needed unless a fair and

reasonable price cannot be determined by cost or price analysis at the buying activity.

Best Proposal for Price is aimed at award based on initial proposals without negotiation. The solicitation must notify all offeror's of the possibility that award is intended to be made without negotiations/discussions. However, discussions are not disregarded where such discussions are essential for complete understanding of the proposals and a meeting of the minds, which is a necessity for an equitable source selection and a valid contract. Clarifications not affecting price or competitive position are not considered discussions or negotiations, therefore Best and Final Offers (BAFOs) are not necessary. The actual contract to be used for award is included in the solicitation. Each offeror is required to sign the contract, incorporating name and dollar amount, plus any fill-in information, and submit it with the proposal. Any change to the contractual document may be unilaterally accomplished with an award sheet incorporating the contractor's letter by reference. If negotiations are deemed necessary, negotiations are conducted with all offerors within the competitive range and the normal acquisition process of requesting BAFOs prevails.

TEST DETAILS

The candidate for initial application of the Best Proposal for Price concept was an Armament Division program entitled Defense Suppression Concept Study, a state-of-the-art analysis and preliminary design effort. The stipulated contract amount was $300,500 each for an anticipated two contracts with a contemplated firm fixed price contract type. On July 29, 1982 the Research and Development (R&D) Contracts Directorate awarded parallel firm fixed price contracts for $300,500 each as a result of this initial test. Source selection was in accordance with R&D evaluation procedures (AFSCR 80-15). Acquisition lead time (acceptance of purchase request to award date) was fifty-eight days. Thirty firms were solicited, eight responded and prices ranged from $293,500 to $300,500.

The Directorate of Test and Evaluation Contracts awarded a firm fixed price contract for $197,732 utilizing Best Proposal for Price on August 20, 1982. The Forestry Operation solicitation, a resource management study effort, stipulated a contract amount of $250,000 with a contemplated firm fixed price contract type. Source selection was in accordance with R&D evaluation procedures. Acquisition lead time was fifty-one days. Twenty-one firms were solicited with five responding. Prices ranged from $197,732 to $245,538.

On May 31, 1983 the Directorate of Systems Contracts awarded three firm-fixed price contracts for $599,321, $599,998, and $599,991 using this concept. The On-Board Electronic Warfare Simulator solicitation, a preliminary design study effort with a downselect leading to prototype fabrication, stipulated a contract amount of $600,000 with a contemplated firm fixed price contract type. Source selection policy and procedures (AFR 70-15) were utilized. Acquisition lead time was one hundred twelve days. Forty-two firms were solicited with eleven proposals received and prices ranged from $581,410 to $600,000.

All contracts awarded involved no negotiations. Audits were either waived or not required. Minor clarifications were necessary with some proposals. Recommended contractor changes to the model contract were accepted where they did not affect price or requirements. Cost analysis was performed in all cases to determine if negotiations were necessary. All contracts were awarded to sources ranked the highest technically.

LESSONS LEARNED

Due to Best Proposal for Price being essentially a technical decision, highly discriminate evaluation criteria are a necessity. Specific evaluation criteria can be burdensome to generate because the research or development effort itself cannot be clearly defined. However, the technical evaluation criteria must be as detailed as possible and needs to provide for a structured, accurate and specific technical decision. The approach may create a "Catch 22" situation in a research engineer's mind. The technical personnel cannot say the proposals are essentially equal technically therefore award to the lowest price. This concept is not a price competition in the classical sense.

Attention needs to be given to the wording of solicitations regarding what is included in the maximum contract dollar amount. The request for proposal needs to discuss such things as rent-free use of government facilities or use of government computer time as it relates to the maximum dollar value of the contract, e.g., if the additive value of such items exceeds the maximum price, would the proposal be considered non-responsive. In addition, the request for proposal must indicate acceptability of progress payments and other negotiable provisions.

CONTROVERSIAL ASPECTS

Should contractor price/cost details be obtained and is price/cost analysis necessary?

A prominent controversy of this initiative is whether price/cost proposals should be soli-

cited and price/cost analysis performed. The Department of Defense, through its research and development programs, must seek the most advanced scientific knowledge attainable and the best possible equipment, weapons, and weapon systems that can be devised and produced. This means seeking scientific and technological sources consistent with the demands of the proposed contract for the best mix of cost, performance, and schedule. In determining to whom the contract shall be awarded, consideration must be given not only to technical competence, but also all other pertinent factors including management capabilities, cost controls, and past performance in adhering to contract requirements.

While cost or price should not be the controlling factor in selecting a contractor for a research or development contract, cost or price should not be disregarded in the choice of the contractor. Since consideration of price is a requirement, then the price must be determined to be fair and reasonable in relation to the technical proposal. The evaluation and analysis of a proposed contractor's price estimate would determine not only whether the estimate is reasonable but also determine the offeror's understanding of the project and plan to organize and perform the contract.

Price analysis generally considers the overall reasonableness of the proposals in relation to the total contemplated expenditures and the extent and nature of the task scheduled to be accomplished. The conclusions reached by price analysis techniques can then be verified by cost analysis procedures, which are used to examine the details of the offeror's proposal.

Some form of price or cost analysis is required in connection with every negotiated procurement action. The method and degree of analysis, however, is dependent on the facts surrounding the particular acquisition and pricing situation. Cost and pricing data, and the certificate if applicable, would still be required and cost and pricing personnel would still have to ascertain that the effort proposed corresponds to the price specified.

Does Best Proposal for Price violate the principal of considering price in government contracting actions? A controversy exists as to whether Best Proposal for Price violates the principal of considering price as an element in the competition. United States Statute 10 USC 2304 dictates adequate competition must include price. Price competition exists if offers are solicited and at least two responsible offerors, who can satisfy the requirements, independently contend for a contract to be awarded to the responsive and responsible offeror submitting the lowest evaluated price. Best Proposal for Price does not indicate award will be made based on this criteria. Violation of the principal of price competition is curtailed, however, by not requiring all proposals to be mandatorily submitted at exactly the given dollar amount. This approach satisfies the spirit and intent of federal statute and regulations. Award utilizing Best Proposal for Price is strictly the best proposal for a price that is within the government's stated maximum dollar amount.

Does Best Proposal for Price represent adequate negotiated contracting procedures? Regulations state written or oral discussions shall be conducted with all responsible offerors who submit proposals within a competitive range. This requirement need not be applied to acquisitions in which it can be clearly demonstrated from the existence of adequate competition, or accurate prior cost experience with the product or service, that acceptance of the most favorable initial proposal without discussion would result in a fair and reasonable price. This is subject to the solicitation having notified all offerors of the possibility that award might be made without discussion, and provided that such award is in fact made without any written or oral discussion with any offeror.

In relation to the Best Proposal for Price concept, controversy arises regarding the diminished use of the negotiation process. Experience gained from initial applications of the concept, though, has shown that difficulties arise with adherence to the "no negotiations" rule and the interpretation as to what constitutes negotiations. Limited clarifications are usually necessary but technical transfusion by discussions must be avoided.

If areas of negotiation are discovered, must negotiations be conducted? Controversy interjects as to what dictates when negotiations are mandatory. Potential problems are created when a signed contract is submitted with proposals in relation to the need for negotiations. A contractor signing the model contract without reservations indicates intent to be bound by its terms and conditions. Contractor signature based on contingent changes to the model contract lends itself to negotiations unless the source does not have the opportunity to be awarded a contract because of unacceptable technical ranking of the proposal. Lack of negotiation relative to contractor recommended changes to the model contract is defensible.

To accomplish changes to a model contract after contractor signature, minor informalities or irregularities and apparent clerical mistakes should be resolved and communications with offerors should not be considered negotiations. However, if the resulting clarification prejudices the interest of other offerors, award shall not be made without opening negotiations with all offerors within the competitive range.

How would contractor performance be assured? To assure contractor performance, the preparation and use of a clear and complete statement of work is essential. In research, exploratory development and advanced development, statements of work must be individually tailored to attain the desired degree of flexibility for contractor creativity, both in submitting proposals and in contractor performance. In research and development acquisitions it is generally not possible to formulate precise specifications. In relation to this, to assure contractor performance the basic Best Proposal for Price approach seems particularly well-suited to large fixed price parallel prototype development programs where each contractor is paid the same amount to build an item of hardware. The end results may then be compared against each other.

A detailed description of the technical requirements, with emphasis on achievement of performance, operational and support requirements, rather than specifying detailed procedures or methods of accomplishment, is required. Additionally, to maximize performance, the government prepared statement of work along with the contractor's proposal/ statement of work is incorporated into the contract. This lessens the government's vulnerability to the criticism that proposal preparation is being incentivized and not contract, performance.

CONCLUSIONS

Best Proposal for Price is a change of philosophy and emphasis in government contracting. A variety of concerns still exist regarding the concept. In any event, acquisition personnel should not be apprehensive to apply Best Proposal for Price since it has the potential for improving the Department of Defense acquisition process.

Further consideration of the controversial aspects is being accomplished. Award of contracts must not be made without full understanding of terms and conditions and agreement between the government and contractor. The government must use prudence, sound judgment and exercise discretion in determining whether to award on the basis of initial offers without negotiations. A concrete definition of what constitutes negotiations must be established. And, caution must be taken to insure the government gets satisfactory results at the price level established. Best Proposal for Price requires accuracy in developing program estimates, specifications, and evaluation criteria.

Limited discussion with contractor personnel indicates the Best Proposal for Price concept is being accepted by industry; however, some contractors have mixed emotions on not being able to get to the negotiation table. Likewise, there is a concern that some firms will initiate a bidding game by proposing to undercut the government's stated price. Our first experiences with this concept do not prove out the expressed contractor concern, but did demonstrate price cutting might occur. The information provided to offerors needs to clearly indicate that price cutting is not an objective. Although the government informs contractors the maximum price given is not intended to restrict submittal of proposals at a lower price, the government expects to evaluate the technical effort against the proposed contract price.

The Armament Division is refining its usage to overcome the controversies and concerns related to price. This innovative concept has proven to be beneficial in reducing government and contractor efforts in proposal preparation, evaluation, negotiation and revisions. Reduction of acquisition lead time is established along with government receipt of contractor's best initial proposals. Of major importance is that continuous acquisition action is permitted if negotiations become necessary. Negotiations can commence without delay because of initial contractor submittal of all certifications and data, including cost or pricing data. Also, Best Proposal for Price provides for early release of the contractor proposal team, all of which should consequently lower government acquisition costs.

Best Proposal for Price is continuing to be prudently tested to determine expansion of use. Wider implementation is expected. Additional questions, controversies and concerns will arise as all possible aspects of the technique are yet to be determined. But, even being controversial in nature, Best Proposal for Price has the intrinsic momentum to be highly contributory for better government contracting.

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COST APPLICATIONS

Panel Moderator: Colonel John D. Voss
Director, Contract Data Systems
DCS/Contracting & Manufacturing
Headquarters Air Force Systems
Command

Papers:

A Cost Based Acquisition Planning Model Utilizing Expert System Concepts
by Marco A. Bucciarelli and George L. Roeder

Computer Generated Acquisition Document Systems (CGADS)
by Stephen F. O'Shaughnessy and George L. Roeder

Computer Aided Source Selection (CASS)
by George L. Roeder

An Application of the Causal - Integrative Model
by Ivan A. Somers and Peter C. Gardiner

An Automated Airframe Production Cost Model
by Norman Keith Womer

Risk Analysis: Comparing Different Contract Types
by George Worm

A COST BASED ACQUISITION PLANNING MODEL UTILIZING EXPERT SYSTEM CONCEPTS

Marco A. Bucciarelli, VTI, Inc. Consultant
George L. Roeder, Roeder Software

ABSTRACT

A micro-processor based computer model utilizing expert system concepts has been developed to provide cost based acquisition planning information to the DoD acquisition community. The model, called ACROM, is a menu driven inquiry-response system wherein qualitative acquisition profile descriptions are converted, via embedded algorithms, to quantitative system acquisition cost estimates in a MIL-STD-881A Work Breakdown Structure format. The choice of one of two input modes provides for a top-down (Mode A) estimate using only six high level input parameters or a bottom-up (Mode B) estimate by characterizing each of 45 WBS elements for the system acquisition. Estimates may be accumulated by subsystem for large scale programs or by phase for total program and/or life cycle cost estimates. The model has been exercised for over 70 DoD system acquisitions and has provided relatively accurate estimates for electronic computer-based systems. It is anticipated that continued use and enhancements of the model will improve the embedded "expertise" in specialized acquisition areas and will provide a readily accessible and easy to use program management support tool in the critical area of system cost.

INTRODUCTION

The concept of a microprocessor based "expert" computer program [1] to aid in the estimating of system acquisition costs originated with the recent advent of automated tools to prepare technical and program management documentation such as Statements of Work (SOW's), Specifications, and Program Management Plans (PMP's). These computer programs are being evolved at the Air Force Electronic Systems Division as menu-driven inquiry-response systems which provide access to pre-defined data bases related to the document being prepared. [2] As the program manager and/or his technical staff begin documenting the system, the ultimate basis for system acquisition cost is being evolved with each acquisition requirement or procurement objective defined in writing. It is at this point in the process that an automated tool which permits the examination of the cost implications of system requirements was perceived to be needed and to be potentially useful in making trade-off decisions in a timely and informed manner. With this objective in mind, a private initiative was undertaken in 1982 to develop a self-contained cost based acquisition planning computer program designed to aid System Program Office engineering and management personnel. The ground rules for the "cost" model were established as follows:

- Utilize system and management input data describing the acquisition in non-cost terms;
- Provide the capability to analyze each of the system life cycle phases independently or in the aggregate;
- Provide summary cost data with the option to examine lower level contributions;
- Provide an override feature for user tailoring of cost data to refine the model estimate;
- Facilitate the examination of alternate system acquisition profiles for "what-if" considerations.

In September 1982, a prototype cost model for electronic systems was completed. The model, called ACROM, accepted qualitative inputs characterizing the system and the acquisition contemplated at a MACRO-level of detail and derived, via embedded algorithms, a most probable distribution of costs in a quantitative MIL-STD-881A format and level of detail. Since then, the model has been privately tested against over 70 DoD acquisitions, and has evolved to the level described in this paper.

INPUT/OUTPUT OPTIONS

The model is designed for two modes of operation which permit either a top-down (Mode A) system estimate with minimum input, or a bottom-up (Mode B) estimate with individual Work Breakdown Structure characterization. In Mode A, the minimum input field needed to produce a system estimate includes entering:

- Phase of acquisition
- Technology class of system hardware and software
- Acquisition complexity level
- Quantity of systems being acquired
- Program schedule
- FY of program start.

With these six input parameters, the model calculates a generic system acquisition estimate which may be displayed in the choice of man-months of labor, or in constant/current year dollars. The output contains the following level of detail:

Direct Labor - The estimated labor costs for

each of 45 WBS elements and costs at the summary level.

Hardware/Material - An estimate of the typical cost of hardware or material.

Data - An estimate of the typical data costs.

Other Direct Costs - An estimate of the typical ODC costs to be expected.

Total Acquisition Cost - The estimated total acquisition cost in 1983 dollars and in inflated dollars.

Unit Cost - The estimated recurring cost on a per unit system basis.

In Mode A, the user of the model may examine each of the contributing cost elements and may override or tailor the costs to transform the estimate from a "generic" estimate or a system specific estimate. Alternately, he may reexamine or change any of the six input parameters to evaluate the impact upon the overall system estimate in a "what-if" situation.

In the Mode B or "Bottom-Up" construction of an acquisition estimate, the user is provided a series of menus for each of 45 WBS elements, the answers to which permit the development of both individual WBS estimates and the overall system estimate from the model's data base. The following menu(s) are displayed to the user in Mode B:

1. WBS 1010 Prime Mission Equipment - Design Development and Fabrication

   1A. Enter quantity of systems being procured. _____ = Q$

   1B. Select the most applicable system descriptor

      1. Ground-based Electronics
      2. Airborne Electronics
      3. Spaceborne Electronics
      4. Shipborne Electronics
      5. Submarine Electronics

   1C. Select the most applicable descriptor for system hardware

      1. New Design-New Technology
      2. New Design-Conventional Technology
      3. Modified Design-Conventional Technology
      4. Off-the-Shelf

   1D. Select the most applicable descriptor for procurement environment

      1. Sole Source with Follow-on Potential
      2. Sole Source, Limited Follow-on Potential
      3. Limited Sources-Follow-on Potential
      4. Limited Sources-Limited Follow-on Potential
      5. Multiple Sources-Follow-on Potential
      6. Multiple Sources-Limited Follow-on Potential

   1E. Select the most applicable descriptor for level of review

      1. DoD-DSARC Review
      2. Command-PAR/CAR Review
      3. Division Review

2. WBS 4210 Software

   2A. Select most applicable descriptor for applications program

      1. New Application S/W
      2. Modified Application S/W
      3. Off-the-Shelf Application S/W

   2B. Select the most applicable descriptor for S/W code

      1. More than 500K lines
      2. 200K-500K lines
      3. Less than 200K lines

   2C. Select most applicable descriptors for system software

      1. Conventional HOL Programming
      2. Assy. Language
      3. Machine Language
      4. New HOL Programming

3. WBS 1062D Integration

   3A. Select all applicable interface descriptions

      1. Intra-System Interface
      2. Inter-System Interface
      3. Intra-Equipment Interface
      4. Inter-Equipment Interface

   3B. Select most applicable descriptor

      1. Tri-service Application
      2. Service Wide Application
      3. Command Application

NOTE: For all remaining WBS areas, select (circle) one of the items listed.

4. WBS 1050 Test and Evaluation

   1. Informal Contractor Test
   2. Formal Contractor Test
   3. Government Test
   4. None

5. WBS 1061 System Engineering Management

1. Full MIL-STD-499A and 1521A
2. Tailored MIL-STD-499A and 1521A
3. No MIL-STD-499A and 1521A
4. None

6. WBS 1061A Reliability

1. Formal Program, Formal Demo
2. Formal Program, Informal Demo
3. Informal Program, No Demo
4. None

7. WBS 1061B Maintainability

1. Formal Program, Formal Demo
2. Formal Program, Informal Demo
3. Informal Program, No Demo
4. None

8. Parts Control Program

1. Full MIL-STD-965
2. Tailored MIL-STD-965
3. Minimal MIL-STD-965
4. None

9. WBS 1061D Nomenclature

1. Multiple Nomenclature Req.
2. Limited Nomenclature Req.
3. One Nomenclature Request
4. None

10. WBS 1061E Aerospace Environment

1. New Environmental Design, Formal Test
2. Modified Design, Informal Test
3. Off-the-Shelf Design, Minimum Test
4. None

11. WBS 1061F Transportability

1. New Design, Formal Test
2. Modified Design, Informal Test
3. Off-the-Shelf Design, Minimum Test
4. None

12. 1061G Electromagnetic Compatibility

1. New Design, Formal Test
2. Modified Design, Informal Test
3. Off-the-Shelf, Minimal Test
4. None

13. 1061J Tempest

1. New Design, Formal Test
2. Existing Design, Formal Test.
3. Off-the-Shelf, Minimal Test
4. None

14. 1061K Survivability/Vulnerability

1. Individual Equipment Protection
2. Sub-system Level Hardening
3. System Level Hardening
4. None

15. 1061L Safety

1. Formal Program, Formal Test
2. Formal Program, Informal Test
3. Informal Program, Informal Test
4. None

16. 1061M Communications Long Lines

1. Responsible for Long Lines
2. Planning for Long Lines
3. Interface with Long Lines
4. None

17. 1061N Radio Frequency Management

1. Multiple R/F Requirements
2. Limited R/F Requirements
3. One R/F Requirement
4. None

18. 1061P Value Engineering

1. Formal Program
2. Informal Program
3. Contractor Discretion
4. None

19. 1061Q Availability

1. Formal Program, Formal Test
2. Formal Program, Informal Test
3. Informal Program, Limited Test
4. None

20. 1061R Defective Parts Control Program

1. Formal Program, Formal Data
2. Formal Program, Informal Data
3. Informal Program, Informal Data
4. None

21. 1062AA Contract Work Breakdown Structure

1. Formal Requirement, Formal Data
2. Formal Requirement, Informal Data
3. Informal Requirement, Informal Data
4. None

22. 1062AB Cost Information Systems

1. Formal System, Formal Reporting
2. Informal System, Formal Reporting
3. Informal System, Informal Reporting
4. None

23. 1062AC Cost/Schedule Control System

1. Formal System, Formal Reporting
2. Informal System, Formal Reporting
3. Informal System, Informal Reporting
4. None

24. 1062AD Life Cycle Cost

1. Formal Program, Contractor Model
2. Formal Program, Government Model
3. Informal Program, Estimate Only
4. None

25. 1062AE Schedule Management

1. Formal System, Multiple Schedules
2. Formal System, Limited Schedules
3. Informal System, Limited Schedules
4. None

26. 1062B Manufacturing Management

1. Formal Program, Formal Monitoring
2. Formal Program, Informal Monitoring
3. Informal Program, Informal Monitoring
4. None

27. 1062C Configuration Management

1. Formal Program, Formal Data
2. Formal Program, Contractor Data
3. Informal Program, Contractor Data
4. None

28. 1062E Quality Program

1. Special Inspection Requirements
2. Normal Inspection Requirements
3. Reduced Inspection Requirements
4. None

29. 1062F Photographic Documentation

1. Multiple Records
2. Limited Records
3. Minimal Records
4. None

30. 1062G STINFO

1. Formal Program, Formal Reporting
2. Formal Program, Informal Reporting
3. Informal Program, Informal Reporting
4. None

31. 1062H Security

1. Top Secret Level
2. Secret Level
3. Confidential Level
4. None

32. 1063 Integrated Logistics Support

1. Formal Program, Formal Reporting
2. Formal Program, Informal Reporting
3. Informal Program, Informal Reporting
4. None

33. 1063A Preoperational Supply Support

1. Complete Supply Support
2. Limited Supply Support
3. Supply Support Planning Only
4. None

34. 1063B Preservation, Packaging, Packing and Marketing

1. Formal Program, Formal Inspection
2. Informal Program, Formal Inspection
3. Informal Program, Informal Inspection
4. None

35. 1063C Transportation

1. Material Shipment, Multiple Destinations
2. Material Shipment, Limited Destinations
3. Material Shipment, One Destination
4. None

36. 1063D Travel

1. Extensive Travel Domestic and Overseas
2. Limited Travel Domestic and Overseas
3. Minimal Travel Domestic and Overseas
4. None

37. 1063E Preoperational Maintenance

1. Formal Plan, Formal Data
2. Informal Plan, Formal Data
3. Informal Plan, Informal Data
4. None

38. 1063H Logistic Support Analysis

1. Formal Plan, Formal Data
2. Informal Plan, Formal Data
3. Informal Plan, Informal Data
4. None

39. 1040/9200 Support Equipment

1. Special Purpose Design
2. Modified Design/Tailored Application
3. Common Test Equipment
4. None

40. 1064/1020 Human Factors and Training

1. Formal Program, Formal Testing
2. Formal Program, Informal Testing
3. Informal Program, Informal Testing
4. None

41. 1070 Data Management

1. 80 to 100 Formal Data Items
2. Approximately 40 to 80 Data Items
3. Under 40 Data Items
4. None

42. 1071 Technical Orders

1. Formal Validation and Verification
2. Informal Validation, Formal Verification
3. Informal Validation, Informal Verification
4. None

43. 1072 Engineering Data Drawings

1. Formal Data, Formal Inspection
2. Informal Data, Formal Inspection
3. Informal Data, Informal Inspection
4. None

44. 1082 Real Property Facilities

1. Responsible for Government Property
2. Limited Use of Government Property
3. Interface with Government Property
4. None

45. 9600 Initial Spare/Repair Parts Provisioning

1. Formal Program, Formal Reporting
2. Informal Program, Formal Reporting
3. Informal Program, Informal Reporting
4. None

Completion of this checklist automatically provides the equivalent output format and level of detail as with the Mode A procedure.

APPLICATIONS AND EXPERIENCE

The model has been exercised for over 70 known DoD acquisitions covering the spectrum of phases and in dollar ranges from $700,000 to $3,000,000,000. Table I shows the distribution of estimates for the first 35 validation runs by service and by phase for which statistical data was maintained.

TABLE I. Distribution of Estimates

Agency	Acquisition Phase				Totals
	Concept	Validation	FSD	PROD	
USAF	5	3	7	2	17
USA	1	1	2	4	8
USN	2	-	2	2	6
NASA	-	-	1	-	1
Postal	-	-	-	1	1
Industry	-	2	-	-	2
TOTALS	8	6	12	9	35

Table II shows the data base behavior in approximating the actual system acquisition cost for these same systems. This latter information should not be construed as an indicator of the "predictive" capability of the model across the board. Experience gained subsequent to these initial trials shows that wide variances from actual are possible if the system acquisition is improperly classified, or if the actual system acquisition profile differs markedly from the generic profiles in the model data base. Such situations could include artificially stretched-out or compressed acquisitions to meet budgetary constraints and/or concurrency of development and production. Methods to deal with these situations have been identified and are being developed as enhancements to the model. In addition to the 35 systems described above, the model has been exercised against large scale acquisitions in the billion dollar range by developing subsystem estimates and using the built-in accumulation feature to aggregate system level costs. This same feature may be used to estimate Life Cycle Costs. Recent applications of the model in support of current DoD programs include:

- Uncertainty analysis for an AWACS maintenance training simulator acquisition to establish a highest to lowest probable cost range;
- Development of cost profiles for four classes of maintenance trainers for cryptologic systems to support early acquisition planning; [3]
- Input to an independent cost estimate being formulated for the CCPDS replacement program.

TABLE II. Relative Accuracies

Phase	Trials	Cost Range Millions $	Model Accuracy (±%)
Concept	8	0.7- 8	10.4
Validation	6	3.5- 10	7.6
Development	12	4.0-158	7.6
Production	9	19.0-211	5.9
All Phases	35		6.8

SUMMARY

The use of the expert system concept to provide cost-based acquisition planning tools to the technical and management acquisition community shows promise in providing ways to improve initial system estimates and in decision making under conditions of uncertainty. The authors have combined their individual 25 years of acquisition experience and computer modeling to create the system described herein. Within this domain of expertise, the model provides a reasonable representation of the real world. Such a system, by its very nature, has limitations and is not intended as a substitution or replacement for professional and detailed system cost estimates as presently conducted. However, there is the promise and potential for significant improvement to early planning and forecasting with the aid of such expert systems. Further, the continuing use and evolution of these models will result in enhancements which make them "smarter" by increasing the level and depth of the embedded expert judgments.

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ADP002784

COMPUTER GENERATED ACQUISITION DOCUMENT SYSTEM (CGADS)

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ABSTRACT

The Computer Generated Acquisition Document System (CGADS) is a computer program written in F77 (version of FORTRAN 77) through which draft Statements of Work (SOW) and Contract Data Requirements Lists (CDRL) for weapon systems acquisitions may be created. CGADS was developed by the Electronics Systems Division at Hanscom Air Force Base, Massachusetts, to provide automated assistance to project/procurement offices in the development of acquisition documentation for inclusion in solicitations and Request for Proposals (RFPs). This paper describes the current version of the operational CGADS.

INTRODUCTION

During the past several years, the Federal Government in general and the Department of Defense (DOD) in particular, have been introducing computer based office automated systems designed to improve the quantity, quality, and timeliness of typical office products. CGADS is one such system, developed by AFSC/ESD, and oriented to assist project/program offices in the generation of initial draft Statements of Work (SOWs) for incorporation into procurement Request for Proposals (RFPs). In addition, CGADS has the capability to produce draft Contract Data Requirements Lists (CDRLs) and other related procurement documentation. CGADS has been designed with an interactive menu driven data entry and document generation capability which provides for an on line data base tailored for each user. The results are draft SOWs and CDRLs, tailored to program direction and in a format consistent with that recommended by the DOD Specifications and Standards Seminar (November 1981).

While CGADS only provides a draft SOW and CDRL for further refinement and review, it is proving to be an excellent tool in developing initial acquisition documents by program project offices. Experience is showing that the quality, timeliness, and consistency of CGADS products have improved compared to documents produced using traditional methods of preparation.

CGADS was made fully operational at the AFSC's Electronic Systems Division (ESD) on 4 January 1982, replacing former manual methods, procedures, and policies for SOW preparation. Since the primary mission of ESD is to acquire ground based electronic systems, CGADS is designed to reflect this orientation and is generally available to DOD users having similar, or related procurement requirements. CGADS has the capability to be modified, tailored and/or enhanced so as to serve a broader based segment of the DOD system acquisition community. The following paragraphs describe the CGADS System and capabilities as presently configured.

SYSTEM DESCRIPTION

CGADS is a software program consisting of approximately 4400 lines of code written in F77 language, which is a VAX version of FORTRAN 77. The system has two basic modes of operation, namely file creation and update (CREATE), and document production (AUTO). The CREATE program is designed to permit the CGADS supervisor/administrator to enter basic information relative to an acquisition document, and to store this source data in a series of interrelated files. In addition, CREATE provides the capability to add, modify, or delete acquisition-document information as revisions to basic standards and specifications.

In the AUTO mode, a user interactively interfaces with the system to produce a document. A user is asked to enter the system by establishing an identity and by designating a document to be produced. The system guides the user in developing a document by displaying a series of menus from which an option is selected. The user is then offered the opportunity to respond to a series of functionally related questions, within a user-selected functional area. Responses enable the system to retrieve the appropriate information from its data base to produce a document. The following paragraphs provide a detailed description of major CGADS program functions.

CGADS was originally designed to run on the PRIME 2000 host processor in F77. It is currently operational on the VAX 11/780 and has the capability to be transferred to other host processors and to other similar languages. Equipment such as the PDP-11/23 might be used to allow inexpensive local use, modification and control over a tailored program.

SYSTEM CAPABILITIES

At the present time, CGADS automates the preparation of a draft SOW. A SOW is the document incorporated into an RFP or Invitation for Bid (IFB), identifying the design, engineering, management, administrative, and support tasks that a contractor must perform, and the results that must be obtained during the execution of

the contract. CGADS products associated with the preparation of a draft SOW are:

a. A draft of the SOW in the specified format, tailored to the user's program direction;

b. Action messages to assist the user to further refine the SOW being generated and to assist in the preparation of other contract solicitation documents.

CGADS will create a word processor file after each draft document has been generated. The word processor file can be transferred directly from the computer to the user's word processor equipment where the draft document can be refined and tailored to the final version of the SOW. The final SOW can then be incorporated in the RFP.

A particularly noteworthy feature of CGADS is the capability to prompt the user to eliminate the redundancy of text among the various solicitation documents via action messages. The action messages tell the user the most appropriate place (SOW, CDRL, a particular contract section, or product specification) for the inclusion of various requirements in the solicitation package; for example, if a requirement exists for the quality assurance provisions of MIL-Q-9858A to be tailored to an individual program, CGADS will instruct the user to tailor MIL-Q-9858A to the program in Section H (special provisions) of the Contract Schedule instead of the SOW. The CGADS data base has been designed to eliminate duplication of text of: Applicable Documents (Standards/Specifications); Defense Acquisition Regulations (DAR); CDRL; and product specifications.

SYSTEM ACCESS

CGADS can be assessed either directly or remotely. For direct or remote access, one must have an alphanumeric display terminal comparable with the host computer. Remote access typically requires the use of modems compatible with the Bell 103 or 212A Data Sets depending on the baud rate of the terminal equipment. The input/output (I/O) terminal can be an alphanumeric terminal or word processing equipment, however, the word processing equipment must have a communications option. Whatever I/O terminal equipment is used, it would typically have the following characteristics.

a. Character Code -ACSII
b. Parity -None
c. Stop Bits -2
d. Speed -300 or 1200 baud

Examples of compatible terminals are: Hazeltine Models 30/30A, Televideo Model 920C and the DEC VT 100. The modem must be compatible with the Bell 103 data set if operating at a 300 baud transmission rate, or compatible with the Bell 212A data set if operating at 1200 baud. There are many modems available that can be used in this application; for example, the Racal Vadic VA3434. A telephone is required to establish the dial up connection and to connect the modem onto the line after the connection is established. This can be done through an acoustic coupler or via a switch internal or external to the telephone set. The telephone on the host computer end of the connection will have an automatic answer capability.

Once the equipment has been set up and is working, the user can access CGADS. There are essentially two access procedures; one for generating a document, and one for transferring a generated document to a word processor storage file. The first step taken to access CGADS for either procedure is to establish the physical connection to CGADS. To establish the connection, one must go off-hook using the telephone instrument at this location. The user will hear ring back and then a continuous tone. The continuous tone indicates that the automatic answer modem on the host computer end has gone off-hook. When the continuous tone is heard, one must connect the modem onto the line either by telephone switch action or via an acoustic coupler. After the modem is connected to the line, the user waits until a Clear-to-Send indication is provided by the modem. The physical connection is now established and the user can log-in to use CGADS. To log-in the user enters "ESDRFP" using the I/O terminal. CGADS will acknowledge a valid log-in by responding with a message.

DOCUMENT PREPARATION

After the CGADS has been accessed and all log-in procedures have been completed, the CGADS software will initialize the files and provide general instructions (see Figure 1) on the user's terminal.

****

AUTOSCRIPT FILE INITIALIZATION IN PROGRESS
- PLEASE WAIT

WELCOME TO ESD'S COMPUTER GENERATED
ACQUISITION DOCUMENTS SYSTEM (CGADS)

1. This computer program is designed for the generation and tailoring of acquisition documents to specific program direction.

2. In order to effectively use this program, you must be thoroughly familiar with your program direction - such as the Program Management Directive (PMD), the AFSC Form 56 and the ESD Form 211.

G - Generate/Search for a Document.
T - Transfer a Document
Q - Quit

Please enter your option.

Fig. 1 - GENERAL INSTRUCTIONS

****

The CGADS software will then prompt the user via questions during the SOW generation process. This process is acquisition phase and task oriented. The questions asked are easily understood and are of two types. One type of question is directed to the selection of an item from a menu that is presented on the display screen; for example, the current products are displayed (see Figure 2) and the user will enter the number of the product (document) he wants to produce. CGADS will then display additional menus or start to ask questions regarding the item selected from the menu. To each question asked by CGADS, the user must respond with one of the three answers: yes, no or undecided. Depending upon the user's response, the CGADS will:

a. Ask another question to obtain more user information prior to deciding upon a course of action;

b. Take the appropriate action to generate a portion of the SOW text and/or indicate as required action messages;

c. End the session regarding the task functional area of concern and prompt the user to another functional task area;

d. Allow the user to transfer the word processor file generated in the CGADS host computer to a word processor;

e. Allow the user to sign off.

****

CURRENT PRODUCTS

1. SOW/CONCEPTUAL PHASE
2. SOW/VALIDATION PHASE
3. SOW/FULL SCALE DEVELOPMENT PHASE
4. SOW/PRODUCTION PHASE
5. SOW/DEPLOYMENT PHASE
6. CDRL/CONCEPTUAL PHASE
7. CDRL/VALIDATION PHASE
8. CDRL/FULL SCALE DEVELOPMENT PHASE
9. CDRL/PRODUCTION PHASE
10. CDRL/DEPLOYMENT PHASE

ENTER NUMBER OF PRODUCT YOU WISH TO PRODUCE.

Fig. 2 - CURRENT PRODUCTS MENU

****

CGADS will ask the user to select the product he wants to produce at this time (see Figure 2). The user selects the SOW for the acquisition phase desired. CGADS responds with the title of the product (SOW) selected and requests the user to insert their program name and other related information. After affirming the user identification and program title, CGADS presents the options menu and asks the user to select an option. Since a SOW is being generated, the "RUN FUNCTIONAL TASKS" option will be selected. The functional tasks are then displayed by CGADS (Figure 3). The user will select a functional task area and CGADS will list the tasks associated with the functional area selected on a menu.

****

Area 1 - Engineering
Area 2 - Configuration and Data
Area 3 - Program Management
Area 4 - Logistics
Area 5 - Packaging/Transportation

PLEASE ENTER ONE OF THE ABOVE AREA NUMBERS (1-5)

Fig. 3 - FUNCTIONAL AREAS

****

Figures 4 through 8 depict the menus associated with each functional task area. The user selects a task area to be generated, and the CGADS will prompt the user through the task with questions.

```
**********************************************
                AREA NUMBER 1

PRODUCT:  SOW/FULL SCALE DEVELOPMENT

TASK    TITLE

1.      SYSTEMS ENGINEERING
2.      SYSTEM SAFETY
3.      HUMAN FACTORS
4.      VALUE ENGINEERING
5.      SECURITY
6.      AVAILABILITY
7.      MAINTAINABILITY
8.      RELIABILITY
9.      PARTS CONTROL PROGRAM
10.     METEOROLOGICAL ENVIRONMENT
11.     ELETROMAGNETIC COMPATIBILITY
12.     SURVIVABILITY/VULNERABILITY
13.     COMMUNICATIONS LONG LINES
14.     COMMUNICATIONS/TEMPEST
15.     RADIO FREQUENCY MANAGEMENT
16.     TRANSPORTABILITY
17.     QUALITY ASSURANCE
18.     TEST AND EVALUATION
19.     COMPUTER RESOURCES
        MANAGEMENT
20.     REAL PROPERTY FACILITIES
21.     MANUFACTURING MANAGEMENT

ENTER TASK NUMBER TO BE RUN OR
RETURN FOR ANOTHER OPTION
```

Fig. 4 - FUNCTIONAL AREA 1 ENGINEERING

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**********************************************

                AREA NUMBER 2

PRODUCT:  SOW/FULL SCALE DEVELOPMENT

TASK:  TITLE

1.      CONFIGURATION MANAGEMENT
2.      DATA MANAGEMENT
3.      ENGINEERING DATA
4.      NOMENCLATURE
5.      TECHNICAL ORDERS
6.      STINFO
7.      PHOTOGRAPHIC DOCUMENTATION

ENTER TASK NUMBER TO BE RUN OR
RETURN FOR ANOTHER OPTION
```

Fig. 5. - FUNCTIONAL AREA 2 - CONFIGURATION AND DATA

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**********************************************

                AREA NUMBER 3

PRODUCT:  SOW/FULL SCALE DEVELOPMENT

TASK:     TITLE

1.        WORK BREAKDOWN STRUCTURE
2.        COST INFORMATION SYSTEMS
3.        COST/SCHEDULE CONTROL
          SYSTEM
4.        SCHEDULE MANAGEMENT

ENTER TASK NUMBER TO BE RUN OR
RETURN FOR ANOTHER OPTION
```

Fig. 6 - FUNCTIONAL AREA 3 - PROGRAM MANAGEMENT

```
**********************************************

                AREA NUMBER 4

PRODUCT:  SOW/FULL SCALE DEVELOPMENT

TASK:  TITLE

1.      LOGISTICS SUPPORT ANALYSIS
2.      INTEGRATED LOGISTICS SUPPORT
3.      INITIAL SPACE/REPAIR PARTS
4.      PREOPERATIONAL MAINTENANCE
5.      PREOPERATIONAL SUPPLY
        SUPPORT
6.      SUPPORT EQUIPMENT

ENTER TASK NUMBER TO BE RUN OR
RETURN FOR ANOTHER OPTION
```

Fig. 7 - FUNCTIONAL AREA 4 - LOGISTICS

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**********************************************

                AREA NUMBER 5

PRODUCT:   SOW/FULL SCALE DEVELOPMENT PHASE

TASK: TITLE

1.    PRESERVATION/PACKAGING/PACKING
2.    TRANSPORTATION
3.    TRAVEL

ENTER TASK NUMBER TO BE RUN OR
RETURN FOR ANOTHER OPTION
```

Fig. 8 - FUNCTIONAL AREA 5 - PACKAGING AND TRANSPORTATION

```
**********************************************
```

When the end of a task is reached, the functional area menu that is being worked on will again appear with the notation of which tasks in the area have been completed. The user is asked to select another task within the same functional area or to hit "RETURN" for another option. The user can run more tasks in the same functional area, if desired, or go to a completely different functional area. The user is not required to finish one functional area completely before selecting another functional area. Assuming that the user has decided that he would like to

leave functinal area 3 and select another functional area to work in, the user would hit "RETURN" and the option menu would appear again. If the user wants to continue, he will have the functional areas (Figure 3) listed again.

At this point, it will be assumed that the user has generated all of the SOW tasks required.. When he gets the option menu display he can either select the "Q" or "P" option. The "Q" or "quit this session" option will terminate the session and the file he generated will remain in the storage file. If the user desires a printout of the material (SOW) generated or a word processor file generated, he will use the "P" option. The user can then transfer the generated file which will be held in storage.

If the user wants to transfer a generated document (such as a SOW) to a word processor file, he will connect to CGADS using a word processor. The user will use the transfer option (Figure 1). CGADS then asks for the user's word processor file name. The word processor file name was assigned during the process of generating a document. After the word processor file name is entered, the user will be asked to provide information regarding the type of word processor equipment he is using. Figure 9 provides a menu of word processor currently being used with CGADS. The user is required to place his word processor terminal in the receive mode if this has not been done previously. After a short time out, the host processor will transfer the document file to the word processor's storage file. Once the transfer is completed and the user has disconnected from CGADS, he can tailor the draft document into a final form using his own word processor.

****

SELECT WHICH TYPE OF WORD
PROCESSOR YOU ARE USING

---

1. LANIER
2. MICOM
3. WANG
4. PARALLEL PRINTER CONNECTED
   TO STANDARD TERMINAL
5. CPT
6. NBI
7. XEROX
8. AB DICK
9. OTHER
10. STANDARD TERMINAL
11. END PROGRAM

Fig. 9 - WORD PROCESSOR SELECTION PROCESS

****

CONCLUSION

Since the advent of intelligent computer systems, word processors and other related office automation equipment, people have been saying, would't it be nice if we could push a button and get a finished document from the computer. Although CGADS does not provide this capability, it does allow the user the capability to create a draft document that is tailored to the users needs. The degree of detail and completeness of a document is only limited by the detail of the data base and the respective questions.

CGADS is an expert system which has proven to be a rapid, cost-effective method for producing draft documents for the DoD acquisition community. Users have attested to the friendly interaction via simple menus and the ease of transferring the document to a word processor for final tailoring. The flexibility and ease of modification of the system data base makes this a dynamic tool in todays changing environment. The methods and techniques developed in implementing CGADS has illustrated that this approach can be applied effectively to the generation of any type of document, process or procedure.

ADP002785

COMPUTER AIDED SOURCE SELECTION (CASS)

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INTRODUCTION

The source selection process in the Department of Defense is a labor intensive effort which ties-up the management, technical, and administrative resources of acquisition agencies on a continuing basis. At a typical AFSC product division such as the Electronic System Division, Hanscom AFB, MA, it is estimated that from 20 to 50 source selections are conducted annually to evaluate competitive proposals. Evaluation teams can range from 5 to 50 evaluators supporting one or more of the following source selection organizational functions for 2 to 12 months.

- Source Selection Authority (SSA)
- Source Selection Advisory Council (SSAC)
- Source Selection Evaluation Board (SSEB)

In addition, there are a variety of ad-hoc teams which support the process depending upon the magnitude, complexity and criticality of the acquisition.

The CASS series of prototype computer programs have been developed with the objective of providing automated aids to facilitate the conduct and management of the source selection process. It is anticipated that the following benefits can accrue with the use of CASS by the DoD:

- Shorten the time required for source-selection decisions;
- Reduce the manpower supporting proposal evaluations for both the Government and Industry;
- Improve traceability of evaluation findings to contractor selection;
- Serve as a training aid to new and inexperienced evaluators;
- Provide more flexible decision support tools;
- Reduce the administrative burden of documenting the source-selection; and
- Facilitate a "lessons learned" data base.

The CASS system currently consists of two main programs, CASS-SSEB and CASS-EVAL.

CASS-SSEB PROGRAM DESCRIPTION

This computer program is designed to organize and define the Source Selection Evaluation Board functions in terms of specific evaluation areas, items, factors, and sub-factors. The program allows team leaders and evaluators to be identified and assigned to technical, management, and cost evaluation teams. The proposals to be evaluated are coded and scored at the item level. Weighting at the item level is also provided such that a composite weighted score for each proposal can be tabulated at any level. The program is intended for use by the SSEB and/or SSAC chairman responsible for managing and controlling the evaluation. Evaluation assignments can be tracked at the lowest level desired, and status and progress checks made quickly and easily. CASS-SSEB is a menu-driven create program which establishes what has to be done, who has to do it, when they must do it, and their progress and status is given at a summary level.

The first CASS-SSEB function of board designation/configuration includes features for designation of the board, the evaluation criteria, the vendors and the weighting and scoring at the item level within the established criteria. The board designation provides for identifying its leader. Criteria may be established at the following normal levels within an SSEB: 1) areas with assigned items, 2) items with assigned factors and provision for both weighting and scoring, 3) factors with assigned evaluators or, if necessary, assigned subfactors, and 4) optional subfactors with assigned evaluators. All criteria may have an assigned leader. Modification features provide for an interactive capability to alter the structure of the board at any time.

The feature for vendor designation includes vendor name, point of contact, address, telephone number and role as prime or subcontractor. This function also provides for the document control of vendor proposals, rated findings of evaluators, a log of clarification requests, and a log of discrepancy reports.

The feature for item weighting and scoring implements a dynamic capability to enter weights and scores at the item level, review the results, and modify weights or scores as results dictate or to investigate what if analyses (based on weight variances).

The second CASS-SSEB function of personnel administration includes features for personnel identification and entry control of individuals within the SSEB secured area.

The features of personnel identification provides for archiving all personnel information which is critical to the integrity of the SSEB process. The data include name,

SSAN, security clearance, and the DoD component or company the individual represents. The individual's rank or position, and the addresses and telephone numbers may be entered for office, home and local locations since personnel often perform SSEB duties at locations away from their home. The ETA/arrival and inbriefing dates and ETD/departure and debriefing dates may be entered. The individual's status as visitor or assignment to SSEB position(s) are available together with a remarks section that may be used to track badges/permits issued for board duration.

The second feature of entry control identifies which personnel or visitors are in the SSEB secured area at any time and acts as an automated sign in/sign out roster from which a daily/periodic log is available.

CASS-EVAL PROGRAM DESCRIPTION

The CASS-EVAL program is for the use of the SSEB members or data entry personnel. It accomplishes the two major functions of evaluation and status review. In addition, design provides for an automated message board and entry of lessons learned.

The first function of evaluation provides a feature for an identification check to certify evaluators and restrict their system penetration to their assigned criteria. Evaluators identify which criterion they wish to evaluate and which vendor. They may then perform finding entry or modification. Each finding may include a title, brief summary, the full text of the finding and the rating for the finding assigned by the evaluator. Clarification requests and/or discrepancy reports may be opened/closed with date against the finding and the proposal reference(s) entered for ease of later review/validation at higher board levels.

The second function of status review provides a feature for an identification check to certify criterion leaders and restrict their system penetration to their assigned criteria or lower levels within the assigned criteria. Leaders identify which criterion they wish to review and may see the status of each evaluator together with the findings and status of clarification requests and discrepancy reports.

The automated message board feature may be used by any member to send messages to any other member.

This computer program is designed to track the evaluation progress either at the lowest level of detail or at successively higher levels of evaluation criteria. In addition to the data contained in CASS-SSEB, CASS-EVAL provides individual findings for each sub-factor, factor, item, and area being evaluated. The findings are identified with the respective coded proposal designation and rated in accordance with the conventional method of comparing the proposal to the standard. Clarification requests and discrepancy reports are identified as being open or closed and can be tracked at any level. The program is intended for use by individual evaluators, SSEB, and/or SSAC managers. Code word entry to the program limits access to pre-designated data base elements such that an individual evaluator can only access his evaluation status while team leaders and managers can access authorized summary level status information. The program is menu-driven and user-friendly so that status information can be updated and accessed easily and quickly.

SYSTEM DESIGN OUTLINE

In the following outline of the CASS system design, those functions and features which have been implemented in the concept core package are denoted by an asterisk (*).

CASS-SSEB PROGRAM OUTLINE

```
Board Designation/Configuration *
  Name *
    Leader *
  Criteria * (All With Leaders)
    Areas *
    Items * (With Weighted Scoring)
    Factors * (With Evaluators)
    Subfactors * (With Evaluators)
  Vendors *
    Identification *
      Point Of Contact
      Address
      Phone
      Prime/Sub
    Document Control
      Proposals
      Findings (With Ratings) *
      Clarification Requests *
        Log
      Discrepancy Reports *
        Log
  Item Weighting And Scoring *
    Entry/Modification/Review *

Personnel Administration *
  Personnel Identification *
    Name *
```

SSAN
Security Clearance
DOD Component/Company
Rank/Position
Office Address, Phone
Home Address, Phone
Local Address, Phone
ETA/Arrival Data
ETD/Departure Data
Inbriefer, Date
Debriefer, Date
SSEB Position * (Or Visitor)
Remarks: Badges/Permits Issued
Personnel * Assignments Roster
Entry Control
Personnel/Visitors In SSEB Area
Daily Log

Lessons Learned Review

SUMMARY

Each of these computer programs is written in BASIC and is CPM compatible so either program can be run on most desk-top micro processors. This feature was incorporated to maintain source selection security and to facilitate multiple work-stations for the evaluation team.

Additional CASS software packages planned for development include a master scheduling system which integrates all of the activities which contribute to the source-selection process including DCAA audits, negotiations, contract writing, etc. We are also investigating the feasibility of an automated report generator for the SSEB report and the SSAC report, as well as certain automated decision aids for the SSA.

It is anticipated that the operational use of these automated aids to source selection will result in future program tailoring and enhancements which respond to the needs of the users.

ADP002786

AN APPLICATION OF THE CAUSAL-INTEGRATIVE MODEL

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INTRODUCTION

Historical analyses of program acquisitions indicate that the probability of cost growth and/or schedule slippages is high. Many research efforts have been directed at identifying the causal factors leading to these changes in program performance. Much of the research has been devoted to modeling the acquisition process with the goal being a more effective control of program performance. A common observation of researchers is that the acquisition process is a complex and interrelated set of events. As such, any comprehensive model that claims to represent this process must reflect these interrelated activities, many of which can be described by feedback loops.

This paper discusses one such model that utilizes the Systems Dynamics approach to simulation to portray the processes that form collectively the program acquisition cycle. The Causal-Integrative Model (CIM) was just presented in its conceptual form at the Management of Risk and Uncertainty Symposium in February, 1981, at the U.S. Air Force Academy, Colorado, [6]. This paper reports on the computer-based operational form of the CIM. The results of applying the computerized model to one acquisition program are presented.

Research Trail

The basis for the Causal Integrative Model (CIM) can be traced to E.B. Cochran's concept of Disruption Theory [2]. In his research, Cochran identified three aggregate variables in program acquisition. Depending on programmatic conditions, any one or more of these variables, or sub-variables, could introduce a program disruption to the acquisition process. This disruption could then led to a change in cost and/or schedule.

A study conducted at the University of Southern California by Rowe and Cochran identified 27 causes of cost overruns in six military and civilian programs [3]. Further research by Rowe and Somers categorized these into the four aggregate variables that form the conceptual version of the CIM [4]. A computer-based version of the model was presented in July, 1983 at the Defense Systems Management College [5].

Overview of the Causal-Integrative Model

The four aggregate variables of the CIM are shown in Figure 1. Although this figure is a static representation of the dynamic acquisition process, it can be used to represent the interrelatedness of the variables included in the model.

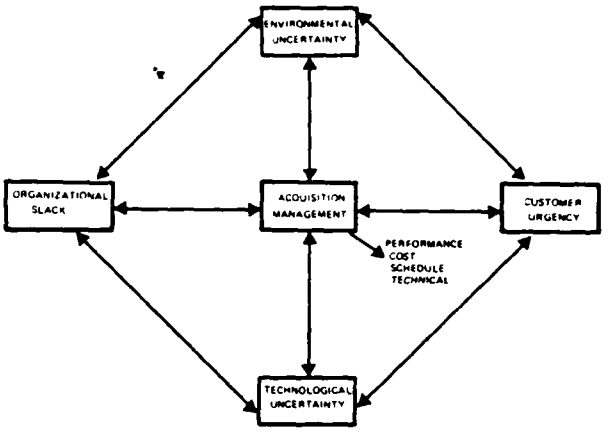

Figure 1. Acquisition Management Process

The four factors in Figure 1 are defined as:

- Environmental Uncertainty - any exogenous variable that causes program disruption.
- Technological Uncertainty - measures of state-of-the-art and degree of interrelatedness among the process components.
- Organizational Slack - measures of the organization's ability to perform the task requirements.

The output of the acquisition process as described by Figure 1 is the contractual criteria with respect to cost, schedule, and technical performance. Since each of the factors in the model are shown to be interrelated, a change in one of the factors will produce changes in each of the other factors as well as changes in the performance criteria. For example, if a change occurs in Customer Urgency (e.g., the schedule is accelerated), the effects of this change would impact Organizational Slack (e.g., the additional labor required to accelerate the schedule versus the availability of the required number and types of labor), Technological Uncertainty (e.g., the effects of a compressed schedule on the complexity of design) and Environmental Uncertainty (e.g., the lack or availability of new funding required to compress the schedule).

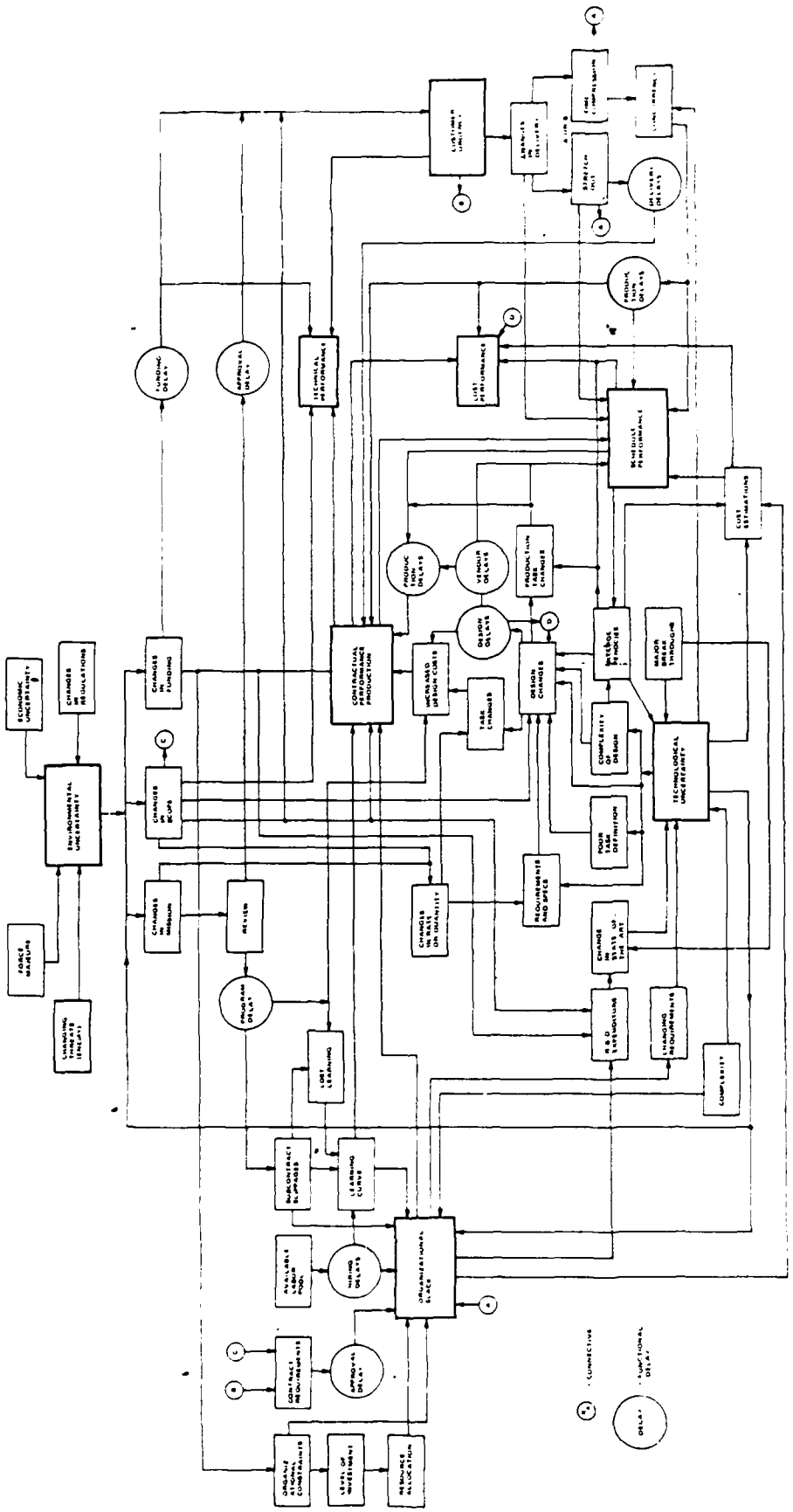

Figure 2. Causal-Integrative Model In Conceptual Form

Systems Dynamics and the CIM

The four aggregate factors shown in Figure 1 can be disaggregated to the diagram represented by Figure 2. In this conceptual form of the CIM, the various interlocking feedback loops and sub-processes are identified along with the lower level variables. Because of the interrelatedness of the many loops and variables, Systems Dynamics was used as a tool to transform the conceptual CIM into a computer-based version. This transformation was necessary in order to perform "what if" testing for various programmatic inputs.

A methodology developed by Forrester and Senge was used to validate the computer-based version of the CIM [6]. This approach establishes an hierarchy of tests that examines both the structure and behavior of the model. Following this validation methodology, it was determined that a high level of confidence exists in the model as developed.

During the development of the model, the research examined indicated that major portions of cost growth appeared as functions of labor. With this observation in mind, the final portions of this paper will address the CIM from the organizational slack sector.

Organizational Slack

Figure 3 represents the various sectors of the aggregate variable identified as organizational slack. The five sectors are the contract data,

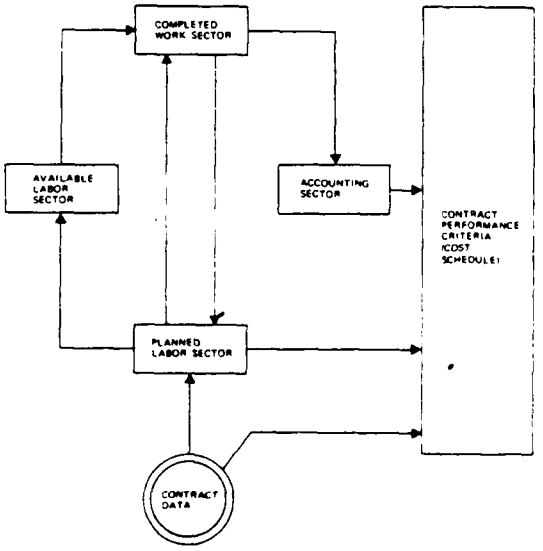

Figure 3. Organizational Slack Sectors

the planned labor sector (original schedules of labor charges), available labor sector (by type, level, and quantity), completed work sector (accounts for false starts, rework, changes, etc.), and accounting sector (summarizes the costs by labor category and determines the earned value). Although it is not evident from Figure 3, inputs from each of the other factors -- environmental uncertainty, customer urgency, and technological urgency -- impact the sectors.

For each level and type of labor utilized in the acquisition program, one replication of the model is needed. For example, if seven categories of labor are identified, then seven "CIMs" are needed to simulate the process. Since these categories are not independent (e.g., the design must be complete before testing can begin), some representation of the interfacing of each category of labor must be included. Figure 4 describes the linkage for a simple project with three types of labor categories.

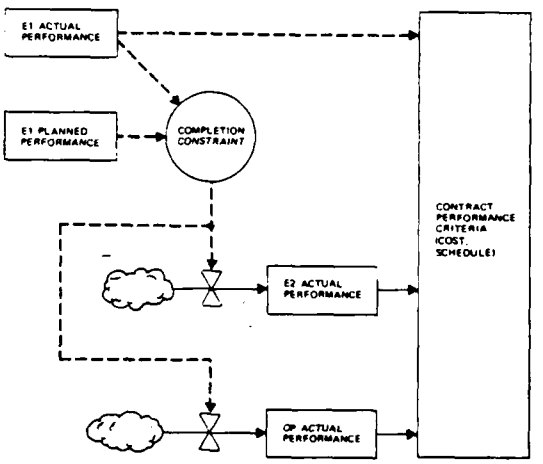

Figure 4. Performance Constraint Linkage

In this example, the E1 can be thought of as a designer with E2 and OP being the manufacturing engineer and test technician, respectively. In this model, a unit of work by E2 cannot begin until the preliminary requirements of E1's task are completed and met. A similar "cascade" effect exists for OP category. Thus, if the design is not completed as scheduled, not only does E1 fall behind schedule, but the E2 and OP level of performance varies from performance requirements.

Limitations and Uses of the CIM

Two limitations of the model should be noted. The first is that the model was developed and validated for a one-program organization. This limitation is not a serious one since it merely means that additional loops and interfaces must be identified and added to the model if it is to be used when more than one program is involved. The model would then be required to be validated in its expanded form.

The second limitation is becoming less of a problem as time passes. This constraint deals with software and its availability. Until recently, all of the computer languages that

adapted well to Systems Dynamics Simulation -- for example DYNAMO, SIMSCRIPT, SLAM -- were compiled only on large frame computers. With the availability of powerful personal computers (e.g., the IBM XT Personal Computer has a 10 megabyte hard disc and up to 256k main memory) discrete and continuous simulation compilers are being marketed now for personal computers.

Three uses of the model are program planning and control, pricing of program changes, and as a tool for seeking contractual relief. For program planning and control usage, the model will allow "what if" testing with regard to tradeoffs between schedule slippage and cost overrun. Also, manpower plans can be tested since the model allows control of learning curves and availability of labor segments.

Pricing of program changes can be done using the model. In this mode, a baseline simulation for the "as bid" or "contracted" conditions is developed. The changes are then made to the model to reflect the changes made to the contract and the differences in schedule and cost can be calculated. Since the simulation is time-phased and event-oriented, this type of analysis is readily accomplished.

A third use is as a tool for seeking contractual relief for constructive changes and/or delay and disruption costs. Similar to program pricing usage, this approach would center on acts or ommissions with regard to the contract and help identify these costs associatd with them.

Case Application

Figure 5a and 5b are plots of cost and schedule data from an actual contract. Figure 6a and 6b are simulation runs of the same contract. For

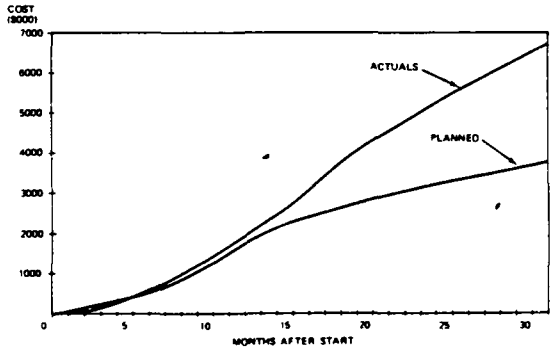

Figure 5a. Contract Cost Data

comparisons, note that the time base of Figures 5a and 5b is 32 months while the simulation time base is 40 months. The intent of the simulation was to predict program disruptions and overruns utilizing 'a priori' contractual data. Thus, correspondence in the shape of the curves was the objective. For this simulation magnitude of the cost values would be closer to actual had not average wages been used rather than forecasted labor rates by category.

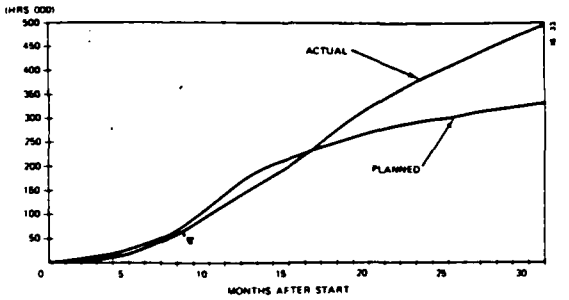

Figure 5b. Contract Schedule Data

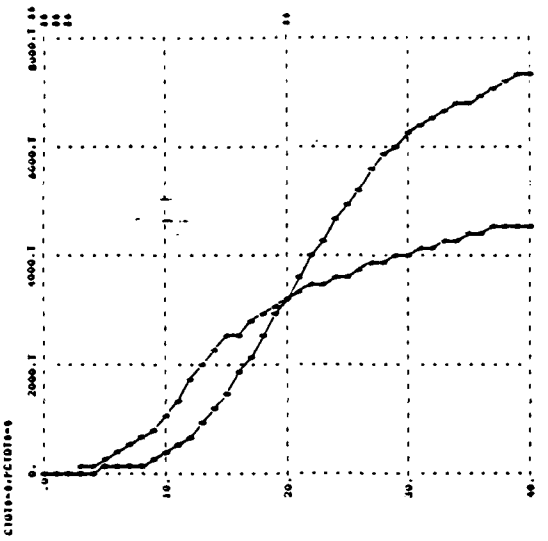

Figure 6a. Simulated Cost Data

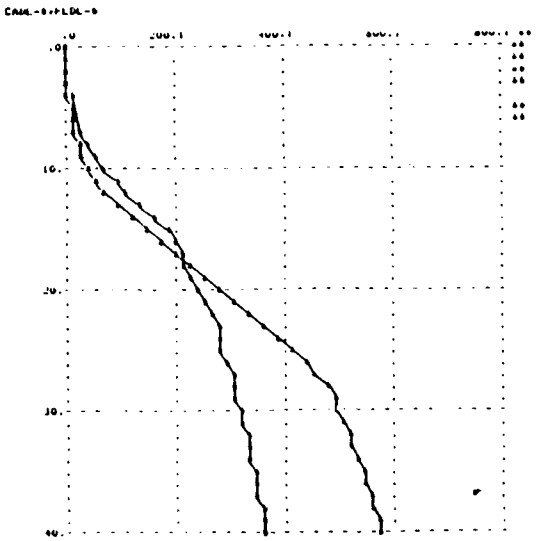

Figure 6b. Simulated Schedule Data

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AD P002787

AN AUTOMATED AIRFRAME PRODUCTION COST MODEL

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ABSTRACT

This paper is dedicated to developing a better understanding of the factors and forces that determine weapons system cost during production. Here we report on a tool that provides timely estimates of the cost impacts of program policy decisions. This tool was developed from theoretical principles. The economists production function was incorporated into a model which addressed the realities of program management. The model uses the calculus of variations to include the production cost drivers of learning by doing, learning over time, the speed of the production line and production line length. It is estimated from data on the C-141 program and tested on other Air Force programs. This work is fully documented in Cost Functions for Airframe Production Programs a report prepared for the Air Force Business Research Management Center and the Office of Naval Research by Womer and Gulledge.[8] This paper concentrates on the results and applications of that study.

INTRODUCTION

Due to cost overruns, Congressional concern, and a continuing need for better planning estimates, it is imperative that new techniques be developed and old techniques refined to obtain better cost estimates for major weapon system production and acquisition. Along with these techniques, a better understanding of the factors and forces that determine cost is required. In particular, the sensitivity of program costs to alternative policy decisions must be accurately estimated if we are to meet the challenge of providing wise acquisition policy. Furthermore, the cost impacts of policy decisions must be readily available if they are to have an impact in the dynamic world of systems acquisition.

The problems of estimating the cost of military aircraft are legion. Current methods of estimating costs are: (a) the parametric method, which generates simple, imprecise estimates which are insensitive to many production decisions and (b) the "bottoms up" industrial engineering method, which generates complex, imprecise estimates which must be substantially revised if almost anything changes. Neither of these procedures offer much help to the program manager who must develop appropriate funding profiles, lot release dates and delivery schedules prior to program start. They offer even less aid to the program manager who must respond quickly to proposed changes in funding and schedules prior to and during a production program.

In contrast to parametrics, methods recently developed at Clemson University, model the factors that influence cost during an airframe program. This work was jointly funded by the Air Force Business Research Management Center and by the Office of Naval Research. The work is carefully documented in the final report Cost Functions for Airframe Production Programs [8] by Womer and Gulledge. That research effort was to develop, test, and illustrate the use of a significant new approach to estimating the cost of an airframe production program. The theory was developed to unify previously separate methods of describing program costs. The effort was to result in a cost function that could be estimated from already collected data on Air Force airframes. Clemson was to provide the Air Force with a calibrated tool capable of providing timely answers to significant problems of program management.

These objectives were met by the revised model described in the final report. It was based on the four production cost drivers of learning by doing, learning over time, the speed of the production line, and production line length. The model focuses on the production of an individual airframe as a function of its start date and its planned delivery date. The model includes both technical features of the airframe production program and the contractor's behavior.

The first production cost driver is the concept of learning by doing. The basic idea is that as the cumulative number of airframes produced increases the unit costs (or at least labor hours) decreases. This component is the only production cost driver that is sometimes included in parametric cost estimates. It is commonly discussed in both the industrial engineering and the operations research literature, but the learning curve is only rarely mentioned in the economics literature on production and cost.

To aid our thinking about learning and the other production cost drivers, we follow Washburn [7] by adopting the concept of a production line as a frame of reference. Learning by doing affects cost by affecting efficiency at each position on the production line. That is, as the number of airframes passing each position on the line increases, yielding more experience, the efficiency at the position increases, thus lowering labor cost.

Notice that this process implies that at any point in time the experience on the production line may vary dramatically from the beginning to end. (In the C-141 program as many as two years elapsed between the lot release date and delivery of an airframe.)

The second production cost driver is a different learning effect. Over time, learning how

to produce more efficiently may take place due to events other than experience at a position on the production line. For example, early in a production program labor hours may be spent to learn how to produce more efficiently. Later in the program this may result in increased efficiency independent of experience at a point on a line. If this is the case, positions at the end of the line work more efficiently on the same airframe than positions at the beginning of the line. Or, this effect may be related to experience at other locations on the production line. That is, positions late in the production line may benefit from the experience of earlier positions, thus work at later positions proceeds more efficiently than work at early positions on the same airframe.

A third production cost driver is the speed of the production line. Unless compensated for by learning, increasing the speed of the line is expected to require more labor at each position on the line. Furthermore, due to diminishing returns, the additional labor required is expected to be more than in proportion to the increase in speed. Anyone who has observed activity around an airframe during production will recognize the likelihood of diminishing returns to labor on that airframe.

The fourth cost driver is the length of the production line. One way to increase delivery rate is to increase the number of positions on the production line, reducing the amount of work to be done at each position, and increasing the total amount of work accomplished per unit of time. If alternative length production lines are planned this driver may not be a source of variation in unit costs. However, if the length of the line is changed on short notice, unit costs may be affected. For example, increasing the length of the line may result in crowded facilities and overused tools and other fixed resources. This adversely affects the efficiency of production and may result in increased unit costs. This last effect involves an interaction among the airframes that are in the facility at the same point in time.

The model of production described in the next section represents an attempt to capture these effects in an estimable analytic model.

THE MODEL

Like the model in [10] this model augments a homogeneous production function with a learning hypothesis. The discounted cost of production is minimized subject to a production function constraint to derive the optimal time path of resource use. Since factor prices are assumed to be constant over the relevant time period, cost is measured in the units of the variable resource. The variables used in the analysis are:

i = the sequence number of an airframe, $(i=1,\ldots,n)$;

V = the average number of airframes in process;

t_{si} = the date work begins on airframe i; work on all airframes in the same lot is assumed to start on the lot release date;

t_{di} = the delivery date for airframe i;

$q_i(t)$ = the production rate at time t on airframe i;

$Q_i(t)$ = the cumulative work performed on airframe i at time t, i.e.;

$$Q_i(t) = \int_{t_{si}}^{t} q(\tau)\, d\tau;$$

$x_i(t)$ = the rate of resource use at time t on airframe i;

δ = a parameter describing learning prior to airframe i;

ε = a parameter describing learning on airframe i;

γ = a parameter describing returns to the variable resources;

α = a parameter associated with decreases in labor productivity as an airframe nears completion;

ν = a parameter describing returns to the length of the production line;

ρ = the discount rate;

C = discounted variable program cost;

C_i = discounted variable cost of a single airframe.

The production function is assumed to be of the following form:

$$q_i(t) = A(i-\tfrac{1}{2})^{\delta} Q_i^{\varepsilon}(t)(t_{di}-t)^{\alpha} x^{1/\gamma}(t) V^{\nu} \qquad (1)$$

where A is a constant. The input x is assumed to be a composite of many inputs whose rate is variable throughout the production period.

This production function represents an attempt to include the production cost drivers described in the previous section, it conforms to economic production theory, and it also accomodates the fact that the nature of work along the production line changes from position to position. On the other hand it is still a very simple function and it can only be expected to describe such a complex production process with some error.

The term $(i-\tfrac{1}{2})^{\delta}$ describes learning by doing in producing the ith airframe. The terms $Q_i^{\varepsilon}(t)$ and $(t_{di}-t)^{\alpha}$ represent attempts to describe learning that occurs over time during the process of producing airframe i. These terms also admit the possibility that the nature of work changes as the airframe moves down the production line. In particular, it is assumed that as the delivery date is approached it is more difficult to substitute labor for time in the production process. ε and α are both expected to be between 0 and 1. However, below it is seen that the effect of learning while producing an airframe and the effect of the learning prior to production cannot be separated with our data so the ε cannot be estimated.

Still one more term t^h would have been useful to include in the production function to model this effect. Unfortunately, we have been unable to solve the resulting control problem if time is included in this way.

The term $X_{ij}^{1/\gamma}(t)$ captures the effect of the speed of the production line. We expect γ to be greater than 1.

Finally, the term V^{ν} is intended to capture the effect of working on alternative numbers of airframes in the same facility. It is assumed that more airframes in the same facility results in a slight decrease in efficiency (ν is negative and small).

Although the objective of the firm is a function of the wording of the contract, one goal of most contracts is to induce the firm to minimize discounted cost. The problem may be stated as:

$$\text{Min } C = \sum_{i=1}^{n} \int_{t_{si}}^{t_{di}} x_i(t)e^{-\rho t}dt \qquad (2)$$

$$\text{s.t. } q_i(t) = A(i-\tfrac{1}{2})^{\delta}Q_i^{\varepsilon}(t)(t_{di}-t)^{\alpha}x_i^{1/\gamma}(t)V^{\nu},$$

$$Q_i(t_{di}) = 1, \quad Q_i(t_{si}) = 0. \quad (i=1,\ldots,n)$$

Since total cost is monotone nondecreasing and the sub-problems are additive, the solution can be obtained by minimizing each of the sub-problems. The representative problem for the ith airframe may then be stated as:

$$\text{Min } C_i = \int_{t_{si}}^{t_{di}} x_i(t)e^{-\rho t}dt \qquad (3)$$

$$\text{s.t. } q_i(t) = A(i-\tfrac{1}{2})^{\delta}Q_i^{\varepsilon}(t)(t_{di}-t)^{\alpha}x_i^{1/\gamma}(t)V^{\nu},$$

$$Q_i(t_{di}) = 1, \quad Q_i(t_{si}) = 0.$$

Except for the determination of constants this is the same calculus of variations problem that was solved in [9]. The reader is referred there for the solution procedure. Following that procedure yields the following resource requirement function:

$$x_i(t) = B(i-\tfrac{1}{2})^{-\gamma\delta}\Gamma^{-\gamma}[\rho(t_{di}-t_{si})/(\gamma-1),\alpha\gamma(\gamma-1)+1]$$
$$(t_{di}-t)^{\alpha\gamma/(\gamma-1)}e^{-\gamma\rho(t_{di}-t)/(\gamma-1)}V^{-\gamma\nu} \qquad (4)$$

where $B = A^{-\gamma}(1-\varepsilon)^{-\gamma}[\rho/(\gamma-1)]^{\alpha\gamma^2/(\gamma-1)+\gamma}$ and $\Gamma(\ ,\ )$ is the incomplete gamma function. This is the optimal time path for resource use on any airframe.

Since the data presented by Orsini is quarterly data, the quantity of interest is the total resource use over a quarterly period. If T_1 and T_2 represent the beginning and ending dates for a quarterly period, then the appropriate expression for airframe i is:

$$X_i(T_2)-X_i(T_1) = \int_{T_1}^{T_2} x_i(t)\,dt, \qquad (5)$$

and using (4) the integral is:

$$X_i(T_2)-X_i(T_1) = Z_i$$

where $Z_i =$

$$B'(i-\tfrac{1}{2})^{-\gamma\delta}\Gamma^{-\gamma}[\rho(t_{di}-t_{si})/(\gamma-1),\alpha\gamma/(\gamma-1)+1]$$
$$V^{-\gamma\nu}(T_1,T_2)\{\Gamma[\gamma\rho(t_{di}-T_1)/(\gamma-1),\alpha\gamma/(\gamma-1)+1]$$
$$-\Gamma[\gamma\rho(t_{di}-T_2)/(\gamma-1),\alpha\gamma/(\gamma-1)+1]\} \qquad (6)$$

Because of the nature of the data it is impossible to observe the quantity on the left side of equation (5). What is observable is direct man-hours per lot. This means that the observed quantity is:

$$\sum_{i=K_j}^{n_j} [X_i(T_2) - X_i(T_1)] \qquad (7)$$

where K_j and n_j are the sequence numbers of the first and last airframes in lot j. In this instance, the sum is the observed values of labor hours that are reported in Orsini's data set. This sum and the airframe delivery dates are the variables that are used to estimate the model.

EMPIRICAL RESULTS

To explore the applicability of the theoretical specification, the parameters in (6) are estimated using the C-141 data. This data is described in [8]. In an earlier model [9] all airframes in the same batch were assumed to be delivered at the midpoint of their delivery month. Here delivery dates are assigned by spreading the delivery dates evenly across the delivery month. Otherwise, this is the same data used in [9] and reported in Appendix A of [8].

Let $\beta_0 = B'$

and

$$\beta_1 = \alpha\gamma/(\gamma-1) + 1.$$

The model may be restated as:

$$\sum_{i=K_j}^{n_j} Z_i = \sum_{i=K_j}^{n_j} \beta_0(i-\tfrac{1}{2})^{-\gamma\delta}\Gamma^{-\gamma}[\rho(t_{di}-t_{si})/(\gamma-1),\beta_1]$$
$$V^{-\gamma\nu}(T_1,T_2)\{\Gamma[\gamma\rho(t_{di}-T_1)/(\gamma-1),\beta_1)] \qquad (8)$$
$$-\Gamma[\gamma\rho(t_{di}-T_2)/(\gamma-1),\beta_1]\}$$

Equation (8) is estimated using nonlinear least squares as implemented by SAS's Proc NLIN [5]. The results of this regression are presented in Table 1. Almost all of the parameter estimates seem to be significantly different from zero. However, the asymptotic standard errors for β_0 and ρ seem to be large. In the case of β_0 a scale parameter, this is not of much concern. If ρ is not much different from zero then the objective function in the optimization problem need not include the exponential term and more appropriate production functions might be used. This is a matter for future investigations.

The relatively high asymptotic standard error for ρ should not be interpreted as an indicator that the model does not fit the data well or that it is not correct. The asymptotic standard errors reported are calculated based on the assumption that the model is approximately linear in the parameters in the neighborhood of the estimate. This is extremely unlikely in the case of ρ. Another indicator that ρ is an important parameter is the fact that restricting ρ to be zero produces a model with substantially higher mean squared errors.

Table 1

Parameter Estimates and Asymptotic Standard Errors

Parameters	Estimates	Standard Errors
β_0	1.150	0.688
β_1	3.045	1.162
δ	0.484	0.064
γ	1.002	.004
θ	-0.440	.165
ρ	0.002	.004

MSE = 3.66×10^{10}

This functional form generates a time path of resource use for an airframe that conforms to our understanding of that process. Unfortunately, we cannot observe resource use by airframe. We can, however, observe the time path of resource use for the entire program. Figure 1 illustrates the predicted time path of resource use for the program and the actual resources used. While the model fits the data well (R^2 = .69) the model shows more variation with time than the data does. This is particularly true for the period between quarter 12 and quarter 18. In this interval the model first predicts that more man-hours should be used and then that somewhat fewer man-hours should be used. We suspect that this is because the model includes no penalty for hiring or firing costs. Therefore, even though the model predicts that the workforce should rise, then decline, and then rise again, the company (correctly) chose to maintain a more moderate sized workforce over the relatively brief peak and slump in requirements. If this is true, then a more appropriate delivery schedule should have permitted substantial savings on the program.

To further illustrate the sensitivity of the model to changes in the delivery schedule several alternatives to the actual delivery schedule were evaluated in [8].

Figure 2 illustrates one of these analyses. There the time path of resource use (equation (4) summed over i) for the actual program is plotted as a dashed curve. The alternative schedule has the first airframe in the program delivered one month later than reported in the actual delivery schedule. This is the solid curve. This causes the rate of resource use to be lower early in the program but higher as the new delivery date is approached. The net effect is a small increase in predicted program cost. This delivery schedule change operates by adding one month to the first airframe's production time increasing t_{d1}. The time from program start until first delivery ($t_{d1} - t_{11}$) is also increased. Furthermore, V is increased during quarters five and six. The effect of delaying this delivery increases the learning applicable to the first unit by providing more time prior to delivery, but this effect is offset by the fact that V increases (the number of positions on the production line increases). The net effect is a slight rise in program cost and a delay in program costs (and benefits).

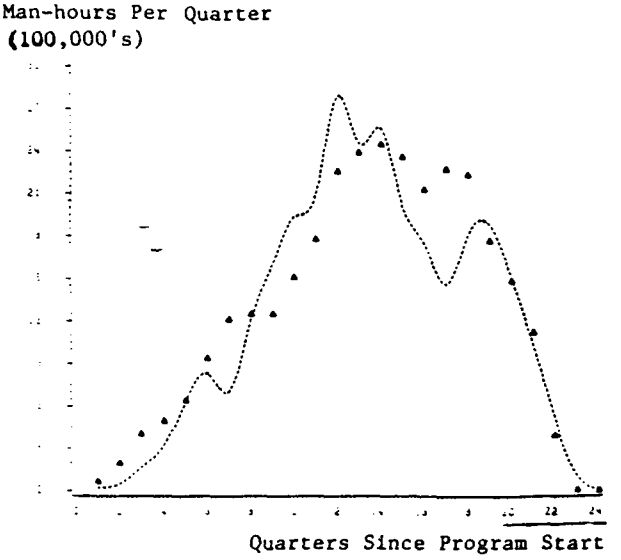

Figure 1. The Timepath of Resource Use

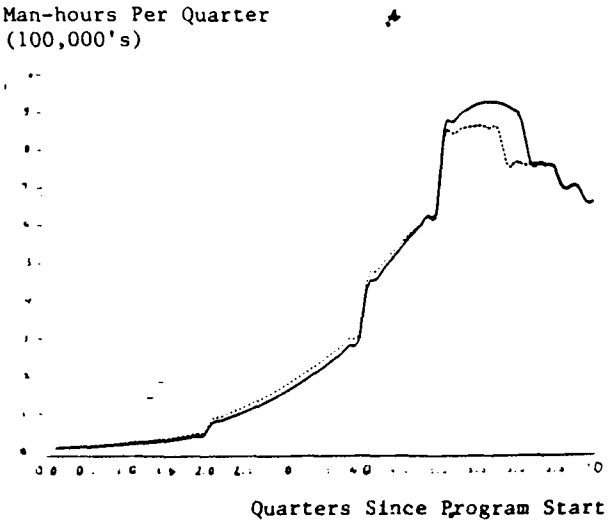

Figure 2. Deliver the First Airframe One Month Later

The sensitivity analyses of [8] clearly imply that some alternative delivery schedules would have resulted in lower costs for the C-141 program. If so, we must ask, "Why were these lower cost, higher benefit schedules not chosen?"

Certainly one possibility is that the decision makers know better than the model what is best. There are several areas in which flaws in the model may be important. One is the lack of hiring and firing costs. A second is the incomplete interaction among the airframes that is permitted in the model. To elaborate, the model does not permit work on an airframe to start later than the lot release date or to end sooner than the delivery date. From the point of view of the single airframe, neither of these events would ever be optimal. If starting late or ending early could affect V, then from the point of view of the program, they may be attractive. As it is now, V is completely determined by the lot release dates and the delivery schedule. Of course, more and better data might permit more accurate and different estimated parameters too.

On the other hand, it is also possible that with a tool which permits decision makers to grasp the program implications of funding cuts, stretchouts and of altered delivery schedules, more optimal decisions will be made. Management science is based on possibilities such as these.

APPLICATIONS TO PROGRAM MANAGEMENT

In this section these results are reviewed for application to program management decisions.

Understanding Production Scheduling

All too often both the critics and the friends of a particular program argue as if there are simple, almost trivial, relations between production schedules and program costs. Often the learning curve is the only relation used to discuss the implications of alternative production schedu[illegible] Likewise, when the timing of foreign milit[illegible]y sales is considered, only the learning curve is used to analyze the situation. The learning effect is the only production cost driver that is included in the Selected Acquisition Reports (SAR) to Congress on major programs.

Even without explicitly using the model, the four production cost drivers discussed above can be used to paint a word picture of the consequences of altering a program's delivery schedule. This could significantly increase a service's ability to communicate internally with higher authority.

For example, consider the sensitivity analyses depicted in Figure 2. There the first airframe's delivery was to be delayed one month. If a learning curve were used to analyze the situation, there would have been no affect reported. In fact, the effect on total program costs is not large. However, the effect is significant in terms of the timing of costs and the resources required for other airframes in the program. Delaying the delivery of the first airframe provides more time for learning on airframe one (driver 2), and it reduces the planned speed of the production line (driver 3) both these effects tend to lower cost. They are offset by the fact that work on airframe one is delayed to a time when there are more airframes scheduled to be in the facility. This increases V and the length of the production line (driver 4). Thus the cost of producing all the airframes in the facility is increased during the month that is added to airframe one's delivery date. While these effects are not large, they do amount to almost 300,000 man-hours. So they are not trivial.

This research has also contributed to the understanding of production scheduling by unifying earlier models of Smith [6], Alchian [1], and Dreyfuss and Large [2]. This is also of significance to the services. Without a generalized model, debate about the relations among production rate, delivery rate and program costs boil down to a matter of opinion. With the generalized model there will still be debate and opinion, but there are also explicit statistical tests that can be performed. The model provides a clear cut framework within which to address the various effects of alternative schedules. These discussions are not academic exercises. They occur in contract negotiations, the Defense Systems Acquisition Review Council process (DSARC), the Program Objective Memoranda process (POM), Cost Improve Improvement Group (CAIG) meetings and contract disputes. Thus, increased understanding of production scheduling can lead to higher quality decisions about defense programs at all levels.

Program Management and Monitoring

In addition to contributing to our general understanding of production scheduling, the revised model can be used for particular tasks in program management. For example, during contract negotiations the revised model may be used to evaluate a production rate variance formula similar to the one proposed for the A-10 contract (see Gaunt [3]). The contractor's proposed costs at alternative production rates can be compared to those forecasted by the model. This can be a significant basis for the negotiations about the clause. This is not to say that the model's forecasts are correct and the contractor's incorrect, but the model's forecast can serve as the basis for significant questions about why the contractor proposes a particular formula.

Likewise, the SPO can use the revised model as

an aid in constructing the delivery schedule for the program. With a small amount of programming, the costs of many alternative delivery schedules can be quickly compared. These costs together with other considerations can be used to choose the best schedule.

Given the production schedule the SPO may use the model to layout a funding profile for the program. This plan could project costs by month by airframe for the entire program. As actual costs are reported and work packages are completed, this profile could serve as a check on program progress. Slips in the schedule could be spotted quickly and small problems identified before they become large problems. In this use, the model could play a role similar to the actual cost of work performed-budgeted cost of work performed comparisons that are now made.

The model can also provide a SPO with a quick response capability. Educating higher authority about the costs of changing production schedules will not eliminate all the proposals for change. As a result the SPO must be able to respond quickly and reliably to proposals for changes in delivery schedules and funding profiles. The revised model provides the means to forecast alternative cost profiles for different delivery schedules quickly and accurately. It can also be used to find a set of delivery schedules that fit a particular funding profile. Therefore it provides this quick reaction capability. This capability is demonstrated in the previous section where five alternative delivery schedules were evaluated for the C-141 program.

Basis for Further Research

Still one more reason that this work is significant is the fact that it forms a strong basis for further research on production scheduling and program planning.

Certainly one area in which more work needs to be done is in the area of data consolidation. AFPRO's routinely collect data on airframe programs by month and by lot. This data is used for program management and by various defense audit agencies. Yet, for some reason, it does not seem to find its way to the permanent storage facilities like the ASD Cost Library.

The data that is collected there is almost all associated with cumulative labor hours by lot of airframes. In some instances, the labor hours are available by airframe, but the library does not collect monthly data on airframe programs. As a result, it is very difficult to find data of sufficient quality to estimate the model accurately.

For this study, only the C-141 data was in a form which permitted adequate estimation of the model's parameters. This success should provide the impetus to consolidate existing data from the AFPRO's at cost libraries. With more appropriate test data, the ability of the model to perform should be enhanced. This follow on research would fit nicely with thesis research in new graduate programs in cost analysis.

A second area for further research is the application of the model to other products; certainly engines and missiles are good possibilities. It may very well be that tanks, ships, and ammunition would also be appropriate items for this type of modeling.

There are also three areas in which the model itself might be enhanced. First, more work needs to be done on multiple product production functions. This will permit a more complete linking of the airframes to each other in the model. A second area of enhancement is the application of the model to alternative contracts. The model is based on the assumption that the contractor is motivated to minimize discounted program costs. In fact, the contractor's motivation depends on the wording of the contract. In principle a model that is unique to the contract can be derived. This could form the basis for choosing among alternative contract types. It could also provide a substantive case for multi-year contracting. Work still needs to be done in this area.

Third, the model should be expanded to include hiring and firing costs. This will tend to slow down and smooth out the model's reaction to schedule changes. As it is now, the model tends to react a bit too quickly and too strongly to changes in delivery schedules.

CONCLUSIONS

This study is not the last word on airframe production planning or cost estimation. It represents but one more step in our understanding of the factors and forces that determine the costs of a production program. Nevertheless, at this stage, we can offer some hypotheses about these forces that are consistent with the data we have examined so far. While these hypotheses are not in any sense proved, they have been derived with the use of the C-141 data and confirmed by data on the F-102 and the T-38 airframes.

The first point to be made is that production scheduling does matter as a determinant of program cost. It is clear that even very small changes in the production schedule have an impact on the timing and the magnitude of program costs. Second, it is important to realize that changes in the delivery schedule and in lot release dates cannot be easily summarized by a single variable like production rate or delivery rate. It seems clear that one of the reasons that past studies came to contradictory conclusions about the impact of production rate on production costs is that they asked the

wrong question. We conclude that questions about the relation between production schedules and program costs require an examination of four production cost drivers: learning by doing; learning over time; production line speed; and production line length.

Furthermore, we conclude that it is necessary to analyze the behavior of the contractor when developing cost models. Models which regard costs as mechanically related to other variables are destined to have problems in explaining real world data.

In addition, we find that the revised C-141 model is stable. It can be estimated reliably from early observations on an airframe program and used to predict later observations. The model also seems to be very stable among programs. When corrected for the scaling factor difference, a model estimated from one program does a reasonable job of predicting for a new program. Because of this, the services need to do a better job of maintaining and consolidating data on what will permit the model to be fully used. That is, existing data at cost libraries should be augmented by monthly data on aircraft programs. This data is regularly collected by AFPRO's and SPO's at the present time.

Because of these encouraging results, we believe that the revised model is ready for use on defense programs.

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AD P002788

RISK ANALYSIS: COMPARING DIFFERENT CONTRACT TYPES

George Worm, Pel, Inc.

ABSTRACT

This paper presents a brief description of how the results from a cost risk analysis can be used to distribute the risk in a contract between the government and the contractor. The main contract types discussed are Firm Fixed Price (FFP) and Fixed Price Incentive (FPI). Other contract types may be structured around a risk analysis but are not discussed here.

INTRODUCTION

The results of a cost risk analysis is the probability of exceeding different total costs for a contract. Numerous methods are available for the determination of these probabilities [1, 3, 4, 5, 6]. An example end-product of a risk analysis is presented in Figure 1.

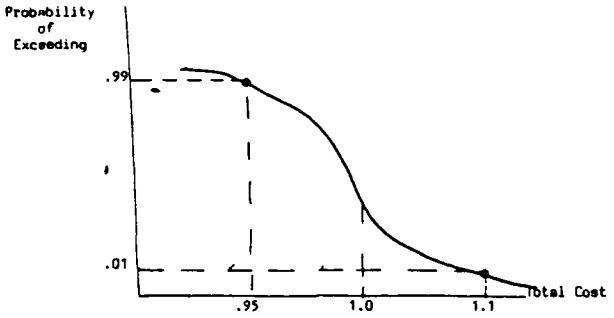

Figure 1

In this example, there is a 1% probability of exceeding 1.1 million and the most likely total cost is $1 million. In other words, there is a 1% probability of a 10% (1.1M) over run or a 5% (.95M) under run of the most likely total cost. The variation between .95 and 1.1 million is not under the control of either the contractor or the government. Contractor efficiency in the establishment of distribution shown has been assumed at a given level. Improved or superior performance will cause a shift of the curve to the left or right but not change the risk involved.

Two contract types are discussed here. The first is a Firm Fixed Price (FFP). For a FFP contract the price is set at a fixed value at the time of negotiations. Any over runs or under runs are absorbed by the contractor. The price negotiated is the total obligation of the government. The second contract type is more complicated in that several factors must be negotiated. A Fixed Price Incentive (FPI) contract is a way of tieing profit to cost. A target cost and target profit are established along with a share ratio and a ceiling cost. A FPI contract is illustrated below in Figure 2.

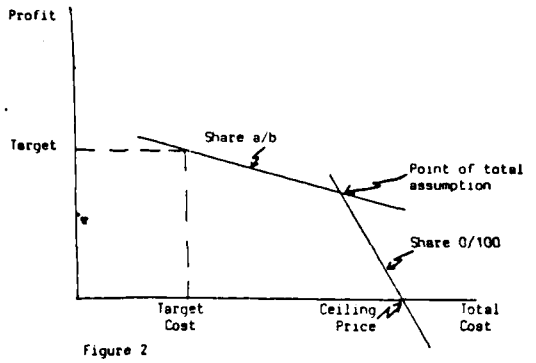

Figure 2

In this example, if the cost at the end of the contract is equal to the Target Cost, then the contractor is paid the Target Profit. If the cost over runs or under runs the Target Cost, then the government will pick up "a%" and the contractor will gain "b%" additional or less profit. At the "point of total assumption", the contractor will pay 100% of any excessive cost from profit. The ceiling price is the maximum government obligation. Note that the "Total Price" is equal to the cost plus profit.

A contract with estimated cost as shown in Figure 1 is a candidate for use of an incentive contract. Generally speaking incentive contracts have been written so that they offer the contractor a real incentive to meet or better the cost objectives of a contract (the target cost). An incentive contract also offers the contractor rewards commensurate with the risks he assumes.

A FFP type of contract usually incorporates a premium for the risk. The sharing of risk is negotiated at the time of writing the contract rather than based on the outcome of total cost as in an incentive contract.

Both the FPI and FFP contract structures are discussed in great detail in the Incentive Contracting Guide [2]. The discussion contained in the next section applies equally to other contract types commonly used.

COMBINING RISK ANALYSIS & CONTRACT STRUCTURING

This section contains three parts. First, there is a discussion of how risk analysis can be used to choose target cost, a target profit, a ceiling and a share ratio. Second, the difference between the cost to the government for FFP verses FPI contract types is presented. Finally, five contractor positions on FFP contracts are discussed. Throughout the remainder of this paper we assume that the risk analysis is a true reflection of the probabilities of different total costs.

Figure 3 places on a single graph the probability of exceeding different costs and an FPI contract structure. Currently the target cost being used in structuring incentive contracts is the expected total cost from the risk analysis. The Target Profit is established using the Weighted Guidelines which incorporates a factor for risk. The Warranted Profit is the Target Profit less the risk factor. The point of total assumption is currently assumed to be the cost for which there is only a 1% chance of exceeding. Each of these points are identified in Figure 3. The Share Ratio can then be calculated as:

$$\text{Share Ratio} = \frac{\text{Target} - \text{Warranted}}{\text{1\% Cost} - \text{Target Cost}}$$

The ceiling cost is then:

Ceiling Cost = 1% Cost + Warranted Profit

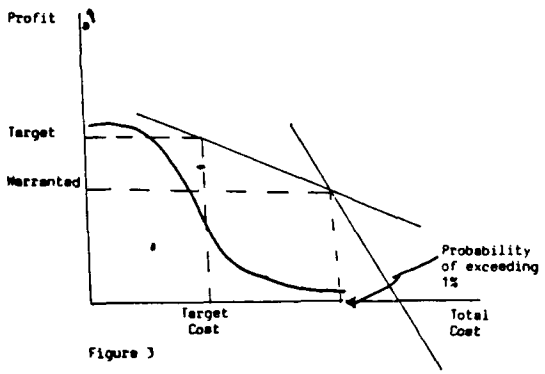

Figure 3

The thought process used in making the choices of Target Cost and the point of total assumption were that the target profit should be an average profit rather than a most likely profit and thus should be based on the expected cost. Furthermore, due to the common skewness of the total cost distribution the expected would be a more conservative estimate of the resulting total cost. The warranted profit is the desired profit if all risk is removed. Here we assume that a probability of 1% of exceeding has removed the risk.

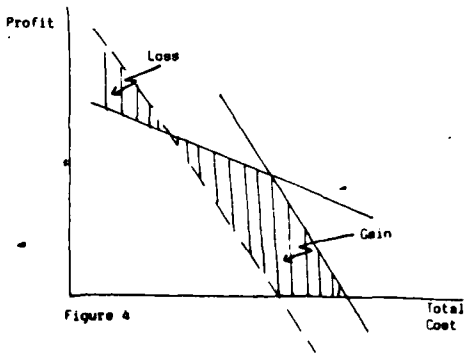

Figure 4

If we compare a FFP contract with a FPI contract, we can see that depending on the actual total cost, the government will either lose or gain (pay more or less). Figure 4 illustrates an FPI contract(solid line) and a FFP contract (dotted line). The FFP contract amount can be determined by the intersection of the dotted line and the x-axis. The vertical distance betweeen the FFP and FPI lines is the magnitude of the gain or loss

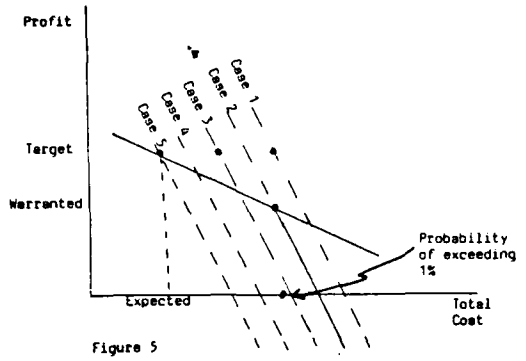

Figure 5

Figure 5 presents a comparison between FFP contracts and an FPI contract for five different positions which could be taken in the choice of an FFP. The reasoning behind each is given below:

Case 1: The contractor is 99% confident of covering the cost and making target profit.

Case 2: The contractor is 99% confident of covering cost and making warranted profit.

Case 3: The contractor is 99% confident of not losing money.

Case 4: The contractor is less than 99% confident of not losing money, but has a higher expected profit than target profit.

Case 5: The contractor has an expected profit equal to target profit, but must absorb over runs by reduced profit.

The point of the five cases is that an FFP contract of the form shown in cases 1 and 2 are not more beneficial to the government. Cases 4 and 5 may not be acceptable to the contractor if there is a considerable amount of risk. More than likely, Case 3 is more near what a compromise would look like. However, if we go back to Figure 4, the gain or loss by the government is not more than the warranted profit.

It is important to observe that the amount of risk will generally dictate which contract type should be used. For small amounts of risk an FFP contract is appropriate and for large amounts of risk a CP type of contract is appropriate. The FPI contract types are useful between the two.

SUMMARY

This paper has tried to show the importance of using risk analysis in the structuring of incentive type contracts. Probabilities from a risk analysis such as the ones shown in Figure 1 can be used to build a case for a particular contract type and to develop targets, shares and ceilings. It is important to use good judgement concerning the contract structure and to use risk analysis as only one input into the decision making process.

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COST GROWTH CONTROL

Panel Moderator: Colonel John D. Edgar
Dean, Department of Research and Information
Defense Systems Management College

Papers:

Managing for Success in Defense Systems Acquisition
by J. Stanley Baumgartner, Calvin Brown, and Patricia Kelley

Nuclear Reactor: On Schedule and Under Cost
by Robert D. Larson

Reshaping the Philosophy of Spare Parts Acquisition: Project PACER PRICE
by George Leininger

The Problem of Cost Growth
by Gerald R. McNichols and Bruce J. McKinney

AD P002789

MANAGING FOR SUCCESS IN DEFENSE SYSTEMS ACQUISITION

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Defense Systems Management College

ABSTRACT

This study, an offshoot of a DOD cost growth study, was conducted to identify elements common to successful programs, programs that met most of their cost, schedule, and performance goals, and worked well when fielded. Key government and industry officials of twelve "successful" programs were interviewed to find out how success is measured and what impact various forces had on the success of these systems. The primary measure of success is that the system worked well when fielded. Main elements of a successful program are stability, realistic requirements, good people, good leadership and, particularly, confidence and teamwork between the program office and the contractor. The PM's tenure, pushing the state-of-the-art in technology, and meeting the requirements of regulations and directives have little impact on the success of a program. Outside influences are, on balance, helpful. The people we interviewed enjoyed their jobs and the challenges of program management. One program manager said it was the finest job he ever had--high risk, high rolling. A Navy PM said it was the closest thing ashore to the command of a ship.

INTRODUCTION

What have we been doing right in defense systems acquisition that we want to repeat? That's the thrust of a study we made recently on successful weapon systems acquisition management. We were well aware of various studies in and out of the Defense Department that took the opposite approach. We wanted to find out what makes for success.

We learned that success is not just avoiding pitfalls where other programs have been less-than-successful. It is something different--in practices, purposes, and in the eyes of the program managers (PM) themselves. One difference is that most PMs don't see cost, schedule and performance goals as being their main objective. Their primary yardstick is "does it work in the field?" "Battle effectiveness, not cost effectiveness, is what wins wars!" declared a PM.

Many commonly held beliefs are valid, such as stability, the need for good people, and wide-open communications between the defense program office and its industry counterpart. Other beliefs don't hold up, such as "stay within the state-of-the-art" and "the PM should remain at least three years on his program." One program manager said, "We pushed hell out of the state-of-the-art." Continuity is essential, but not necessarily on the part of the program manager. His key staffers can provide the needed continuity.

What do successful PMs do differently? Sometimes it's a matter of what they do. In other cases it's more a matter of degree, such as their openness in communicating.

THE SUCCESS STUDY

Our first requirement was to determine what constitutes success: Success in both development and production? Success in one phase but perhaps not in another? Success on the current program only? Success in whose eyes?

We asked the Joint Logistics Commanders to nominate some successful programs, leaving the criteria for success up to them. They recommended a combined total of 52. We selected twelve, based on trying to obtain a mix in type of system, size and purpose, time frame and acquiring service. Most are reported on the Selected Acquisition Report (SAR). The selection of these programs as successes does not mean that they had no cost growth. A review of the SARs for seven of the successful programs shows growth, but the primary causes must be recognized: escalation, changes in quantities, and unrealistic initial estimates. Hellfire, CG-47, F-16 and the E-3A have substantial quantity increases; the FFG-7 quantity requirements have changed from 50 to 74 to 50 ships so far. The OSD escalation indices used for budgeting purposes were very low compared to the actual escalation experienced. On one program the initial, highly optimistic estimate given by the chief of the service to Congress is still used for then and now comparisons. The responsibility for the programs finally selected is ours. We are well aware that in this way we have eliminated others that are also successful.

The programs we selected are:

- FFG-7 Frigate
- CG-47 Aegis Cruiser
- Polaris
- F-16 Fighter Aircraft
- C-141 Cargo Aircraft
- BMEWS, the Ballistic Missile Early Warning System
- Atlas Ballistic Missile
- E-3A Airborne Warning and Control System (AWACS)
- Multiple Launch Rocket System (MLRS)
- Hellfire Missile
- CH-47 Helicopter Modernization
- Firefinder Radars

We identified present and previous program managers and their industry counterparts, then set about interviewing 47 of them using a 22-point questionnaire for defense program mangers and two 10-point subsets for their deputies and industry managers. We sought answers to the basic question posed above: what have we been doing right in DOD that we want to repeat? We believe the lessons learned will be valuable in the Defense Systems Management College curriculum and in the acquisition community at large.

One of the questions we asked was how PMs themselves measure success:

-- works well when fielded
-- meets cost objectives
-- meets initial operational capability (IOC) date
-- meets technical performance objectives
-- meets logistics supportability objectives

Their answer came back loud and clear. Sixty-eight percent ranked "works well when fielded" as most important. The least important, ranked last by fifty-eight percent, is the IOC date, which is perceived as an artificial date whose main purpose is to aid in planning and scheduling for training and logistics support. Meeting technical objectives was second in importance, closely followed by cost objectives.

REASONS FOR SUCCESS

The factors that make or made for success differ, but there are recurring themes. Reasons for success cited most often are good people, good program managers on both sides, realistic and stable requirements, a good contractor, and factors related to stability-personnel stability, funding stability and product stability. Here are the main factors for success.

People. Good people are an absolute must. So how did they get good people? Industry gets these people primarily by growing their own: selection, attendance at company and other acquisition related courses, and development by giving them a chance to show what they can do. "But," one manager mentions, "it takes time to develop them." The service PMs try to request people by name after careful, deliberate evaluation of their capabilities and background. The FFG-7 hired young engineers-in-training at the beginning of the project and has been able to retain them throughout the life of the project by promoting them from within. Both service and industry PMs said they fire those who are not performing.

Stability. This is a theme that permeates the reasons for success. Product stability depends upon realistic requirements (realistic for the funds available) and keeping changes to an absolute minimum. An Army PM notes, "Systems that have problems are those with lots of changes, especially with the user pushing for them." Stability in funding is also essential. VADM Levering Smith of the Polaris program is admired for his frankness in advising Congressional committees on what it would cost to achieve a particular level of performance. When he was pressed to lower this figure, he explained how this would buy less performance. Over the nearly 30 years of the program this straightforwardness has stood the test of time.

Interestingly, time pressures often are a factor in stability and success. The reason - a clear national need. As a result, outsiders who might be inclined to dabble in the management of a project are less likely to do so. Some multinational programs enjoy similar benefits of "hands off" treatment because of their management complexity. Since multinational programs often receive high level attention, intermediate levels tend to leave those programs alone.

Ability of the PM. This is a vital element reflecting operational background, leadership ability, and education for the position of program manager. Sub-items are ability to gain the confidence of higher levels (including not asking for additional dollars each year); ability to motivate a team; tenacity in driving toward program goals; and, usually, maintaining good relations with higher authority. A t ait common to almost every PM is an aoility t communicate well with all types of audiences.

In every case, it was clear who ran the show - the PM. Sometimes this was stated in some form of directive. More often though, the PM took the authority he thought he needed to do his job. This didn't always make him popular, of course. In one service the question arose whether dedication to program objectives may be a hindrance to career objectives.

Continuity. The continuity of key individuals is necessary, but not necessarily the continuity of the PM. One program has had five PMs in a little over seven years. On the other hand, Polaris had only three PMs during its first 21 years. RADM Meyer had been the first and only PM on the Aegis cruiser since 1970. The key factor again is stability, with continuity being one important aspect.

Acquisition Strategy. Contractors themselves give credit to acquisition strategy as a reason for program success. On the Hellfire program, the service PM established second sourcing as a principle of acquisition strategy. This tended to sharpen the competition and keep a discipline on costs, schedule and technical performance.

The MLRS program employed competition with source selection based on "ammunition cost effectiveness" which forced the contractors to optimize technical performance within a cost envelope. MLRS also used "design to unit production cost" as a primary criterion in evaluating proposed changes. The acquisition strategy for MLRS included the evaluation of the relative cost effectiveness of multiyear procurement versus second sourcing. The FFG-7 acquisition strategy employed ship system design support which provided for design support by prospective shipbuilders during the early stages of ship design; lead ship-follow ship concept, with a schedule interval of two years between their construction in order to implement lessons learned from the lead ship; government validation of drawings and other technical data; utilization of landbased test sites for integrating ship subsystems; and the use of grooming sites for repairing, testing, and delivering government furnished equipment.

Resources. It would be easy, and understandable, for observers to conclude these programs are successful because they had everything going for them, including high level backing, connection to a national need, choice of personnel, and funding.

In analyzing and discussing the question of success because of resources, or resources because of success, we came to two conclusions: 1. None of these successful programs would have "flown" if they had been unsuccessful in technical performance or had costs that soared above budget. 2. After a need has been established and a project is under way, there is a period of a year or so during which the PM has an opportunity to demonstrate that higher levels' confidence is justified. Then, the resources, attention, and other advantages seen in hindsight become available.

Of the programs we studied, all had to prove or demonstrate their probability of success, their ability to do what they were being developed to do. Polaris and Atlas, classics in systems management, emerged after indecision and delays that might have killed other programs. A high official said of early Navy efforts to establish a long-range missile capability, "The Navy was really in danger of being read out of its ballistic missile altogether. There just wasn't enough money in the defense budget."[2] Success looks easy in retrospect.

Multinational and coproduction programs usually receive adequate funding. At least three of the successful programs which were part of this research project have received Congressional support and funding partly because of their NATO and foreign military sales aspects.

State-of-the-Art. Seventy-eight percent of the managers contacted reported their programs pushed state-of-the-art technology and felt this had a positive, motivating effect on their programs' success. On the other hand, those whose programs did not push the state of-the-art also felt this had a positive effect on the success of their programs. Polaris pushed the state-of-the-art in five or six different areas simultaneously. This in fact had a lot to do with acceptance of the program. An industry manager regarding the state-of-the-art, made this perceptive comment: "I don't believe this (advancing the degree of state-of-the-art) is critical to the program success, so long as you don't have incompatibilities between state-of-the-art, program goals and program commitments."

From this, we conclude that program success is not determined by the technological state-of-the-art, but by associated risks, and these risks must be adequately funded to avoid cost overruns. These results seem to refute the belief that successful programs depend on proven technology.

The Contractor. One of the questions asked of government managers was whether they had an integrating contractor. Ninety percent of the service PMs did have an integrating contractor, usually the prime. This contributed to the program's success. We also asked them about the technical expertise and management ability of their contractors. With few exceptions, all of the PMs responding to this question characterized their contractors as being very good or excellent.

A strong common theme, one that recurred often throughout the interviews, was openness and frankness on the part of both the PM and his industry counterpart. There is no substitute for the confidence and team spirit that develop from this straightforwardness.

It is interesting to note that two of the particularly successful contractors had been involved in other less-than-successful programs. The difference seems to be the working relationship between the program office and the contractor.

DOD and Outside Agencies. We asked the government program managers whether the success of their program was helped or hindered by outside government influences such as the user, supporting agencies, higher command headquarters, service headquarters, DoD, Congress and GAO. Slightly over half of the responses to this question said that overall outside influences were a help rather than a hindrance. One PM listed six separate outside influences that had hindered his program; but he then said that in the long run, the hindrances had helped. The problems and stumbling blocks encountered helped his office sharpen their skills, knowl-

edge and abilities.

In general, if the other levels agreed with a program's objectives, if the PM kept them informed and got them working together and gave them the feeling that the program was theirs also, the PMO was helped rather than hindered. VADM Raborn brought even the GAO and the Secretary of the Treasury onto his team of supporters.

The hindrance or adverse "outsider" effect mentioned most often concerned staff personnel at the service or DOD level. One PM stated "There are a lot of people in the Pentagon who can say No - and cause you a lot of delays and other problems - but do not have the authority to say Yes." Another common complaint from both government and industry managers involved the numerous time consuming audits performed by DOD and GAO inspectors. In most instances, new inspectors had to be taught the program before they could perform the audit.

Outsiders tend to leave a program alone if it is going well. PMs varied in their reactions of how to cope when there are problems. One PM said that when someone outside his office tried to force him to do something, he explained what the repercussions would be. If the person persisted, the PM said he would tie the person's name to the required change and its related cost and schedule changes so that everyone throughout the briefing cycle would know who was pushing for that change. Usually, the person backed off.

The PMs gave Congress credit for, on balance, being a help rather than a hindrance. One PM suggests, "Brief them. Talk to the staffers, the Representatives and the Senators. Answer them truthfully. Be credible. Don't try to con them. Explain the national defense need that the program is filling."

We also asked the program managers how they dealt with micromanagement. The approach generally followed was to be open, and to keep outside agencies informed on what was happening on the program. Some, however, said they didn't volunteer information, although they answered all questions without elaboration. "Being truthful is different from being candid, though," one PM stated.

DOD Directives and Regulations. We asked both government and industry program managers which regulations or directives caused problems and contributed to program costs. Their answers surprised us. Most of the responses indicated that regulations and directives didn't cause any significant problems. Two even said that specifications and standards are written for good reasons, are important and useful, and are not a waste of time.

No single regulation or directive was cited as a culprit. Most program offices tailor directives to what makes sense to them, or they ask for waivers. The PM himself generally doesn't get involved in the administration of directives and regulations.

We also asked for observations regarding DOD Instruction 7000.2 on cost performance measurement. The response, with a couple of qualifications, was generally favorable. One Army PM said that he looked into reducing the cost of various reports, including the cost performance report. The reports' total cost was $4 million, but he found that his contractor would use the reports for his own management purposes anyway; the most the PM could save was ten percent.

The ease with which current PMs relate to levels of approval and administrative requirements is remarkable. The PM on one of the early programs said of the current environment, "We spend more, trying to avoid mistakes, than if we made mistakes. Time is money." On the various requirements, justifications and bureaucratic red tape the PM must live with, he said, "Now we have echelons on echelons...the Soviets couldn't have imposed a more restricting system!" Defense and Congressional staffs have grown tremendously over the past decade or two, and life for the PM has grown more complex. But the current PMs are well-equipped, by temperament, experience and education, for coping with their jobs. They like what they are doing.

INDUSTRY AND SERVICE OBSERVATIONS

As an illustration of how well industry and the services work together, no significant differences in practices, goals, methods or other factors surfaced during our study.

We asked managers in both industry and government to rank eight factors for successful program management. In slightly abbreviated form the factors are:

- Establish a teamwork relationship of mutual trust between government and contractor program management.
- Understand the program objectives.
- Have good, visible program plans.
- Get accurate and timely information on actual progress.
- Note deviations between planned and actuals.
- Take corrective actions.
- Make friends for the program.
- Establish total program definition at the start of the program.

The overwhelming majority rated teamwork and mutual trust as the most important. The next most important was ensuring that everyone really understand program objectives. The two

tasks rated lowest require some explanation. One of these is "make friends." The reason for this ranking is that if the item produced works as it should, making friends is incidental to the system's objectives. As expressed by one PM, "if a program is managed correctly, it is bound to make some enemies because some people will not get what they want individually."

Also ranked low is "establishing total program definition at the initiation of a program." Most PMs felt the initiation of a program is much too early to establish total program definition. Their rationale is clear when one recalls that most of these programs pushed the state-of-the-art in technology.

All individuals cited open communications as a basic practice. An industry spokesman refined this somewhat: "We had many informal channels, but we and the Navy require very careful control of the formal channels." Most of these programs involved high-risk technological advances and used cost-type contracts. Several industry executives said this contractual arrangement tended to promote communications. On lower risk programs, we see no reason why fixed-price contracts should inhibit communications.

Industry's view of what makes a successful PM is similar to DOD's: bright, flexible, intent on results, able to make right but timely decisions (right 75% of the time), good health and business acumen. On a high technology program, he should also have some type of technical background.

TIME PERSPECTIVE

One factor in selecting the dozen programs we looked at was to find whether there are significant differences in program management now from what it was earlier. Most of the programs are fairly recent. The C-141 and BMEWS programs go back to the 60s. Going back even further, there's Polaris, famous for both management and technical breakthroughs, and Atlas, an outstanding program and the forerunner of modern project management dating from 1954.

As might be expected, there are differences between program management as practiced earlier and as it is today. But an observer is struck more by the similarities than the differences, quite a compliment to the pioneers who blazed the trail.

Similarities, Then and Now. Although the degree of authority of the PM has changed - generally less now than formerly - one critical aspect has remained constant - the PM has used his authority. Successful program managers have taken authority where it is not specifically granted. One PM has said, "Any PM has as much authority as he is willing to step up and take."

The need for strong leadership remains constant, regardless of a program's era - dedication and determination to get the job done well, ability to attract good people, ability to communicate well.

Other similarities pertain to requirements. Typically, a successful program's requirements have been established early, and are realistic for the resources available. Plans are definitized early and requirements stay virtually intact throughout a particular phase of a program. The type of contract is appropriate to the risk and complexity of the particular phase.

Differences, Then and Now. There are far more directives, regulations and "help" now than during the early programs. But today's PMs do not view this as a major problem, perhaps because they have learned to survive in the present environment.

A more obvious difference relates to the climate of the times. In the time of Atlas, Polaris, C-141 and BMEWS the need for each system was clear and these programs received strong, high level support. There was greater urgency and team spirit then and the PMs strove diligently and successfully to develop this spirit.

The needs today are generally not as clear, the urgency is not so apparent, and perhaps the support is not so strong. One PM on an early program says, "(these higher levels) were 95% helpful. We made friends; they didn't try to manage for us."

The PM in earlier days was freer to make mistakes. This may have been part of pushing the state-of-the-art. VADM Levering Smith, the technical director and subsequently the PM on the Polaris, says, "When making new things, you have to expect surprises."

PMs' RECOMMENDATIONS to PMs

The final question in our discussion with PMs was "Do you have any other recommendations that might benefit program managers on other defense programs?" Some responses follow:

"Tell a new PM that it is important to baseline his program - not just cost, but technically also so he really understands what's there..." "Have your program planned out in as much detail as possible, as early as possible, so that there is a comprehensive baseline from which to evaluate changes."

A senior PM said, "Be in charge - 100%. Keep people off your program, take charge, don't give your program away. Limit outside influences on your program to those which you

request." One program office has a sign that reads "Do not participate in our decision-making unless you share the consequences."

An area noted by several individuals was the importance of getting and developing the best people possible and then giving them authority and responsibility. One PM commented, "The biggest problem a PM faces is saturation. If the PM insists on making all the decisions he gets into overload. Let your people make the decisions they can make and save the big problems for the PM. Successful program management means you get the broadest participation throughout the organization. Real success is measured by how few decisions the PM has to make. Ultimate success mea the PM makes no decisions, just sets the program objectives."

"Create a program office team atmosphere and everyone must aggressively manage - not just the PM. Delegate authority within the office and hold people accountable. Let people have latitude to make this happen and feel that they are responsible."

"Establish open communications with the contractor and maintain mutual respect for all decision making. Seldom are decisions popular to both sides. The contractor must understand why you are making the decision and respect it."

"Understand the contractor. It takes a team of the contractor and the PM to build a supportable system. They must agree it is the best they can do. Have a good interface with the contractor. There is no need for an adversarial relationship."

"Do not keep problems to yourself; surface them and work them. Determine who - government or contractor, by name - is responsible for solving the problem. You have plenty of good experience available within the program office - use it."

They also emphasized the need to be cost conscious. Regarding funding, the consensus was, "Know how to protect your money and don't let anyone take it away from you. Let those who try know what the repercussions will be if they succeed."

"Don't ask for permission to act in Washington. Don't be reluctant to act when you know what you are doing." "Make timely decisions; don't procrastinate; make them as naturally as possible. Don't agonize over decisions; make the best one you can, as soon as you can, and get on with it."

CONCLUSION

The basic question asked of PMs was the reasons for success on their programs. The reason most often given was good people, followed by good program management, good relationships between the contractor and the PMO, good contractors, firm requirements and stability. The differences in what makes for success are minimal, regardless of service affiliation, size or type of program, and time period.

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ADP002790

NUCLEAR REACTOR: ON SCHEDULE AND UNDER COST

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INTRODUCTION

The National Society of Professional Engineers has named the Fast Flux Test Facility (FFTF), an experimental nuclear reactor cooled by molten sodium, one of the nation's ten top engineering achievements of 1982. The reactor is located at Richland, Washington.

The FFTF's core simulates the high temperatures, pressures, and intense neutron radiation expected in breeder reactors, allowing scientists to test various alloys and fuels for breeders of the future. Breeders are reactors that create or "breed" more plutonium fuel than they consume, thus expanding potential energy supplies. The FFTF was built over a 10-year period. It began regular operations in April 1982.

In the early 1970's, there were serious concerns whether the reactor would ever be built because of cost overruns, schedule slippages, design changes and a general lack of confidence in control of the project.

Several major management actions were taken to assure that the design-construction project was completed within the cost and schedule re-established by Congress in 1975. While these actions are listed below the major management tool used to incentivize the design-construction contractor and assure completion of the project within the new schedule and budget was the cost plus award fee, cost plus incentive fee contractual arrangement developed for this project.

1. Organize a Government project office with highly qualified and dedicated technical and management personnel.
2. Projectize both the prime contractor and major design-construction subcontractor with excellent personnel.
3. Develop a zero base budget and schedule.
4. Establish a Change Control Board for design changes.
5. Convert the cost type contract to an incentive arrangement.

The uniqueness of this incentive arrangement was that the subcontractor for the design and construction had to save funds from the target cost for funds to be available to pay the award fee. The contractor was evaluated and officially rated for each six months performance period against established goals issued by the Contracting Officer prior to the start of each performance period, but was not paid the award fee until the total project was completed. This CPAF/CPIF arrangement assured the Government that it was not placed in a position where it paid award fee at each performance period and then realize the contractor would overrun the cost and schedule at the end of the project.

OVERVIEW

A Government project office was established in 1975 with approximately 50 employees which managed the prime operating contractor of approximately 3000 employees and the subcontractor who performed the design and construction function with approximately 10,000 employees. This organizational structure required that the Government project office have a management tool to control the pyramiding organizations which had the responsibility to complete the project within schedule and budget.

One of the first management actions the Government project office initiated was to convert the prime and major subcontractor contracts from cost plus fixed fee to incentive arrangements. The prime contractor's contract for overall management responsibility was converted to a cost plus award fee arrangement.[1] The major subcontractor's contract for design and construction was converted to a combination cost plus award fee and cost plus incentive fee arrangement.[2]

The following discussion will explain the subcontractor's unique incentive arrangement and the results:

- Incentive Arrangement
- Target Cost
- Controls of the Award
- Final Fee Determination
- Changes to the Target Cost
- Results of the Incentive Arrangement

INCENTIVE ARRANGEMENT

An award fee pool of 5 million dollars was negotiated for the period July 1, 1976, through

the completion of the project estimated to be in 1978. There were four performance periods of six months each with an award fee weighting factor for each period of 25 percent. Changes to the performance period and the weighting factor could be made unilaterally by the Contracting Officer prior to the start of each period. Criteria used in determining the performance rating for each period was established unilaterally by the Contracting Officer along with the weighting or importance of each criteria. These functions are the usual requirements for a cost plus award fee contract.

A performance rating of the subcontractor for each performance period was determined by the prime contractor subject to approval by the Government Contracting Officer. The subcontractor was advised in writing, within 30 days after the end of performance period of the decision in regard to award performance rating. The evaluation and rating of the subcontractor's performance was in accordance with the following adjective ratings and corresponding numerical values.

Excellent	81-100
Very Good	61-80
Good	41-60
Average	21-40
Acceptable	1-20
Minimum Acceptable	0

The overall Subcontractor Award Performance rating would be computed as the sum of the products of the earned performance points (1-100) for each performance period multiplied by the award performance period weighting factor for each performance period. This process can be summarized as follows:

Award Fee = Savings X Total Award Fee Rating Percent

The following are three examples of how the incentive arrangement would operate. The subcontract had a maximum award fee pool of 5 million dollars which could not be paid until the end of the subcontract. No award fee would be paid if no savings were developed from an underrun of the target cost.

AWARD FEE UNDER $5M

TIME:	4 PERFORMANCE PERIODS, 6 MOS. EA.			
POINTS:	1-100	1-100	1-100	1-100
RATING:	80	60	40	80
WEIGHTING:	25%	25%	25%	25%
TOTAL RATING:	20	15	10	20 = 65
TARGET COST:	$459M			
ACTUAL COST:	$453M			

SAVINGS: $6M
AWARD FEE: $6M X 65% = $3.9M

MAXIMUM AWARD FEE

TIME:	4 PERFORMANCE PERIODS, 6 MOS. EA.			
POINTS:	1-100	1-100	1-100	1-100
RATING:	80	60	40	80
WEIGHTING:	25%	25%	25%	25%
TOTAL RATING:	20	15	10	20 = 65
TARGET COST:	$459M			
ACTUAL COST:	$450M			

SAVINGS: $9M
AWARD FEE = $9M X 65% = $5.8M, BUT SINCE MAXIMUM AWARD FEE IS $5M, THE SUBCONTRACTOR WOULD RECEIVE AN AWARD FEE ON $5M

NO AWARD FEE

TIME:	4 PERFORMANCE PERIODS, 6 MOS. EA.			
POINTS:	1-100	1-100	1-100	1-100
RATING:	80	60	40	80
WEIGHTING:	25%	25%	25%	25%
TOTAL RATING:	20	15	10	20 = 65
TARGET COST:	$459M			
ACTUAL COST:	$459M			

SAVINGS: 0
AWARD FEE = $0 X 65% = 0

TARGET COST

The target cost was a key element in the incentive arrangement and was estimated at $459,435,000. It is summarized as follows:

a.	Direct Materials	$102,677,000
b.	Subcontracts	61,240,000
c.	Labor	226,232,000
d.	Overhead	26,751,000
	Subtotal	$416,900,000
e.	Escalation	23,739,000
f.	Contingency	18,796,000
	Total	$459,435,000

This estimated target cost was developed by a bottoms-up estimate of the project at a time when most of the design of the reactor was complete and 33 percent of the construction was complete. The target cost was audited by the Defense Contract Audit Agency. The audit was then used in the negotiations. After negotiations the subcontractor certified that the

resulting negotiated costs were accurate, current and complete.

TARGET COST ADJUSTMENT

The subcontract had a mechanism to allow for adjustment of target cost under a very formal procedure. This procedure was managed by a Change Control Board. The Change Control Board would meet and discuss the proposed cost changes and then recommend to the Contracting Officer whether the target costs should be adjusted upward or downward based on directions issued by the prime contractor or occurrences beyond the control and without fault of the subcontractor. Directions issued by the prime contractor to correct deficiencies in performance were not included in the adjustment of target cost. Agreement between the subcontractor and prime contractor for these adjustments in target cost were attempted, but a final decision was made by the Government Contracting Officer and was not subject to the Disputes Article in the contract.

CONTROL OF THE AWARD

The subcontract provided for specific controls on the award fee arrangement. The functions and responsibility are shown in the following chart.

	Prime Contractor	Subcontractor	Govt
Establish Evaluation Criteria Prior to Start of the Performance Period	Unilateral	Consulted	Approve
Award Performance Periods Determined	Unilateral	Consulted	Approve
Award Performance Rating	Unilateral	Consulted	Approve
Adjustment of Target Cost Through Change Control Board	Consulted	Consulted	Approve
Award Fee Decision	Unilateral	Consulted	Approve

The prime contractor had the responsibility to develop goals, evaluate the performance and determine the rating for each performance period. However, the Government Contracting Officer had to approve each of these functions prior to the prime contractor advising the subcontractor in writing of the action.

FINAL FEE DETERMINATION

The subcontract provided for an award fee to be made based on recorded costs, at the end of the project, plus the estimated cost of any remaining minor work. Any disagreement as to the estimated cost of the remaining work would be determined by the Contracting Officer and not be subject to Disputes. The award fee would be adjusted, if required, when actual costs for all work under the contract became known. This was necessary because the Government close out process is usually not accomplished until at least a year after contract completion and the subcontractor should receive the award fee payment in a more timely manner.

The procedure of paying award fee based on book value and estimated residual costs prior to obtaining actual costs exposed the Government to some risk. This risk was paying award fee which must later be withdrawn because adjustments to actual costs would either reduce or eliminate project savings. However, the risk is reduced by keeping the provisional billing rates as current as possible in relation to actual costs.

While the award fee decision is not subject to the Disputes Article under the basic contract, the subcontractor had a choice to either accept a determination that certain costs were unallowable under the subcontract, which would reduce the costs incurred to the project, make its savings greater, and increase any potential award fee, or follow the Disputes route in attempting to recover costs determined unallowable. These unallowable costs would be identified in the close out audit, but determined by the Contracting Officer.

CHANGES TO THE TARGET COSTS

Initial Target Cost	$459,435,000
Target Cost Adjustments	21,420,236*
Final Adjusted Target Costs	480,855,236

*Included a six month strike which added $13,863,984 to the original target cost.

Each change to the target cost was documented on a Project Change Control form which was concurred in by the Change Control Board prior

to issuance to the subcontractor by the Contracting Officer.

RESULTS OF THE INCENTIVE ARRANGEMENT

The actual performance ratings for each period and the final performance period are shown below:

AWARD PERFORMANCE PERIOD	AWARD PERIOD WEIGHTING FACTOR	PERFORMANCE POINTS EARNED	AWARD PERFORMANCE RATING
July-Dec 1976	.15	78	12
Jan-June 1977	.40	91	36
July-Dec 1977	.30	92	28
Jan-July 1978 (Subcontract Completed)	.15	91	14
Total:			90

The overall subcontractor rating was 90 of a possible total of 100 performance points. This corresponds to an adjective rating of excellent as defined by the subcontract.

Based upon actual completion cost and the target cost, the subcontractor award fee computation on September 1978 was as follows:

Target Costs	$480,855,236
Actual Costs	423,587,331
Savings	$ 57,273,905
Final Contract Award Fee Rating	X 90 percent
Award Fee Pool	$ 51,546,515

CONCLUSION

Based on the above calculation, the subcontractor earned the maximum amount of award fee of $5 million available under the subcontract. Under this incentive arrangement the Government completed its nuclear project on schedule with a $57 million underrun of which the subcontractor was rewarded with an incentive bonus. This incentive arrangement was one of the major management tools that helped bring this large construction project under control.

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NOTE:

MUCH OF THE INFORMATION IN THIS PAPER IS THE RESULT OF THE AUTHOR'S PERSONAL EXPERIENCE WHILE WORKING FOR THE FAST FLUX TEST FACILITY PROJECT OFFICE AND SHOULD NOT BE CONSIDERED A STATEMENT OF DEPARTMENT OF ENERGY POLICY.

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RESHAPING THE PHILOSOPHY OF SPARE PARTS ACQUISITION: PROJECT PACER PRICE

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ABSTRACT

On June 1st, 1983, a new program called PACER PRICE began operation at the Oklahoma City Air Logistics Center. Staffed by an interdirectorate group of engineers, manufacturing planners, price analysts and packaging specialists, the program was designed as a thorough and comprehensive review process to determine optimum purchase method and price for every actively-purchased replenishment spare part managed at the Center.

After three months of program operation, approximately 62 percent of the sole-source items have been recommended for competitive purchase, and the prices recommended for these items average about 35 percent below the latest contract prices adjusted for quantity and inflation. But beyond that, a new "philosophy" of spare parts purchase has been formulated and effected as a procedural caveat: All spares should be both purchased competitively and PRICED TO CONFORM WITH COMPETITIVE-MARKET PRICES. The paper focuses on this philosophy, detailing in particular the mathematical models used to simulate competitive prices, and offers suggestions for further research into the competitive market place.

INTRODUCTION

On June 1st, 1983, a new acquisition review program officially began operations at the Oklahoma City Air Logistics Center. A twelve member, interdirectorate group of personnel had been assembled for the purpose of providing nothing less than a detailed, comprehensive review of every item in the active spare parts inventory at the Center. Based on the results of their investigations, the group would recommend both the optimum method of acquisition as well as the most cost-efficient production quantity and unit price at which each item ought to be purchased. All recommendations were to be input to the J041 System for automatic print on the Daily Procurement History Record on all future buys; recommended changes in the acquisition method were to be forwarded to the Office of the Competition Advocate (CR) for initiation of the appropriate action; the Directorate of Contracting and Manufacturing (PM) could acquire no item reviewed by the group if the unit price obtained from the supplier varied from the recommended amount by more than 25 percent.

Project PACER PRICE was established to meet an urgent need: response to continuing identification of apparent problems in the prices paid by the Air Force for replenishment spares and, by inferrence those elements in the acquisition system that had resulted in such prices. Clearly an initiative was needed that would at least equal in scope the amount of attention focused on alleged abuses. Clearly a full-scale investigation of the entire acquisition system was needed to identify and correct those abuses. And equally clearly, this review process needed to move swiftly and decisively to insure that such abuses could not recur. By June 1st the planning for just such a process had been underway for more than a month, a complete manual identifying organizational structure, skill requirements and operating procedures had been drafted and revised three times as the planning process proceeded, and the appropriate initial cadre of personnel had been identified and given office space in an area still being vacated by its previous occupants.

But what could not be clear by June 1st was the potential inherent in the special mission and skills mix of the PACER PRICE staff for the formulation not merely of a sophisticated problem-solving mechanism but of an entirely new operating philosophy that could fundamentally alter the entire acquisition system through a subtle shift in attitude. Yet that is precisely what happened. Through a lengthy process of minutely evaluating every drawing, specification, technical order, material and labor standard, price negotiation memorandum and previous purchase document associated with each item selected for review, in addition to the actual item itself, this group of engineers, manufacturing planners, price analysts and packaging specialists developed a set of operating procedures designed to "fix" the system simply by maximizing the practical mechanisms it already contained to achieve the goals it had always espoused. Very simply, the key was competition. Competitive pricing as well as competitive acquisition. Competition not as the exception to the rule but as the rule itself.

The July 29th revision of the operation plan was the first to set forth the concept in the form of operating "precepts" that were to guide all aspects of the review procedure: "All replenishment acquisition should take place in a competitive market environment," and "All replenishment items should be purchased at competitive market prices." Simple statements on the face of it, statements with which few people could disagree. But when the implications of these statements are examined in detail, when the impact they can have on the total acquisition system is evaluated in terms of the changes they would demand, they are neither simple nor easy precepts to adopt within the framework of the purchasing process as it now exists. The magnitude of the apparent spare

parts acquisition problem, or, more accurately, the magnitude of the PRECEPTION of a problem makes it imperative, however, that at the very least some consideration be given to this new constellation of attitudinal approach and procedural system.

This paper is an attempt to "explain" the PACER PRICE program not so much as a nuts-and-bolts review process but as the practical arm of the total philosophical system, to evaluate the results of the review process in terms of their linkage to the system, and to demonstrate how these results reflect the potential for positive systems change inherent in the PACER PRICE initiative. As such, the paper will be divided into two major sections, "Competitive Acquisition" and "Competitive Pricing," each of which will focus on the particular internal logic system within that part of the philosophy, how this logic system shapes operating procedures, and how these operating procedures yield the desired results in terms both of the logic system itself and of the total acquisition system.

It is neither possible, given publication-space constraints, nor essential that PACER PRICE operating procedures be described at any length in this paper. For maximum clarity in the discussion that follows, however, Figure 1 provides a flow chart of the total PACER PRICE review system.

I. COMPETITIVE ACQUISITION

The Defense Acquisition Regulation (DAR--formerly Armed Services Procurement Regulation) is quite clear in describing the importance of competition in Department of Defense acquisition. Consider paragraph 1-300.2, for example: "All procurement, whether by formal advertising or by negotiation, shall be made on a competitive basis to the maximum practicable extent." [1] Given even the fairly significant number of factors that can legitimately limit competition within the purview of the DAR, the fact that only 28 percent of the total number of spare parts managed at Oklahoma City are estimated to be capable of competitive purchase as of this writing (August 31st, 1983) seems reasonable cause for suspicion as to whether the acquisition system is indeed fostering competition "to the maximum practicable extent."

The fundamental question answered by the PACER PRICE engineering staff is therefore, "What is required to enable purchase of this item in a competitive market environment?" The basic assumption is that, by their very nature, the large majority of Air Force spare parts could be produced by more than one manufacturer and thus purchased from more than one manufacturer. It is the responsibility of the engineers to explore all factors contributing to existing source restrictions and to make a detailed recommendation as to how these factors can be

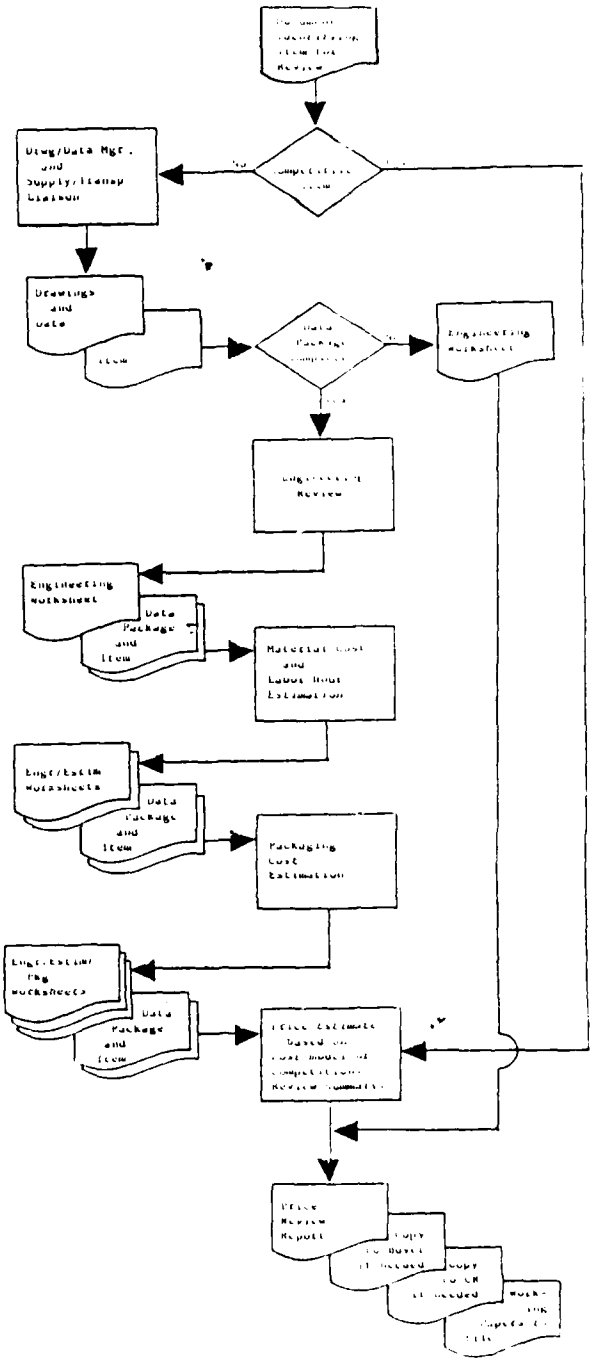

Figure 1

The PACER PRICE Review Process

eliminated. Any factors that cannot be eliminated must be fully documented before source-restriction is accepted. The number and scope of these factors have been considerably reduced and lie primarily in the areas of stringent quality and manufacturing control requirements and of production technologies that are not commonly available. The result: as of this writing, with nearly one percent of the total estimated item population having been reviewed, approximately 62 percent of all items previously restricted to sole-source acquisition have now been recommended for competitive procurement. Comparing this statistic with the current status of the spare parts inventory as mentioned above, it is safe to say that competition has indeed become the rule rather than the exception in PACER PRICE review.

To explore the practical mandate of the philosophy in more detail, the internal logic of competitive acquisition dictates a chain of decision-making processes that will ultimately result in an item being capable of production by more than one manufacturer. Perhaps the most important factor in this constellation is the availability of a complete set of manufacturing drawings and requisite support data. In order for an item to be made by more than one manufacturer, the "instructions" for its manufacture must be available to more than one manufacturer. And for this condition to prevail the Government must not only have in its possession a complete set of the instructions, but the legal rights to their use as well. Thus, the first part of the PACER PRICE engineering worksheet is dedicated to describing the state of the current data package and a precise delineation of any information that might be missing. Due to the complexity of the matter, the question of rights to data usage has not yet been fully explored. Part of the problem is simply determining which of the drawings now in possession of the Logistics Center are actually of a proprietary nature. Many of the drawings reviewed by PACER PRICE engineers that are stamped with the proprietary legend are in fact not proprietary (the drawings associated with the B-52 aircraft being a case in point). The Office of the Competition Advocate has begun communication on a total-inventory basis with the major suppliers of replenishment spares regarding the rights to usage of the data the Government now possesses, but it is too early in the life of the program to offer any tangible results. With regard to acquisition of additional data, the Engineering Data Section (MMEDD) at Oklahoma City routinely orders those drawings which it does not now possess for items coming under PACER PRICE review. But here again this policy has not yet proven a success.

Whatever the outcome of these efforts, one thing is certain: the size of the data repository is bound to increase. And with increased size must come a more readily accessible system of data usage to both the PACER PRICE staff and acquisition personnel in general. Current problems associated with effective acquisition and management of Air Force data have been detailed in a recent report to the Air Force Management Analysis Group (AFMAG) by a research group working under contract with the Air Force Business Research Management Center. [2] The situation is a cause of some concern. The proposed realignment of the Office of the Competition Advocate to include the PACER PRICE program, MMEDD, and the Replenishment Parts Breakout Program is expected to give impetus to a positive change in this area. And another promising factor is the recent development of computer hardware and software that allows for the electronic digitization, storage and transmission of drawings and data, a development which appears to be the answer to the most immediate problem of data file space requirements as well as the longer-range question of data indexing and retrieval systems.

A second factor affecting competitive capability is the very design and manufacturing requirements of the item itself. Obviously, given even the most complete and readily available set of drawings and data, an item may still not lend itself to competitive acquisition if the requirements are so narrowly defined as to limit production to only one source. Yet equally obvious, the form, fit and function requirements of some parts must be so defined--sometimes even source-directed--owning to the criticality of the item. It is thus the task of the PACER PRICE engineers to determine the optimum set of design specifications and manufacturing requirements that will secure proper item functioning at the same time as it assures production by the largest number of manufacturers possible.

Some practical considerations aiding achievement of the later objective: it is safe to say that only a very few components of any new weapons system are truly "new." Most items are simply refinements of earlier items serving a like function. Even the greatest technological advancements never affect every component part in a new weapons system. In all likelihood, a certain number of parts not undergoing technological improvement or significant system design changes could be "borrowed" from existing systems. This is particularly true for the simpler "nuts-and-bolts" type items--the items, it will be remembered, that have received the brunt of media attention. For this reason, PACER PRICE engineers are tasked with investigation of the potential use of substitute or interchangeable parts for every item they review.

The PACER PRICE staff has been in a continual process of identifying and obtaining all resources that will aid the engineer in making this determination. Perhaps the most fortuitous circumstance is the existence of the AFLC's Cataloguing and Standardization Office

(CASO) and the possibility of remote access to the Defense Integrated Data System (DIDS). A form request for interchangeability investigation has been prepared for PACER PRICE use in those cases when the engineer cannot reach a satisfactory determination through use of existing resources, and planning is underway for terminal linkage with the CASO computer as a means of facilitating the substitute/interchangeability search.

Barring identification of a substitute or interchangeable part, logic dictates that the engineer then give special attention to the potential use of alternative (less expensive or more readily available) materials and manufacturing processes. Must a bolt be made of titanium when high-grade stainless steel would serve just as well? Must an item undergo six heat-treats when three would suffice? These are just some of the examples of the questions that are raised in the course of engineering review. They must be answered with any eye to both the realities of current production technologies, as well as to the functional requirements to the item. But the determination to use alternative materials or manufacturing processes can be a factor positively affecting both the competitive position and the price of an item.

The summary consideration in the total constellation of factors affecting competitive acquisition is, of course, determination of the proper Acquisition Method/Suffix Codes (AMC/AMSC). This consideration is integrally linked with data availability and item design considerations. The AMC/AMSC is, in terms of the new philosophy, both the connecting link and focal point in determining the practical success of the dual concepts of competitive acquisition and competitive pricing. It at once summarizes the potential for multiple-source pricing. Very simply put: the larger the number of suppliers, the greater the number of price and delivery proposals to choose from, hence the greater likelihood that the market place will yield the optimum price and purchase opportunity. But this is not what makes the PACER PRICE initiative new or elevates its operational approach to the status of a philosophy. The need for maximum competition has been the cornerstone of purchasing philosophy since time immemorial; the recent creation of the Office of the Competition Advocate and issuance of a new DAR Supplement on the Replenishment Parts Breakout Program [3] merely reaffirm the importance of this need. And the use of AMC/AMSC represents nothing more nor less than a simple, effective means of communication between those functions determining competitive status and those actually making the buy.

What is new about the PACER PRICE philosophy is rather the attitude toward the AMC/AMSC and its use. An AMC/AMSC assigned when a new system was taken into the inventory is not necessarily valid three or five or ten or sometimes twenty years later. Manufacturing technologies constantly change; new manufacturers set up shop and open their doors to Government business. The presence of a restrictive AMC/AMSC is regarded not as an indication that the item cannot be competitively purchased but rather as a challenge to the engineer to explore more fully and correct if necessary an obsolete obstacle to multiple-source purchasing wherever possible. A restrictive AMC/AMSC is not the last word in the argument but the first step in resuming the argument with increased thoroughness and vigor.

To restate this approach in terms of the internal logic of the competitive philosophy and thus broaden discussion to its impact on the acquisition system in general: if it is the goal of the PACER PRICE program, the Air Force Logistics Command, and the Air Force in general to purchase ALL replenishment spares competitively where possible, then a restrictive AMC/AMSC must be an indication that for whatever reason this goal is not being met, and the appropriateness of that AMC/AMSC must de rigueur be questioned by all personnel involved in the acquisition system. It is the obligation of any functional unit responsible for AMC/AMSC assignment that source restrictions be applied only when absolutely necessary. It is the obligation of the contracting officer, buyer, and item manager to challenge and investigate all restrictive AMC/AMSCs. It is the obligation of all personnel to forward any information affecting the status of an AMC/AMSC to the appropriate unit of responsibility. In order to meet this objective, some training of cognizant personnel will in all likelihood be needed. This training must include a thorough description of the AMC/AMSC system and what each of the various codes mean. The expansion of CR, carrying with it a realignment of both authority and procedures concerning AMC/AMSC assignment is a significant step toward implementing the new philosophy.

Before discussion of the competitive-purchase philosophy closes, however, and by way of summarizing the factors impinging on its practical implementation, some consideration must be given to the causal starting point for many of the obstacles impeding such implementation: the provisioning process. For it is precisely during the spare-parts provisioning stage of new-systems acquisition that the crucial decisions are made regarding source restriction, competitive potential, and the acquisition of manufacturing data and the rights to its use--decisions that will affect the acquisition of each item in the system from the time of the provisioning conference, through all successive buys, until the item is selected for PACER PRICE review.

It is, hopefully, self-evident that the same sort of attitude toward source restriction as

described above must be maintained by all Government participants in a provisioning conference. It is self-evident that the addition of each new component part to the inventory creates an entire series of conditions that automatically increases the administrative burden of managing and purchasing that part that will be alleviated if the item is interchangeable with some other item or can be borrowed from another system inventory. And it is also self-evident that decisions as to purchase of data will effect the acquisition posture throughout the life of the item. Precisely for this complex of reasons, the PACER PRICE operating plan calls for program involvement in the acquisition process beginning with provisioning. Just exactly now this is to be done continues to be an area of study. But the facts remain: decisions made at provisioning conferences have a direct and lasting impact on the competitive posture of the spare parts inventory; the nature of those decisions will determine the scope of all future PACER PRICE review efforts; the successful implementation of the competitive-purchase philosophy will be greatly furthered or severely hampered through these same decisions.

II. COMPETITIVE PRICING

The second concept in the dual PACER PRICE approach, the idea that all spare parts, REGARDLESS OF WHETHER OR NOT THEY ARE PURCHASED COMPETITIVELY, should be purchased at competitive market prices, is at once a more dramatic shift in philosophical outlook, a more complete reversal of previous methodologies, and hence a far more difficult concept to accept and adopt than is the notion of competitive acquisition. To this writer's knowledge, the current system of cost-based pricing has never been challenged, whereas the goal of competitive acquisition has been a part of the conceptual framework since Government purchasing began. Yet the philosophy of competitive pricing must be an equal partner with competitive acquisition in the total-system philosophy; it is just as important in effecting positive change in the current acquisition system; it is just as viable an operating procedure.

To consider the internal logic of the concept first, if it is agreed that the optimum method of purchase is in a competitive market environment then the price for an item purchased in such an environment must be the optimum price. (Hence the current acceptance of competitively-set prices in the current acquisition system without the need for further justification.) And if the cost-based system of pricing items yields prices that appear to be unrepresentative of the actual worth of an item, then some other system must be used to arrive at a price, and the most logical alternative appears to be the one system that is by definition regarded as producing optimum results: competitive market pricing. If it is not possible to purchase all items competitively, however, then some method must be found to estimate the price that the competitive market place would generate.

The problem with all of this, of course, is how to devise a system that will provide such an estimate in the absence of actual competitive purchase. The solution proved to be monetization on the basis of those factors conditioning manufacture of an item that are either quantifiably definitive owing to the design of the item or common to all manufacturers at a relatively consistent magnitude. In other words, to estimate competitive prices, use industry-wide average costs and rates. This is being done in a systematic, consistent and comparatively reliable fashion by the PACER PRICE staff through the use of mathematical "Rate Application Models" (RAMs). To date two RAMs have been created and implemented, and a third is still in the planning stage. Choice of appropriate RAM depends on the availability or absence of data packages and/or items.

RAM 1, the original and most basic of the models, takes as its starting point the estimate of material type, material cost at current market prices, type of labor required, and the number of labor hours required of each type, as provided by the PACER PRICE Material Cost/Labor Hour Estimators. This estimate is the result of an examination of the data package and actual item, and the application of appropriate material and labor standards. To the labor-hour estimate the Market Price Analyst applies the appropriate direct labor rate taken from the U.S. Department of Labor, Bureau of Labor Statistics summations of employment and earnings data by Standard Industrial Classification (SIC) grouping[4], thus completing the direct cost portion of the estimate.

The remainder of the total price estimate consists of manufacturing labor overhead, other indirect costs, profit and facilities capital cost of money. Estimation of these costs was considerably more difficult to quantify in terms of industry-wide experience, given the wide diversity of indirect-expense estimating structure currently extant among the community of Government suppliers. While it was recognized that each of these systems has its own particular merit in accurately representing the overhead-pool structure of the particular supplier which developed and uses it, it was also recognized that this close linkage between system and supplier was the principal obstacle to adaptation of any one system to total industry-wide experience. It was further reasoned that a price-estimating system tied to a particular organization tends to perpetuate and emphasize corporate structure as a means for establishing cost, when the true determinant should be the costs associated with actual

production of an item. In other words, the indirect-expense portion of the PACER PRICE model is generalized as opposed to one-manufacturer-specific, linked to manufacturing process, not corporate structure.

To achieve this end, the PACER PRICE estimating and price analysis staff identified twenty clearly distinct manufacturing processes that, as of this writing, appear to be the total constellation of elements required in the manufacture of the inventory of spare parts managed at Oklahoma City. These processes are listed in Figure 2 below under one of four categories of relative balance between machine and labor intensive nature of the process. To date, every item reviewed by PACER PRICE at this Center requires one or more of these processes in its production, and no other processes have been identified as factors.

I. MACHINE INTENSIVE	II. MACHINE/ LABOR INTENSIVE	III. LABOR/ MACHINE INTENSIVE	IV. LABOR INTENSIVE
BALANCING	CASTING	ENGINE MACHINING	FABRIC
NUMERICAL CONTROL	FORGING	EXTRUSION	GENERAL MACHINING
	TOOL & DIE	ELECTRONIC ASSY	GLASS & PLASTIC
		FINISHING	HEAT TREAT
		GRINDING	MECHANICAL ASSY
		LAPPING	PAINTING
			PLATING & CLEANING
			SHEET METAL
			WELDING
			WOOD MILL
			ZYGLO & X-RAY INSPECTION

Figure 2

Manufacturing Process by Category

It was further reasoned that the relative mix of machine/labor weighting associated with each manufacturing process type would have some effect on the indirect costs associated with that type, and that the indirect-expense portion of the model could therefore be derived on this basis. This assumption proved true. Through an ongoing process of directed sampling of pricing cases and continual testing of the model against actual market place prices, the PACER PRICE staff in fact did find that the greater the machine-intensiveness of a process, the higher the number of dollars required for overhead-allotment. Figure 3 lists the percentages of indirect dollars so allotted by manufacturing process type.

CATEGORY	I	II	III	IV
MANUFACTURING OVERHEAD	54%	23%	13%	11%
OTHER INDIRECT COSTS	36.7%	33.2%	21.0%	14.0%
PROFIT	12.3%	12.9%	13.0%	13.0%
G&A+IR	2.1%	1.8%	1.5%	1.2%

Figure 3

Indirect Expense Rates by Category

That percentage alloted to profit increases slightly as manufacturing processes become more labor-intensive, while all the other indirect cost factors decrease, as Figure 3 shows, is directly attributable to the fact that the PACER PRICE staff has incorporated the Weighted Guidelines Profit/Fee Objective (DD Form 1547, 1 January 1980) methodology for establishing profit as part of the model. The increase in direct labor costs associated with labor-intensive processes has the effect of increasing the relative monetary size of the Weighted Guidelines manufacturing labor cost element, while increasing the risk factor as well, people presumably being more difficult to control and therefore representing a higher risk than machines. The relative magnitude of the cost of capital rate similarly reflects the greater capital investment associated with machine-intensive processes.

Unfortunately, either a complete data package or an example of the item or both are not always available to the PACER PRICE review team, and detailed estimates of material cost and labor hour type and hours cannot be made. Yet in many cases, owing to the urgence of the situation surrounding particular items, an estimate needs to be made before copies of the data or the item can be obtained from sources outside the normal feed mechanisms. A second Rate Application Model (RAM 2) was therefore created to fill this need. It can be used in any situation in which the previous contract price, quantity and date of award are known, and when the PACER PRICE estimator can provide information as to the probable types of manufacturing process required and the relative mix.

RAM 2 relies on a little-recognized but extremely useful peculiarity inherent in both cost-based systems of price estimation and mathematical models used to estimate price in general. That is, due to the requirement for consistency in estimating costs required by the Government's Cost Accounting Standards

(CAS), the relative magnitude of the cost elements used to generate price will remain fairly stable from one estimate to the next. It can be statistically demonstrated, for example, that one particular contractor's estimating system will consistently yield total direct costs that remain at an approximately 69/31 percent mix of material and labor in price estimates for certain of the aircraft replenishment spare parts they sell to the Air Force. The various indirect cost components will likewise account for a relatively consistent percentage of total price. The internal dynamics of the PACER PRICE model conform to this same consistency in magnitude for the component cost elements they generate. Total direct costs remain consistently at about 19 percent of the total price, for example, with the remaining 81 percent indirect cost component subdividing into relatively fixed percentage plateaux.

RAM 2 serves, therefore, as a kind of translation model, enabling the price analyst to ascertain the magnitude of direct costs associated with any contract price, depending on supplier, then provide a market-price estimate based on adjusting these direct costs to industry-wide experience and completing the total package in accordance with the PACER PRICE overhead structure as related to the manufacturing-process labor mix provided by the estimators. Adjustments of any differences between the cost-based and market-based prices in the area of appropriate manufacturing-process category are made first. Then adjustments required by differences in quantity or length of time between contract award and PACER PRICE review are effected by means of Production Quantity Adjustment Factors (PQAFs) and Economic Change Adjustment Factors (ECAFs) tied directly to manufacturing-process category as shown in Figure 4.

CATEGORY	I	II	III	IV
ECONOMIC CHANGE ADJUSTMENT FACTOR	3.151	3.165	2.894	2.977
PRODUCTION QUANTITY ADJUSTMENT FACTOR	38%	36%	32%	34%
DIRECT MATERIAL SHARE	27%	24%	24%	21%
DIRECT LABOR SHARE	8%	13%	14%	17%
MANUFACTURING HOURLY RATE	12.91	11.49	11.35	10.82

Figure 4

RAM 2 Adjustment Factors

Development of the final Rate Application Model (RAM 3) is expected both to aid in a more precise determination of direct costs without full-scale review by the PACER PRICE estimators and to move market-price estimating capabilities to the stage of development in which items not yet in the inventory but still in the design or provisioning phase can be assigned a realistic market place price. RAM 3 will take as its basis for estimating direct costs three factors that are even now in current use or readily identifiable: total physical dimensions of the item (the "cube" in packaging-requirement estimations); type of material required; and the end-use or function of the item. The cube will determine amount of material which, together with material type and access to material standards will establish direct material cost. Item function will derive determination of correct manufacturing process, as well as number of hours required by category, also based on standards. The remaining market-price build-up will transpire simply on the basis of the indirect cost factors listed in Figure 3 for RAM 1.

As of the writing of this paper, both RAM 1 and RAM 2 were in regular use by the PACER PRICE staff at Oklahoma City, with RAM 3 still in the planning stages. All three RAMs, it should be emphasized, are designed to produce the same result: an estimate of competitive market price. Regular, routine testing of RAMs 1 and 2 have verified that they are indeed producing this result: comparison of prices generated by either of the models with actual prices paid for competitively purchased items indicates that the estimated prices fall about at mid-point in the competitive range. Comparison of the prices paid in actual sole-source situations with those estimated by PACER PRICE, on the other hand, provide a clear indication of the importance of competitive purchasing to obtain the best possible price: to date, sole-source prices are running on the average 35 percent higher than the estimated market prices, for the same quantity of units. If all sole-source items reviewed thus far by PACER PRICE could be purchased at the competitive market-prices generated by the estimating models, substantial savings could be realized.

Beyond the obvious result of identifying potential savings, the practical procedural aspects of the philosophy of competitive market-pricing also hold promise of positively affecting the acquisition system in at least two other areas. For one thing, the data generated in PACER PRICE review could give a buyer or contracting officer detailed information on the manufacture of an item that could be of considerable value in the negotiation of a sole-source item, assuming that all available avenues for purchasing the item in a competitive market had been exhausted. Although the concept of the competitive-market price, that it must be treated as a total entity, must be kept in mind in using detailed component elements of that price, comparison of PACER PRICE estimates of these elements with those actually proposed by small or medium-sized manufacturers has demonstrated the accuracy of these estimates. They would at least provide contracting personnel with tools not now available, particularly in small-dollar procurements falling below the threshold for Certified Cost and Pricing data.

The second important implication lies in the area of automated access to the data. Current plans for the PACER PRICE program call for complete automation of all mathematical models and the data bases required to support them, and include on-line access to several different data systems. The objective is the complete automation of the PACER PRICE review mechanism, an objective that is within easy reach, given the current state-of-the-art in computer hardware and software design, and the existing data bases. Remote linkage would allow a buyer or contracting office to obtain a detailed market-price analysis simply by inputting a National Stock Number (NSN) or part number. The present manpower-intensive nature of the program would thus be alleviated, with the PACER PRICE staff scaled down to a small staff dedicated to routine systems testing and maintenance and to further research in market trends.

All of this is not to suggest that the current cost-based price analysis system either could or should be completely replaced by the market-based system. Such a suggestion is simply not possible, given the imperative to continue purchasing certain items on a sole-source basis. The importance of the competitive pricing philosophy does need to be investigated more fully, however, as a means of cross-checking the cost-based system and providing additional negotiating leverage.

CONCLUSION

This paper has been an attempt to explore the practical implications of what has been termed a "new philosophy" of "competitive acquisition" and "competitive pricing." We might just as well have spoken about a more "business-like" approach to acquisition in the sense of studying current buying practices in private industry to learn how they might be adopted to Government use. Among the PACER PRICE staff at Oklahoma City, as the review process began generating definitive information on the factors required to change the competitive status of an item and estimate a competitive market price, questions continued to arise as to what was actually happening in that market place we were studying. Were the occasional aberrations in price that the model generated, especially when Production Quantity Adjustment Factors were involved, an indication that purchase in a competitive environment, from suppliers in continuous production of the item, somehow negated the effects of order quantity on material cost or labor "learning?" Or were these aberrations symptomatic of some other factor affecting price that was in some way tied to order quantity? If so, did we need to launch a full-scale exploration into the nature of the factors affecting price, factors that a market-based system derived from a cost-based system could not be incorporated into the transition? Were the models working by accident?

These are all questions that deserve further investigation. The entire subject of current market conditions and trends that impact market pricing deserves thorough study, if the results of the PACER PRICE initiative are to be understood clearly, and the philosophy implemented to maximum benefit in the acquisition system. The recommended establishment of a Business Management Strategy Council at each of the Air Logistics Centers, with the function of further market research and investigation of acquisitions in which the PACER PRICE recommended price cannot be met, must be viewed as a positive step toward this end. With an AFMAG-projected minimum return of 10 to 1 on investment expected to be realized as a result of the PACER PRICE initiative in its later stages of implementation along, the prospect for even further perfecting the system through comprehensive market research must be viewed as extremely attractive. The "new philosophy" is a practical reality, well-planned implementation, a functional imperative.

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NOTE:

THE VIEWS EXPRESSED IN THIS PAPER, TOGETHER WITH MUCH OF THE INFORMATION IT CONTAINS, ARE THE RESULT OF THE AUTHOR'S PERSONAL EXPERIENCE IN HELPING TO ESTABLISH THE PACER PRICE PROGRAM AT THE OKLAHOMA CITY AIR LOGISTICS CENTER AND SHOULD NOT BE CONSIDERED A STATEMENT OF AIR FORCE POLICY.

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THE PROBLEM OF COST GROWTH

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ABSTRACT

There is a substantial amount of rhetoric on the subject of cost growth. Usually, we blame such growth on "inflation." There are, in fact, several views on the reasons for cost growth or the measures used to calculate and present cost increases by weapon system. MCR has conducted studies of cost growth for many years. This particular paper will discuss the problem from an historical perspective, and present actual results from an analysis of the 31 December 1982 Selected Acquisition Reports (SARs).

INTRODUCTION

Every newcomer to Washington, D.C. discovers for himself the new "problem of cost growth." They usually do so in the context of examining the DoD budget, particulary with respect to major acquisition programs. Some objective observers are willing to accept reasons for cost growth, such as schedule stretch-outs and inflation, but the claim is usually made that DoD has:

- bad cost estimators, and
- poor engineering or technical control of major programs.

To examine the problem and place it in proper perspective, one needs to examine:

- historical cost growth,
- alternative measures of growth,
- reasons for cost increases, and
- an analysis of current rates of growth.

HISTORICAL COST GROWTH

It is often said that cost analysis is the "oldest profession" in the world. To professional cost analysts, that remark is bothersome. The Old Testament of the Bible talks about "another profession" engaged in by women low in virtue. Cost estimating does not, in fact, get mentioned until the New Testament, Luke 14:28, which states:

> For which of you, intending to build a tower, sitteth not down first, and counteth the cost, whether he have sufficient to finish it.

Contrary to cost overruns being a new discovery of the 80s, E. Gibbon, in his book The Decline and Fall of the Roman Empire, cites this example:

> . . . the young magistrate, observing that the town of Troas was indifferently supplied with water, obtained from the munificense of Hadrian, three hundred myriads of Drachmas (about a hundred thousand pounds) for the construction of a new aqueduct. But, in the execution of the work, the charge amounted to more than double the estimate, and the officers of the revenue began to murmur.

Fortunately, the wealthy Julius Atticus paid the extra cost (a factor of two) out of his own pocket.

According to C. Hitch in Decision Making for Defense, the first major weapon system procurement was made March 27, 1794. Congress authorized the U.S. War Department to build six large frigates. Seventeen months later, six keels were laid. However, due to schedule slippage and cost overruns, this program was cut back to three frigates. Again, a factor of two in cost growth was observed.

Even in modern times, the examples just around Washington are more astounding than those in defense. The Library of Congress' James Madison Building went from an estimate of $75M to $130.7M; the House of Representatives Annex #2 went from $15M to $25M; the two-year-old Philip A. Hart offices went from an initial estimate of $47.9M to a final $137.7M; the older Rayburn House Office Building ws originally $81M, but finally $125M.

Note that these costs all include different assumptions about inflation. How well would General Motors do in predicting the cost of a 1994 Cadillac? Because that is the problem the defense department has to solve when it originally estimates the cost of an F-16, M-1, SSN-688 or any major system at the time of initiation of Full Scale Engineering Development (called Milestone II in the acquisition cycle).

ALTERNATIVE MEASURES OF GROWTH

There are several common ways to measure cost growth dealing with three basic factors:

- Current "Then Year" Dollars - This view is important in terms of measuring budget effects since it includes all program changes and inflation. A program can show cost growth due only to inflation since escalation rates used in developing the current out-year budgets are likely to be different from the rates used for the Development Estimate. Schedule slippage can also cause significant growth attributable only to inflation.
- Constant "Base Year" Dollars - This view is important in measuring program management effects. Cost growth due to inflation is not included.
- Quantity Adjustment - This view is important to accurately compare the Development Estimate (DE) to the Current Estimate (CE). The adjustment is made in base year dollars to exclude the growth due to inflation. In addition, the DE baseline is adjusted to reflect the quantity change in base year dollars. The adjusted DE gives the cost that would have been estimated at Milestone II for the current quantity.

Actually, there are several ways to adjust for quantity, but the point is simple: "don't call it 100 percent cost growth if the quantity originally planned to be bought doubles."

Figure 1 shows an example of the types of cost growth for the F-16 program. Over a five-year period, the estimated program cost went from around $5 billion to over $40 billion. This would be labeled "cost growth" by those who subscribe to the current dollar view (such as U.S. Congress). Starting at the top of the figure, however, note that economic escalation (change in anticipated inflation rates) and program change related escalation (that caused by changes to the program itself) do make up a substantial portion of the so-called "cost growth." Costs due to quantity increases also make up a large portion of the current estimate. The "real" cost growth, that

F-16 PROGRAM COST HISTORY

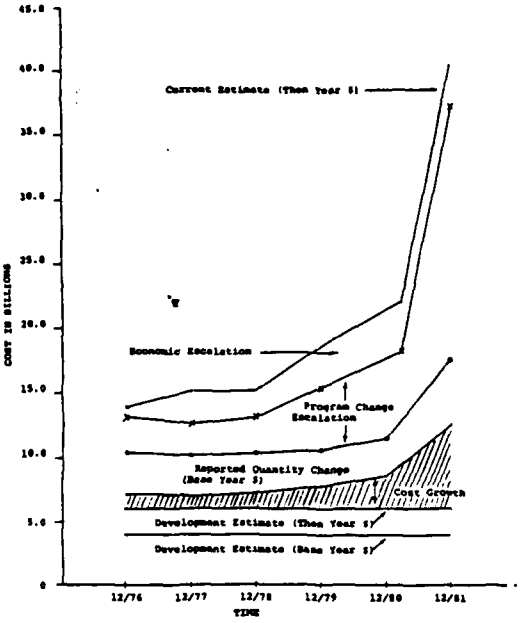


Figure 1

calculated in base year dollars, is shown as the shaded region of the chart. Clearly, one can cite cost growth from just under 200 percent to over 700 percent for the same program depending on the alternative measures of growth selected.

The source of data is usually given as that provided in the Selected Acquisition Reports (SARs). The SAR is a standard, comprehensive, summary status report on major DoD acquisition systems. It was initiated in fall 1967, requested by the Senate Armed Services Committee in April 1969, and legally required by PL-94-106 in 1975 (the FY76 Defense Appropriations Bill). All "major systems," i.e. those having at least $200 million of RDT&E or at least $1 billion of procurement (in FY80 dollars) must be reported.

As an illustration of the three views of cost growth, consider the data of Figure 2, last year's estimates for 62 systems then being reported. The table shows both current and base year dollars, the baseline "development estimate (DE)" made at DSARC Milestone II (start of Full-Scale Engineering Development), the quantity adjusted DE, other program

Dollar Measures	Development Estimates(DE)	DE Adjusted For Quantity	Other Program Changes	Economic Escalation	Current Estimate
Current, Then Year	$272.0B	$375.7B	$124.5B	$39.5B	$539.7B
Constant, Base Year	$185.4B	$217.2B	40.0B	--	$257.2B

Figure 2

changes, economic escalation, and the (then) current estimate.

The *first view of cost growth* would use an unadjusted figure of 98 percent [(539.7-272.0)/272.0] (a factor of two again). Allowing the quantity adjustment would result in a cost growth measure of 44 percent [(539.7-375.7)/375.7]. Including adjustments for quantity and escalation, i.e. using base year dollars adjusted for quantity, yields cost growth of only 18 percent [(257.2-217.2)/217.2]. The difference between an astounding 98 percent cost growth and a controlled 18 percent cost growth is simply a matter of selection of alternative measures of growth. The "correct" measure depends on the particular view being taken.

REASONS FOR COST INCREASES

In the GAO report to Congress on the "Status of Major Acquisition as of September 30, 1981: Better Reporting Essential to Cost Growth," the data shows that 18 percent of the 22 Federal departments or agencies had cost overruns greater than DoD. This is all the more remarkable since most agencies have fewer programs, and they are typically of much shorter duration.

The common beliefs about defense cost growth are that: (1) as costs increase on a program, production quantities are reduced resulting in higher unit costs; (2) engineering changes are frequently made resulting in rework and higher costs, and (3) bad initial cost estimates must be continuously revised upward.

Figure 3 shows the results of an analysis of reasons for cost increases for the 62 systems cited earlier. Several different conclusions can be reached with this data:

Cost Growth Category	All Categories	Allocated Program Change Related Escalation
Economic Escalation	14.8%	14.8%
Program Change Related Escalation	58.6%	-
Quantity	11.7%	38.7%
Engineering	3.8%	10.8%
Support	4.1%	12.3%
Schedule	2.3%	9.8%
Estimating & Other	4.7%	13.6%
	100.0%	100.0%

Figure 3

- About 85 percent of all cost growth can be attributed to changes made to a program (i.e., maintain program stability and cost growth will be controlled);
- About 73 percent of total cost growth is due to escalation (inflation);
- Belief (1) is proven false by the fact that quantities are increasing compared to original baselines (almost 39 percent of cost growth is due to quantity increases);
- Belief (2) is proven false by the fact that quantity, support, and estimating all account for more cost growth than does engineering;
- Belief (3) is neither proven nor disproven by this analysis. Certainly estimating accounts for a significant portion of cost growth. However, estimating as a cost variance category is not disproportionally higher than support or engineering.

AN ANALYSIS OF CURRENT RATES OF GROWTH

There are several other ways to analyze the problem of cost growth. From a statistical viewpoint, the snapshot of data taken each December forms a cross-sectional data base. A regression of cost growth versus time (compound form) while not an extremely good fit, shows a 4.4% annual growth rate (for base year dollars adjusted for quantity). This rate compares favorably with the rate *over the past six years.*

One problem with annual comparisons of system cost growth is that the number of systems being reported changes year to year as new systems come in and old ones phase out. Two recent analyses have been made to examine rates of growth in a consistent manner. The first examined the growth over time of a constant set of 37 weapon systems being reported. The second analysis compared like systems on a year-to-year basis.

A set of 37 systems was selected by agreement with the Congressional Budget Office staff. These systems all were reported in Selected Acquisition Reports in December 79, 80, 81 and 82. Thus, a consistent set of systems could be tracked over four years. Data was examined in Current Then Year Dollars and in Constant Base Year Dollars. A quantity adjustment was allowed so that cost growth due simply to quantity increases (or decreases) was removed. Figure 4 shows the results.

Year Ending December	Current Then Year $		Constant Base Year $	
	Cum	Δ	Cum	Δ
79	50.4%		15.7%	
		21.3%		8.8%
80	71.7%		24.5%	
		-3.9%		5.2%
81	67.8%		29.7%	
		4.3%		3.1%
82	72.1%		32.8%	

Figure 4

The decreasing rate of growth is shown more clearly by the constant base year dollar column. While the set of 37 systems exhibits an increasing cumulative percentage cost growth between 1979 and 1982, the annual increase is decreasing. Another form of calculating annual changes, by ratioing the cumulative factor growth, yields different numbers but the same downward trend. Thus, this data shows DoD is improving.

To avoid the aging bias of the previous set of 37 systems, a pairwise comparison was also made for the same years. This second analysis used more systems by comparing pairs of years. For example, between December 1979 and December 1980, a set of 52 systems was in both data sets. Only 49 systems were reported in December 1980 and again in December 1981. Figure 5 shows the data and results of MCR's analysis.

Time Period December	# of Systems	Constant Base Year $	Δ
1979-1980	52	18.3-26.1%	7.8%
1980-1981	49	25.1-30.0%	4.9%
1981-1982	45	23.8-25.6%	1.8%

Figure 5

Again, the decreasing rate of growth shows up clearly for the constant base year dolar comparison.

CONCLUSIONS

Cost growth means different things to different people. The three prevailing views of cost growth include use of current then year dollars, constant base year dollars, and adjustments for quantity in either type of dollars. The problem of cost growth can only be solved by careful attention to cost as an important parameter of system acquisition. The problem is not new but is a recurring one for DoD. Analysis of recent data does suggest an improving trend. One can only hope this trend continues as the new data point, December 1983, is added.

COST IMPACT OF PROD RATE VARIATION

Panel Moderator: Colonel Larry L. Smith
Dean, School of Systems and Logistics
Air Force Institute of Technology

Papers:

Economic Production Rate Study
by Edward J. Downing, Jr., Gilbert E. Roesler,
and William M. McGovern

An Automated Airframe Production Cost Model
by Norman Keith Womer

ADP002793

ECONOMIC PRODUCTION RATE STUDY

Edward J. Downing, Jr., Gilbert E. Roesler, and William M. McGovern
Advanced Technology, Inc.

ABSTRACT

The Department of Defense Acquisition Improvement Program Action Number 7 stresses the need for each program manager to reduce the unit cost of his system by planning for and maintaining an economic production rate (EPR). The key elements in achieving an EPR are early planning and program stability. However, since stability is seldom possible, flexibility to accommodate a change to the production rate must be built into the plan. For this purpose and also to answer "what if" budget questions, it is important to have a model that relates rates of production with their corresponding estimated unit costs.

The objective of this study is to give the Program Manager tools for use in discussing, planning and evaluating economic production rates. In order to deal with large scale, multi-tiered acquisition programs, a distinction must be made between procurement and production rate. The economic procurement rate refers to the rate of acquisition of the complete system, while the economic production rate addresses each component or contractor contributing to the system. The EPR is defined as that rate of procurement (or production) that permits efficient use of available industrial resources to achieve the lowest unit cost. Using a model suggested by John Bemis, this study examines the procurement profile of five major DoD acquisition programs--the Army's M-1 tank, Fighting Vehicle System and TOW missile, the Air Force's A-10 aircraft, and the Navy's A-6E aircraft. The model can be expressed either graphically or as an exponential equation. The graphical form is especially useful when iso-unit cost lines are plotted on axes of production rate versus cumulative quantity. In this form it is possible to evaluate various procurement profiles of a system and draw some conclusions concerning their relative efficiencies. This analysis was done for each of the five systems, and savings from more economical rates are estimated.

INTRODUCTION

This paper describes a 1982-83 Defense Systems Management College sponsored research study to examine economic production rate theory, its application to specific acquisition programs and the reasons why some systems are not produced at economic rates. A search of the literature uncovered no theoretically accurate models that could be easily applied to an entire defense system and which used readily available data as input. Therefore, emphasis was placed on finding a workable, empirical model that could be used to relate unit cost to production rate.

The scope of this study was limited in two ways. First, the contractors' costs of production were proprietary and therefore unavailable. Second, the number of separately manufactured components of a large system was too great to evaluate them all, and the study generally was limited to variations in only the prime contractor's cost and production rate.

The systems selected for study were:

The Abrams M-1 Tank: a major Army system with a relatively high rate of production that is produced in a Government-Owned-Contractor-Operated (GOCO) plant. This presented an opportunity to study the aspects unique to that contracting method. (Prime contractor: General Dynamics)

Bradley Fighting Vehicle System: an Army system in production for only a short time. (Prime contractor: FMC)

A-6E Aircraft: a mature Naval aircraft with a low rate of production. (Prime contractor: Grumman)

A-10 Aircraft: an Air Force aircraft with a long history of production. (Prime contractor: Fairchild Republic Corporation)

TOW Missile: an Army system with a long history of production at a high rate. (Prime contractor: Hughes Aircraft Company)

On 14 December 1982, as a part of this study, a meeting was held at the Defense Systems Management College (DSMC), Ft. Belvoir, VA. Participants included representatives from the Office of the Secretary of Defense; the program offices of the systems selected for study; headquarters Army Materiel Development and Readiness Command (DARCOM); Headquarters, Air Force Systems Command (AFSC); Headquarters, Naval Air Systems Command (NAVAIR), the DSMC; several defense contractors directly involved with the systems under study; and Advanced Technology, Inc. The first draft of this study was reviewed and discussed by the participants. This meeting had a significant influence on the results of this study.

EPR DEFINITION

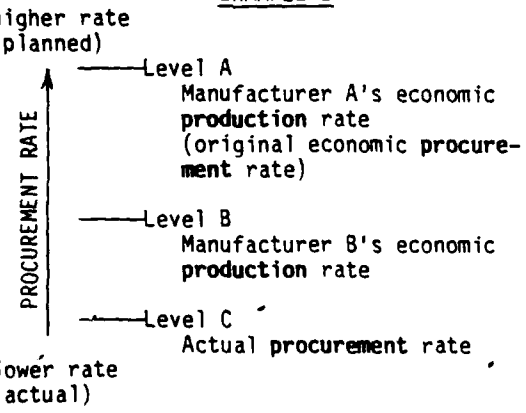
The terms "procurement rate" and "production rate" are used almost interchangeably in this paper; however, because most defense systems are the products of a number of manufacturers, the term procurement is used in the following definition to convey the fact that the production rates of individual contractors result in an overall procurement rate for the system. The following is the definition put forward by this study:

"The economic procurement rate of a system is the rate that permits efficient use of available industrial resources to achieve the lowest unit cost."

When applying this definition to a single manufacturer, the term "economic production rate" may be used.

During production planning for a system, it may be possible to establish a procurement rate that will efficiently utilize all the available resources of the manufacturers, even if it means providing additional funds to some of them in order to meet the agreed upon schedule. If all manufacturers optimize their industrial resources to that rate, it will be, by definition, the economic procurement rate, and all manufacturers will have economic production rates to match it. Usually, however, events lead to a separation of rates as shown below:

EXAMPLE 1



In example 1, both manufacturer A and B are producing parts for a single system. The actual procurement rate of the system has fallen to Level C, far below the planned EPR at level A. The reason for the drop is not important to the example, but typically might be caused by a restriction of funds. Manufacturer A still has all of the resources to produce at Level A and retains A as its economic production rate, although this rate now comes from a production capacity in excess of the needs of the program. Manufacturer B has responded to the lower required rate by diverting some resources to another job and now has a lower economic production rate, Level B. This is still higher than the rate required, but it is closer to the actual rate than Manufacturer A, and the government is paying a lower production rate penalty (proportionately) for Manufacturer B's product than for Manufacturer A's product. A pertinent question in this situation is, "What is the economic procurement rate of the system now?" Total industrial resources are not presently available to procure at a rate higher than Manufacturer B's rate (i.e., Manufacturer B's rate is limiting). Furthermore, because unit cost usually increases with a decreasing procurement rate (as will be discussed), it is uneconomical to procure at a rate less than Manufacturer B's rate. Manufacturer B's rate, therefore, is the present economic procurement rate and is the rate that corresponds to the lower economic production rate of the two major contractors.

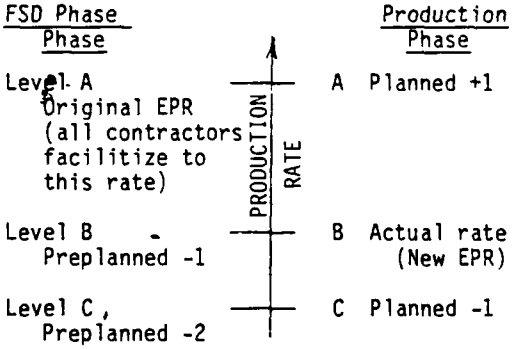
For an individual contractor, the economic production rate is determined by a single industrial resource (tooling and test equipment, plant space, manpower and material) that limits production or assembly of the component being produced. An industrial resource becomes limiting when its capacity is fully utilized, while at the same time, excess capacity is available in the other industrial resources. To be considered "available" (for purposes of the EPR) the resources must be at the location needed, and their costs must fall within approved fiscal constraints.

PLANNING FOR ECONOMIC PRODUCTION RATES

During the Full-Scale Development Phase of a program, a procurement schedule (rate) should emerge that considers operational requirements, life cycle cost, affordability, and other factors pertinent at the time, as well as a procurement rate that will efficiently use the industrial resources of the potential contractors. Furthermore, since an economic production rate will reduce the unit cost, rate might be a factor for negotiation. When a schedule is agreed upon, it becomes the basis for the contractor to optimize the levels of the industrial resources that will be applied to the production of that system. That is, production processes and tooling that are best suited to the chosen rate will be selected. Quantity of production, plant space, tooling and test equipment, manpower and materials (in the form of raw material, and subcontractor and vendor items) will be optimized to reduce unit cost. To the extent that this is accomplished, the EPR and the planned production rate will be the same. Later, however, circumstances may occur that will affect the actual schedule, as well as the EPR. For example, if all else remained

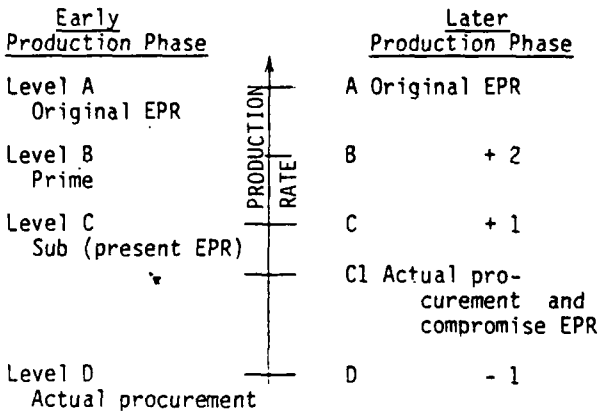
equal, but the government decided to stretch out production, the EPR would remain the same because the industrial resources would not be changed, but the actual production rate would decrease. This production rate decrease would result in a unit cost increase that, when multiplied by the total number of units produced, would be the penalty cost for producing at a rate lower than the EPR. If a contractor were able to reduce one or more of the resources that affect the EPR, such as giving up plant space to another job, the EPR would be lowered, bringing it closer to the actual production rate and reducing the penalty cost. The following examples will help to clarify these points.

EXAMPLE 2
New Program



In Example 2, Level A was the planned rate of procurement to which all contractors facilitized. Two lower preplanned rates, B and C were negotiated in case the procurement rate fell at a later time. These were to be used if, during the production phase, events (budget constraints, shortages of critical items, etc.) caused the actual procurement rate to fall. If they fell to level B, all contractors would shift to that level of production, and Level A would remain a higher (+1) option, and Level C would remain a lower (-1) option. Ideally, the contractors would use the excess capacity for other products, or they would reduce their resources by other means. Then, Level B would become the new EPR. Unfortunately, production resources are usually not that flexible. If they are not, the situation may be as shown in Example 3. Early in the production phase of Example 3 the actual procurement rate dropped from the original EPR at Level A to a lower procurement rate (Level D). The prime contractor and subcontractor both reduced their resources but were unable to reduce them to Level D. The prime contractor's economic production rate is at Level B, and the subcontractor's economic production rate is at level C (which, by definition is also the economic procurement rate). In this situation the cost penalty could be reduced, either by raising the level of actual procurement or by reducing production

EXAMPLE 3
Mature Program



resources and lowering the contractor's economic production rate. In this example, Level C1 was agreed upon by the government and contractors as the target EPR acceptable to all. The contractors reduced their resources to optimize their production at that level, and the actual procurement rate was raised to that level. Levels B (+2), C (+1), and D (-1) remain as options. This, of course, represents an idealistic solution and a complete solution will never be as easy to realize in practice. Nevertheless, the problem of uneconomical production rates can be attacked by these methods.

Although this study uses the term EPR as though it were a single number, it is recognized that the complexities surrounding this subject make pinpoint accuracy impossible. Because industrial resources often come in discrete blocks, there may be a "break point" near the theoretical EPR that will be the practical EPR. This may become obvious only through a discussion with the contractor. However, this does not negate the importance of (a) an independent government estimate of the EPR, or (b) reporting the cost penalty caused by deviation from the EPR.

MODELS

In finding the EPR for a system or contractor, the definition given above is important. At the theoretical EPR, there are no wasted industrial resources. At the practical EPR, wasted industrial resources are only minimized. The government can influence the level of resources during early planning; however, the government can discover the actual EPR only through discussions with the contractor. Of equal importance to establishing the EPR is the capability to estimate the change in unit cost that results from a shift in the rate of procurement or production. This estimating is done with the aid of a model.

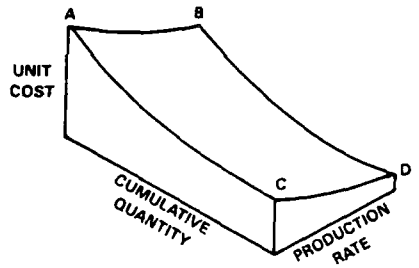
Classical microeconomics predicts the existence of a minimum unit cost as production rate increases (holding industrial resources constant). However, for defense systems, sufficiently high production rates to achieve this minimum are not normally attained during peacetime. Under-utilization of available capacity is normally one of the problems that must be addressed by the program manager. A model that describes the effect on unit cost of production rate change would be a valuable tool to him. The simplest such model is based on the fact that as fixed production costs are amortized over a greater number of units per time, raising the rate of production usually results in a lower unit cost (if the capacity of the facility is not exceeded). This relationship can be expressed as an inverse exponential relationship between unit cost and production rate.

J.C. Bemis (1), expanded a model by L.L. Smith and applied it to many DOD acquisition programs. His model takes the form:

$$UC = (k)\ Q^{-.xxx}\ R^{-.yyy}$$

where: UC = unit "fly away" cost of the Qth item produced at rate R. Constants k, .xxx and .yyy are determined by regression analysis of program data.

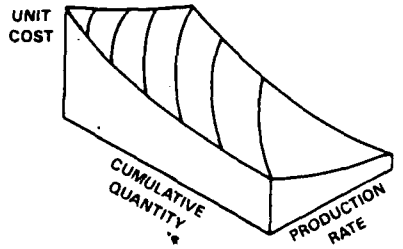
A physical model would appear as shown in Figure 1:



BEMIS MODEL
FIGURE 1

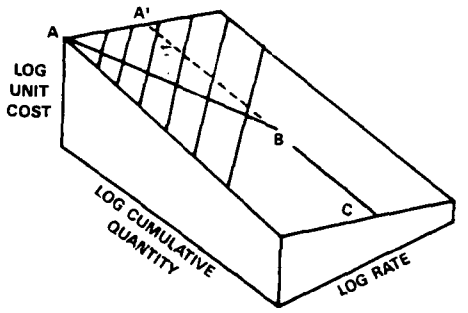
The concave surface A B C D represents the solution to the equation. A is the highest point on the surface and corresponds to the cost of the first unit produced at the lowest production rate. It is also called the "prime unit cost." Note that curve AC is a cost improvement (learning) curve at the lowest production rate, and point A corresponds to the first unit cost of that curve. The surface is concave with point D being the lowest unit cost.

Another feature of the model takes advantage of the fact that unit cost can be lowered by increasing either cumulative quantity or production rate or both. Plotting combinations of cumulative quantity and production rate that yield the same unit cost will describe an isocost line. In other words, all points on an isocost line will have the same unit cost. A family of isocost lines is shown in Figure 2 below.



BEMIS MODEL WITH ISOCOST LINES
FIGURE 2

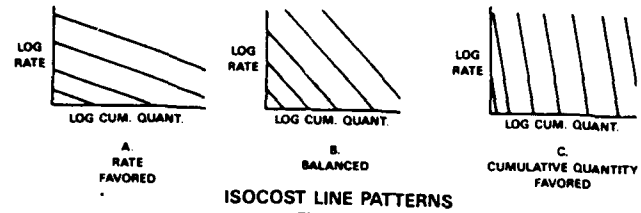
If the Bemis model is plotted using log values, a plane rather than a concave surface, will result and the isocost lines will be straight as shown in Figure 3. If a ball were placed at point A, in Figure 3 and were allowed to roll down the surface, it would follow the straight-line path AB.



ROLLING BALL PATH AND EPR
FIGURE 3

AB is not the most economic path theoretically, but may be thought of as a practical path to follow during the build up stage of production. The most economical path A'C would be one that started at the highest possible rate (EPR), produced at that rate until the required quantity was reached and then stopped. For major DOD systems, this is not practical, and a planned build up to an EPR is required. However, once the Economic Production Rate (EPR) has been reached, it should be maintained until the end of production (BC in Figure 3). Some information on an efficient build up path can be gained by studying the isocost lines of a program.

The following three diagrams in Figure 4 show different patterns of isocost lines. In each pattern, the isocost lines farther from the origin represent lower unit costs than those closer to the origin. The objective, then, is to move as quickly as possible from the



ISOCOST LINE PATTERNS
FIGURE 4

starting point (a point on the Y axis) to the lowest unit isocost line before most of the production occurs. Figure A, "Rate Favored," depicts a situation in which the slope of the rate curve is greater than the slope of the cumulative quantity (improvement) curve. A program with this type of graph is less adapted to long-term, low-level production than the other two cases. A low isocost line can be reached by rapidly increasing the production rate. This high rate should be maintained until the required quantity has been produced. On the other hand, a program with a graph such as C, "Cumulative Quantity Favored," is more adaptable to low-level production than a "rate favored" program. This is evident if one observes that isocost lines are cut more readily, by emphasizing cumulative quantity, rather than by increasing production rate, even though both actions will reduce unit cost.

The Bemis (2) model has not been independently validated by a thorough study. His model is an extension of the L.L. Smith (3) equation that used direct labor hours per pound of airframe as the dependent variable. The high correlation factors, found over two years of working with the model, do suggest a relationship between unit flyaway cost and production rate, but correlations such as these could be caused by multicolinearity resulting from an interdependence between the independent variables of cumulative quantity and production rate.

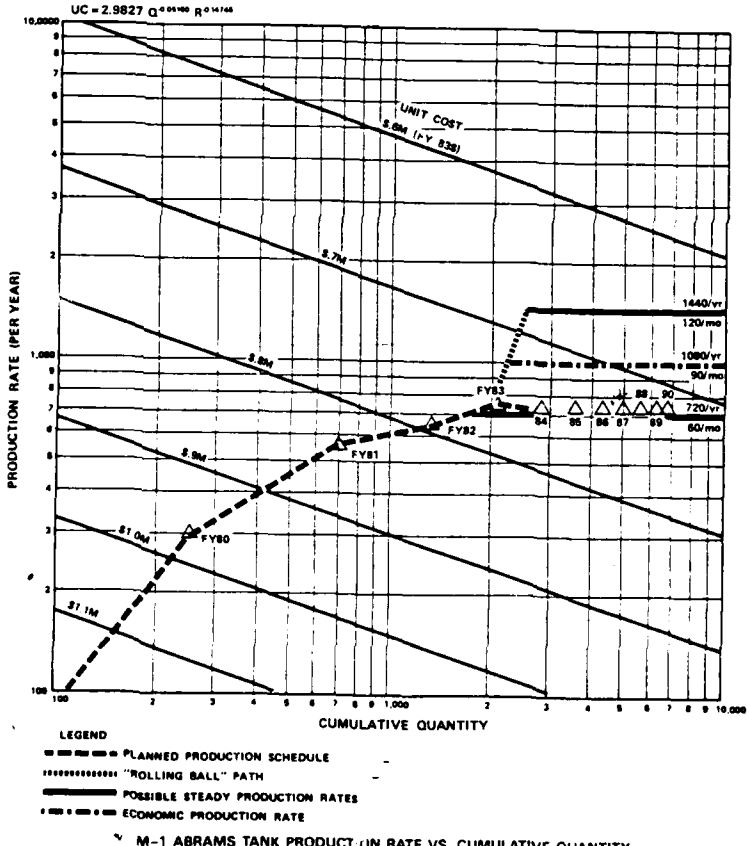
LIMITATIONS ON PRODUCING AT THE EPR

Although the cost savings gained by procuring defense systems at the most economical rates may be substantial, they must be measured against other costs of a program. Procurement costs represent one component of life cycle cost. Operating and support (O&S) costs, a large component of life cycle cost, will be affected by the rate of production. The decision-maker may be forced to choose between reducing immediate (small) production costs, or future (large) O&S costs.

There are other, noneconomic factors that may favor producing a product at a rate other than the EPR. These factors include maintaining a warm production base, a change in the threat, technical improvement or failure, and political considerations. These factors may dictate a specific rate of procurement, but they do not change the EPR.

PROGRAM ANALYSIS

Five defense acquisition programs were studied and their procurement profiles plotted against cumulative quantity and production rate. Regression analysis of cost-production data yielded an equation, in standard form, relating unit cost (UC), cumulative quantity (Q) and production rate (R). Using this equation, iso-unit cost



M-1 ABRAMS TANK PRODUCTION RATE VS. CUMULATIVE QUANTITY
FIGURE 5

lines were drawn to graphically show the procurement profile against unit cost. The economic production rates were arrived at through discussions with the program offices. Data were analyzed and graphed for all five programs, and the results are available in the final report. The discussion of the M-1 tank is presented as an illustration.

The graph and equation in Figure 5 show that the production of the prime contractor, General Dynamics, is rate favored. That is, the rate factor has a greater effect on unit cost than the cumulative quantity factor, and unit cost drops significantly with increasing rate of production. The three steady monthly production rates (60, 90, 120) were discussed during the history of the program; 90/month is the program office's estimate of facilitization and therefore the EPR. The planned production rate at present is 60/month. The estimated current dollar savings to be gained by producing at the higher rates are $517M at 90/month and $706M at a rate of 120/month if that rate could be achieved without major facilitization expense. It is important to note that the M-1 production facilities are government owned and contractor-operated; therefore, much of the fixed overhead costs will continue after the M-1 program is completed. If the facilities cannot be used or sold after the completion of the M-1 program, the savings will be reduced.

CONCLUSIONS

The definition of EPR, as presented, covers most situations, is quantifiable, and gives practical results.

Program data showed excellent multiple correlations between log rate, log cumulative quantity, and log unit cost.

All production, including that intended for Foreign Military Sales (FMS), must be taken into account in determining the EPR.

The isocost lines derived from a regression analysis indicate the relative importance of the production rate and cumulative quantity to an item's production unit cost.

For the programs studied, the most common reason given for not being able to produce at the EPR was affordability. This was caused in part by the low priority of the defense systems (e.g., A-10) and a higher inflation than anticipated (e.g., FVS, M-1). In the case of the M-1, the cost of facilitization limited the EPR. Another reason for not producing at the EPR was to keep the production base warm until a replacement system had been designated (e.g., A-6E). Still another reason for a low rate of production was a stretch out of the production schedule caused by a delay in identifying the requirement for a follow-on system (e.g., TOW).

RECOMMENDATIONS

It is recommended that the definitions of economic production rate and economic procurement rate be accepted and disseminated throughout the defense acquisition community. EPR must be defined before the unit cost associated with it can be established.

In conjunction with the budget cycle, program offices should report the following information to their higher headquarters for evaluation and possible action to reduce unit cost:
1. Present and projected levels of procurement with associated unit costs.
2. Economic production rates of prime and major subcontractors.
3. The economic procurement rate for the system and the associated unit cost.
4. Contingency levels (with unit costs), higher and lower than the economic procurement rate, that will effectively use available or planned industrial resources.
5. Ways and means to reduce the average unit cost of the system by lowering the economic production rates of the contractors or raising the planned procurement rates of the system.

Production contracts should be written to anticipate changes in production rates and the quantity of the items to be produced. One approach would be to ask for a contractor commitment to costs at several rates. These preplanned rate levels would be similar to the -1 and -2 levels of Example 2.

Defense systems production data should be systematically collected for analysis of the possibility of cost savings and for validation and refinement of cost models. Presently such data are sparse and decentralized.

The Defense Acquisition Research Element (DARE) should sponsor a meeting of those persons who have contributed to the basic theory of EPR. The purpose of the meeting would be to find a bridge between EPR models that are theoretically accurate, but often impractical, and those that are practical, but theoretically weak.

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AN AUTOMATED AIRFRAME PRODUCTION COST MODEL

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ABSTRACT

This paper is dedicated to developing a better understanding of the factors and forces that determine weapons system cost during production. Here we report on a tool that provides timely estimates of the cost impacts of program policy decisions. This tool was developed from theoretical principles. The economists production function was incorporated into a model which addressed the realities of program management. The model uses the calculus of variations to include the production cost drivers of learning by doing, learning over time, the speed of the production line and production line length. It is estimated from data on the C-141 program and tested on other Air Force programs. This work is fully documented in Cost Functions for Airframe Production Programs a report prepared for the Air Force Business Research Management Center and the Office of Naval Research by Womer and Gulledge, [8]. This paper concentrates on the results and applications of that study.

INTRODUCTION

Due to cost overruns, Congressional concern, and a continuing need for better planning estimates, it is imperative that new techniques be developed and old techniques refined to obtain better cost estimates for major weapon system production and acquisition. Along with these techniques, a better understanding of the factors and forces that determine cost is required. In particular, the sensitivity of program costs to alternative policy decisions must be accurately estimated if we are to meet the challenge of providing wise acquisition policy. Furthermore, the cost impacts of policy decisions must be readily available if they are to have an impact in the dynamic world of systems acquisition.

The problems of estimating the cost of military aircraft are legion. Current methods of estimating costs are: (a) the parametric method, which generates simple, imprecise estimates which are insensitive to many production decisions and (b) the "bottoms up" industrial engineering method, which generates complex, imprecise estimates which must be substantially revised if almost anything changes. Neither of these procedures offer much help to the program manager who must develop appropriate funding profiles, lot release dates and delivery schedules prior to program start. They offer even less aid to the program manager who must respond quickly to proposed changes in funding and schedules prior to and during a production program.

In contrast to parametrics, methods recently developed at Clemson University, model the factors that influence cost during an airframe program. This work was jointly funded by the Air Force Business Research Management Center and by the Office of Naval Research. The work is carefully documented in the final report Cost Functions for Airframe Production Programs [8] by Womer and Gulledge. That research effort was to develop, test, and illustrate the use of a significant new approach to estimating the cost of an airframe production program. The theory was developed to unify previously separate methods of describing program costs. The effort was to result in a cost function that could be estimated from already collected data on Air Force airframes. Clemson was to provide the Air Force with a calibrated tool capable of providing timely answers to significant problems of program management.

These objectives were met by the revised model described in the final report. It was based on the four production cost drivers of learning by doing, learning over time, the speed of the production line, and production line length. The model focuses on the production of an individual airframe as a function of its start date and its planned delivery date. The model includes both technical features of the airframe production program and the contractor's behavior.

The first production cost driver is the concept of learning by doing. The basic idea is that as the cumulative number of airframes produced increases the unit costs (or at least labor hours) decreases. This component is the only production cost driver that is sometimes included in parametric cost estimates. It is commonly discussed in both the industrial engineering and the operations research literature, but the learning curve is only rarely mentioned in the economics literature on production and cost.

To aid our thinking about learning and the other production cost drivers, we follow Washburn [7] by adopting the concept of a production line as a frame of reference. Learning by doing affects cost by affecting efficiency at each position on the production line. That is, as the number of airframes passing each position on the line increases, yielding more experience, the efficiency at the position increases, thus lowering labor cost.

Notice that this process implies that at any point in time the experience on the production line may vary dramatically from the beginning to end. (In the C-141 program as many as two years elapsed between the lot release date and delivery of an airframe.)

The second production cost driver is a different learning effect. Over time, learning how

to produce more efficiently may take place due to events other than experience at a position on the production line. For example, early in a production program labor hours may be spent to learn how to produce more efficiently. Later in the program this may result in increased efficiency independent of experience at a point on a line. If this is the case, positions at the end of the line work more efficiently on the same airframe than positions at the beginning of the line. Or, this effect may be related to experience at other locations on the production line. That is, positions late in the production line may benefit from the experience of earlier positions, thus work at later positions proceeds more efficiently than work at early positions on the same airframe.

A third production cost driver is the speed of the production line. Unless compensated for by learning, increasing the speed of the line is expected to require more labor at each position on the line. Furthermore, due to diminishing returns, the additional labor required is expected to be more than in proportion to the increase in speed. Anyone who has observed activity around an airframe during production will recognize the likelihood of diminishing returns to labor on that airframe.

The fourth cost driver is the length of the production line. One way to increase delivery rate is to increase the number of positions on the production line, reducing the amount of work to be done at each position, and increasing the total amount of work accomplished per unit of time. If alternative length production lines are planned this driver may not be a source of variation in unit costs. However, if the length of the line is changed on short notice, unit costs may be affected. For example, increasing the length of the line may result in crowded facilities and overused tools and other fixed resources. This adversely affects the efficiency of production and may result in increased unit costs. This last effect involves an interaction among the airframes that are in the facility at the same point in time.

The model of production described in the next section represents an attempt to capture these effects in an estimable analytic model.

THE MODEL

Like the model in [10] this model augments a homogeneous production function with a learning hypothesis. The discounted cost of production is minimized subject to a production function constraint to derive the optimal time path of resource use. Since factor prices are assumed to be constant over the relevant time period, cost is measured in the units of the variable resource. The variables used in the analysis are:

- i = the sequence number of an airframe, $(i=1,\ldots,n)$;
- V = the average number of airframes in process;
- t_{si} = the date work begins on airframe i; work on all airframes in the same lot is assumed to start on the lot release date;
- t_{di} = the delivery date for airframe i;
- $q_i(t)$ = the production rate at time t on airframe i;
- $Q_i(t)$ = the cumulative work performed on airframe i at time t, i.e.;

$$Q_i(t) = \int_{t_{si}}^{t} q(\tau)\, d\tau;$$

- $x_i(t)$ = the rate of resource use at time t on airframe i;
- δ = a parameter describing learning prior to airframe i;
- ε = a parameter describing learning on airframe i;
- γ = a parameter describing returns to the variable resources;
- α = a parameter associated with decreases in labor productivity as an airframe nears completion;
- ν = a parameter describing returns to the length of the production line;
- ρ = the discount rate;
- C = discounted variable program cost;
- C_i = discounted variable cost of a single airframe.

The production function is assumed to be of the following form:

$$q_i(t) = A(i-\tfrac{1}{2})^{\delta} Q_i^{\varepsilon}(t)(t_{di}-t)^{\alpha} x^{1/\gamma}(t) V^{\nu} \qquad (1)$$

where A is a constant. The input x is assumed to be a composite of many inputs whose rate is variable throughout the production period.

This production function represents an attempt to include the production cost drivers described in the previous section, it conforms to economic production theory, and it also accomodates the fact that the nature of work along the production line changes from position to position. On the other hand it is still a very simple function and it can only be expected to describe such a complex production process with some error.

The term $(i-\tfrac{1}{2})^{\delta}$ describes learning by doing in producing the ith airframe. The terms $Q_i^{\varepsilon}(t)$ and $(t_{di}-t)^{\alpha}$ represent attempts to describe learning that occurs over time during the process of producing airframe i. These terms also admit the possibility that the nature of work changes as the airframe moves down the production line. In particular, it is assumed that as the delivery date is approached it is more difficult to substitute labor for time in the production process. ε and α are both expected to be between 0 and 1. However, below it is seen that the effect of learning while producing an airframe and the effect of the learning prior to production cannot be separated with our data so the ε cannot be estimated.

Still one more term t^h would have been useful to include in the production function to model this effect. Unfortunately, we have been unable to solve the resulting control problem if time is included in this way.

The term $X_{ij}^{1/\gamma}(t)$ captures the effect of the speed of the production line. We expect γ to be greater than 1.

Finally, the term V^{ν} is intended to capture the effect of working on alternative numbers of airframes in the same facility. It is assumed that more airframes in the same facility results in a slight decrease in efficiency (ν is negative and small).

Although the objective of the firm is a function of the wording of the contract, one goal of most contracts is to induce the firm to minimize discounted cost. The problem may be stated as:

$$\text{Min } C = \sum_{i=1}^{n} \int_{t_{si}}^{t_{di}} x_i(t)e^{-\rho t}dt \qquad (2)$$

$$\text{s.t. } q_i(t) = A(i-\tfrac{1}{2})^{\delta}Q_i^{\varepsilon}(t)(t_{di}-t)^{\alpha}x_i^{1/\gamma}(t)V^{\nu},$$

$$Q_i(t_{di}) = 1, \quad Q_i(t_{si}) = 0. \quad (i=1,\ldots,n)$$

Since total cost is monotone nondecreasing and the sub-problems are additive, the solution can be obtained by minimizing each of the sub-problems. The representative problem for the ith airframe may then be stated as:

$$\text{Min } C_i = \int_{t_{si}}^{t_{di}} x_i(t)e^{-\rho t}dt \qquad (3)$$

$$\text{s.t. } q_i(t) = A(i-\tfrac{1}{2})^{\delta}Q_i^{\varepsilon}(t)(t_{di}-t)^{\alpha}x_i^{1/\gamma}(t)V^{\nu},$$

$$Q_i(t_{di}) = 1, \quad Q_i(t_{si}) = 0.$$

Except for the determination of constants this is the same calculus of variations problem that was solved in [9]. The reader is referred there for the solution procedure. Following that procedure yields the following resource requirement function:

$$x_i(t) = B(i-\tfrac{1}{2})^{-\gamma\delta}\Gamma^{-\gamma}[\rho(t_{di}-t_{si})/(\gamma-1),\alpha\gamma(\gamma-1)+1]$$
$$(t_{di}-t)^{\alpha\gamma/(\gamma-1)}e^{-\gamma\rho(t_{di}-t)/(\gamma-1)}V^{-\gamma\nu} \qquad (4)$$

where $B = A^{-\gamma}(1-\varepsilon)^{-\gamma}[\rho/(\gamma-1)]^{\alpha\gamma^2/(\gamma-1)+\gamma}$ and $\Gamma(\ ,\ )$ is the incomplete gamma function. This is the optimal time path for resource use on any airframe.

Since the data presented by Orsini is quarterly data, the quantity of interest is the total resource use over a quarterly period. If T_1 and T_2 represent the beginning and ending dates for a quarterly period, then the appropriate expression for airframe i is:

$$X_i(T_2)-X_i(T_1) = \int_{T_1}^{T_2} x_i(t)\,dt, \qquad (5)$$

and using (4) the integral is:

$$X_i(T_2)-X_i(T_1) = Z_i$$

where $Z_i =$

$$B'(i-\tfrac{1}{2})^{-\gamma\delta}\Gamma^{-\gamma}[\rho(t_{di}-t_{si})/(\gamma-1),\alpha\gamma/(\gamma-1)+1]$$
$$V^{-\gamma\nu}(T_1,T_2)\{\Gamma[\gamma\rho(t_{di}-T_1)/(\gamma-1),\alpha\gamma/(\gamma-1)+1]$$
$$-\Gamma[\gamma\rho(t_{di}-T_2)/(\gamma-1),\alpha\gamma/(\gamma-1)+1]\} \qquad (6)$$

Because of the nature of the data it is impossible to observe the quantity on the left side of equation (5). What is observable is direct man-hours per lot. This means that the observed quantity is:

$$\sum_{i=K_j}^{n_j} [X_i(T_2) - X_i(T_1)] \qquad (7)$$

where K_j and n_j are the sequence numbers of the first and last airframes in lot j. In this instance, the sum is the observed values of labor hours that are reported in Orsini's data set. This sum and the airframe delivery dates are the variables that are used to estimate the model.

EMPIRICAL RESULTS

To explore the applicability of the theoretical specification, the parameters in (6) are estimated using the C-141 data. This data is described in [8]. In an earlier model [9] all airframes in the same batch were assumed to be delivered at the midpoint of their delivery month. Here delivery dates are assigned by spreading the delivery dates evenly across the delivery month. Otherwise, this is the same data used in [9] and reported in Appendix A of [8].

Let $\beta_0 = B'$

and

$$\beta_1 = \alpha\gamma/(\gamma-1) + 1.$$

The model may be restated as:

$$\sum_{i=K_j}^{n_j} Z_i = \sum_{i=K_j}^{n_j} \beta_0(i-\tfrac{1}{2})^{-\gamma\delta}\Gamma^{-\gamma}[\rho(t_{di}-t_{si})/(\gamma-1),\beta_1]$$
$$V^{-\gamma\nu}(T_1,T_2)\{\Gamma[\gamma\rho(t_{di}-T_1)/(\gamma-1),\beta_1)] \qquad (8)$$
$$-\Gamma[\gamma\rho(t_{di}-T_2)/(\gamma-1),\beta_1]\}$$

Equation (8) is estimated using nonlinear least squares as implemented by SAS's Proc NLIN [5]. The results of this regression are presented in Table 1. Almost all of the parameter estimates seem to be significantly different from zero. However, the asymptotic standard errors for β_0 and ρ seem to be large. In the case of β_0 a scale parameter, this is not of much concern. If ρ is not much different from zero then the objective function in the optimization problem need not include the exponential term and more appropriate production functions might be used. This is a matter for future investigations.

The relatively high asymptotic standard error for ρ should not be interpreted as an indicator that the model does not fit the data well or that it is not correct. The asymptotic standard errors reported are calculated based on the assumption that the model is approximately linear in the parameters in the neighborhood of the estimate. This is extremely unlikely in the case of ρ. Another indicator that ρ is an important parameter is the fact that restricting ρ to be zero produces a model with substantially higher mean squared errors.

Table 1

Parameter Estimates and Asymptotic Standard Errors

Parameters	Estimates	Standard Errors
β_0	1.150	0.688
β_1	3.045	1.162
δ	0.484	0.064
γ	1.002	.004
ν	-0.440	.165
ρ	0.002	.004

MSE = 3.66×10^{10}

This functional form generates a time path of resource use for an airframe that conforms to our understanding of that process. Unfortunately, we cannot observe resource use by airframe. We can, however, observe the time path of resource use for the entire program. Figure 1 illustrates the predicted time path of resource use for the program and the actual resources used. While the model fits the data well (R^2 = .69) the model shows more variation with time than the data does. This is particularly true for the period between quarter 12 and quarter 18. In this interval the model first predicts that more man-hours should be used and then that somewhat fewer man-hours should be used. We suspect that this is because the model includes no penalty for hiring or firing costs. Therefore, even though the model predicts that the workforce should rise, then decline, and then rise again, the company (correctly) chose to maintain a more moderate sized workforce over the relatively brief peak and slump in requirements. If this is true, then a more appropriate delivery schedule should have permitted substantial savings on the program.

To further illustrate the sensitivity of the model to changes in the delivery schedule several alternatives to the actual delivery schedule were evaluated in [8].

Figure 2 illustrates one of these analyses. There the time path of resource use (equation (4) summed over i) for the actual program is plotted as a dashed curve. The alternative schedule has the first airframe in the program delivered one month later than reported in the actual delivery schedule. This is the solid curve. This causes the rate of resource use to be lower early in the program but higher as the new delivery date is approached. The net effect is a small increase in predicted program cost. This delivery schedule change operates by adding one month to the first airframe's production time increasing t_{dl}. The time from program start until first delivery ($t_{dl} - t_{jl}$) is also increased. Furthermore, V is increased during quarters five and six. The effect of delaying this delivery increases the learning applicable to the first unit by providing more time prior to delivery, but this effect is offset by the fact that V increases (the number of positions on the production line increases). The net effect is a slight rise in program cost and a delay in program costs (and benefits).

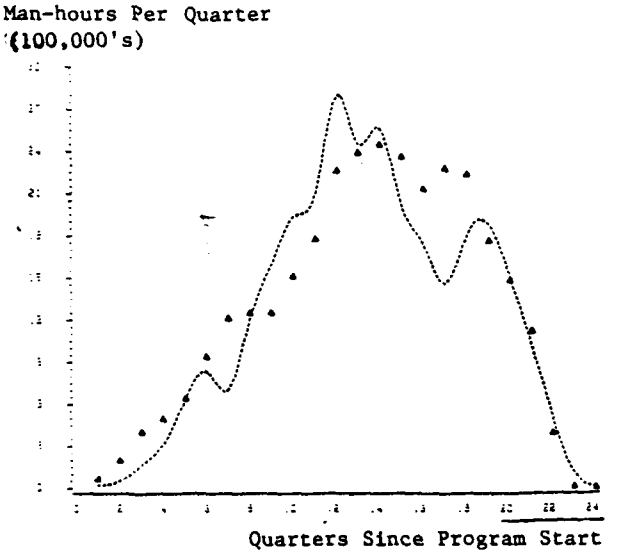

Figure 1. The Timepath of Resource Use

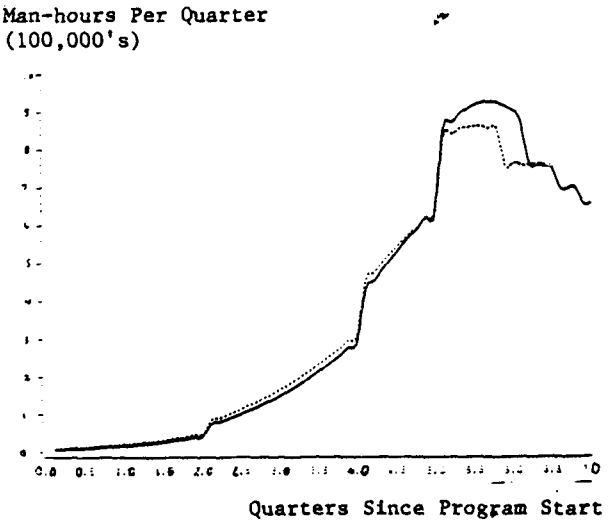

Figure 2. Deliver the First Airframe One Month Later

The sensitivity analyses of [8] clearly imply that some alternative delivery schedules would have resulted in lower costs for the C-141 program. If so, we must ask, "Why were these lower cost, higher benefit schedules not chosen?"

Certainly one possibility is that the decision makers know better than the model what is best. There are several areas in which flaws in the model may be important. One is the lack of hiring and firing costs. A second is the incomplete interaction among the airframes that is permitted in the model. To elaborate, the model does not permit work on an airframe to start later than the lot release date or to end sooner than the delivery date. From the point of view of the single airframe, neither of these events would ever be optimal. If starting late or ending early could affect V, then from the point of view of the program, they may be attractive. As it is now, V is completely determined by the lot release dates and the delivery schedule. Of course, more and better data might permit more accurate and different estimated parameters too.

On the other hand, it is also possible that with a tool which permits decision makers to grasp the program implications of funding cuts, stretchouts and of altered delivery schedules, more optimal decisions will be made. Management science is based on possibilities such as these.

APPLICATIONS TO PROGRAM MANAGEMENT

In this section these results are reviewed for application to program management decisions.

Understanding Production Scheduling

All too often both the critics and the friends of a particular program argue as if there are simple, almost trivial, relations between production schedules and program costs. Often the learning curve is the only relation used to discuss the implications of alternative production schedules. Likewise, when the timing of foreign military sales is considered, only the learning curve is used to analyze the situation. The learning effect is the only production cost driver that is included in the Selected Acquisition Reports (SAR) to Congress on major programs.

Even without explicitly using the model, the four production cost drivers discussed above can be used to paint a word picture of the consequences of altering a program's delivery schedule. This could significantly increase a service's ability to communicate internally with higher authority.

For example, consider the sensitivity analyses depicted in Figure 2. There the first airframe's delivery was to be delayed one month. If a learning curve were used to analyze the situation, there would have been no affect reported. In fact, the effect on total program costs is not large. However, the effect is significant in terms of the timing of costs and the resources required for other airframes in the program. Delaying the delivery of the first airframe provides more time for learning on airframe one (driver 2), and it reduces the planned speed of the production line (driver 3) both these effects tend to lower cost. They are offset by the fact that work on airframe one is delayed to a time when there are more airframes scheduled to be in the facility. This increases V and the length of the production line (driver 4). Thus the cost of producing all the airframes in the facility is increased during the month that is added to airframe one's delivery date. While these effects are not large, they do amount to almost 300,000 man-hours. So they are not trivial.

This research has also contributed to the understanding of production scheduling by unifying earlier models of Smith [6], Alchian [1], and Dreyfuss and Large [2]. This is also of significance to the services. Without a generalized model, debate about the relations among production rate, delivery rate and program costs boil down to a matter of opinion. With the generalized model there will still be debate and opinion, but there are also explicit statistical tests that can be performed. The model provides a clear cut framework within which to address the various effects of alternative schedules. These discussions are <u>not</u> academic exercises. They occur in contract negotiations, the Defense Systems Acquisition Review Council process (DSARC), the Program Objective Memoranda process (POM), Cost Improve Improvement Group (CAIG) meetings and contract disputes. Thus, increased understanding of production scheduling can lead to higher quality decisions about defense programs at all levels.

Program Management and Monitoring

In addition to contributing to our general understanding of production scheduling, the revised model can be used for particular tasks in program management. For example, during contract negotiations the revised model may be used to evaluate a production rate variance formula similar to the one proposed for the A-10 contract (see Gaunt [3]). The contractor's proposed costs at alternative production rates can be compared to those forecasted by the model. This can be a significant basis for the negotiations about the clause. This is not to say that the model's forecasts are correct and the contractor's incorrect, but the model's forecast can serve as the basis for significant questions about why the contractor proposes a particular formula.

Likewise, the SPO can use the revised model as

an aid in constructing the delivery schedule for the program. With a small amount of programming, the costs of many alternative delivery schedules can be quickly compared. These costs together with other considerations can be used to choose the best schedule.

Given the production schedule the SPO may use the model to layout a funding profile for the program. This plan could project costs by month by airframe for the entire program. As actual costs are reported and work packages are completed, this profile could serve as a check on program progress. Slips in the schedule could be spotted quickly and small problems identified before they become large problems. In this use, the model could play a role similar to the actual cost of work performed-budgeted cost of work performed comparisons that are now made.

The model can also provide a SPO with a quick response capability. Educating higher authority about the costs of changing production schedules will not eliminate all the proposals for change. As a result the SPO must be able to respond quickly and reliably to proposals for changes in delivery schedules and funding profiles. The revised model provides the means to forecast alternative cost profiles for different delivery schedules quickly and accurately. It can also be used to find a set of delivery schedules that fit a particular funding profile. Therefore it provides this quick reaction capability. This capability is demonstrated in the previous section where five alternative delivery schedules were evaluated for the C-141 program.

Basis for Further Research

Still one more reason that this work is significant is the fact that it forms a strong basis for further research on production scheduling and program planning.

Certainly one area in which more work needs to be done is in the area of data consolidation. AFPRO's routinely collect data on airframe programs by month and by lot. This data is used for program management and by various defense audit agencies. Yet, for some reason, it does not seem to find its way to the permanent storage facilities like the ASD Cost Library.

The data that is collected there is almost all associated with cumulative labor hours by lot of airframes. In some instances, the labor hours are available by airframe, but the library does not collect monthly data on airframe programs. As a result, it is very difficult to find data of sufficient quality to estimate the model accurately.

For this study, only the C-141 data was in a form which permitted adequate estimation of the model's parameters. This success should provide the impetus to consolidate existing data from the AFPRO's at cost libraries. With more appropriate test data, the ability of the model to perform should be enhanced. This follow on research would fit nicely with thesis research in new graduate programs in cost analysis.

A second area for further research is the application of the model to other products; certainly engines and missiles are good possibilities. It may very well be that tanks, ships, and ammunition would also be appropriate items for this type of modeling.

There are also three areas in which the model itself might be enhanced. First, more work needs to be done on multiple product production functions. This will permit a more complete linking of the airframes to each other in the model. A second area of enhancement is the application of the model to alternative contracts. The model is based on the assumption that the contractor is motivated to minimize discounted program costs. In fact, the contractor's motivation depends on the wording of the contract. In principle a model that is unique to the contract can be derived. This could form the basis for choosing among alternative contract types. It could also provide a substantive case for multi-year contracting. Work still needs to be done in this area.

Third, the model should be expanded to include hiring and firing costs. This will tend to slow down and smooth out the model's reaction to schedule changes. As it is now, the model tends to react a bit too quickly and too strongly to changes in delivery schedules.

CONCLUSIONS

This study is not the last word on airframe production planning or cost estimation. It represents but one more step in our understanding of the factors and forces that determine the costs of a production program. Nevertheless, at this stage, we can offer some hypotheses about these forces that are consistent with the data we have examined so far. While these hypotheses are not in any sense proved, they have been derived with the use of the C-141 data and confirmed by data on the F-102 and the T-38 airframes.

The first point to be made is that production scheduling does matter as a determinant of program cost. It is clear that even very small changes in the production schedule have an impact on the timing and the magnitude of program costs. Second, it is important to realize that changes in the delivery schedule and in lot release dates cannot be easily summarized by a single variable like production rate or delivery rate. It seems clear that one of the reasons that past studies came to contradictory conclusions about the impact of production rate on production costs is that they asked the

wrong question. We conclude that questions about the relation between production schedules and program costs require an examination of four production cost drivers: learning by doing; learning over time; production line speed; and production line length.

Furthermore, we conclude that it is necessary to analyze the behavior of the contractor when developing cost models. Models which regard costs as mechanically related to other variables are destined to have problems in explaining real world data.

In addition, we find that the revised C-141 model is stable. It can be estimated reliably from early observations on an airframe program and used to predict later observations. The model also seems to be very stable among programs. When corrected for the scaling factor difference, a model estimated from one program does a reasonable job of predicting for a new program. Because of this, the services need to do a better job of maintaining and consolidating data on what will permit the model to be fully used. That is, existing data at cost libraries should be augmented by monthly data on aircraft programs. This data is regularly collected by AFPRO's and SPO's at the present time.

Because of these encouraging results, we believe that the revised model is ready for use on defense programs.

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ESTIMATING AND PRICING ANALYSIS

Panel Moderator: Mr. William M. Chamberlain
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DCS/Contracting and Manfacturing
Headquarters Air Force Systems Command

Papers:

Expert Systems for Price Analysis: A Feasibility Study
by J. F. Dillard, K. Ramakrishna and B. Chandrasekaran

Contractor "Hungriness" and the Relative Profitability of DOD Business
by Willis R. Greer, Jr. and Shu S. Liao

Independent Cost Estimates: A Case Study Joint Vertical Lift Aircraft (JVX) Program
by Gerald R. McNichols and Gary L. Sorrell

An Intelligent Manual for Price Analysis
by K. Ramakrishna, J. F. Dillard, T. G. Harrison, and B. Chandrasekaran

On "Before" and "After" Cost Comparisons
by Robert M. Stark

Cost Realism: Assuring More Realistic Contractor Cost Proposals
by Donald L. Trapp

ADP002795

EXPERT SYSTEMS FOR PRICE ANALYSIS: A FEASIBILITY STUDY[1]

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ABSTRACT

The feasibility of alternative designs for an expert price analysis computer system is evaluated by analyzing the price analysis task, and the related support requirements, as performed by Air Force procurement activities. Generally, the Air Force should embark on a coordinated, long-range program of providing adequate expert system support to all procurement functions. Initially, this support can best be provided by a highly structured, interactive expert system which confronts the system user with requisite decision sequences. Each sequence points to a tutorial network which provides explanation and instruction if desired. The most immediate benefit will be experienced at the base level where little expert assistance is currently available. This type of expert system provides the nucleus for developing more sophisticated expert systems for other procurement activities in the intermediate and long term.

INTRODUCTION

The price analysis function, as carried out by United States Air Force (USAF) procurement activities, is surveyed at three different procurement levels:

- Air Force Systems Command-Central (AFSC);
- Air Force Logistics Command-Central (AFLC-C); and
- Air Force Logistics Command-Base (AFLC-B).

The design feasibility of a knowledge-based "expert system" is investigated by evaluating the following questions at each level.

- What are the feasible expert system design alternatives given current technology?
- What assistance can, or should, be provided to price analysts and buyers?
- What information, knowledge, and environment would have to be maintained by the Air Force to support effective expert system utilization by all buying activities?

It is useful to think of expert computer systems in terms of their decision making capabilities (3). These capabilities can range from integrated expert system to a basic data base management system. The most sophisticated type of intelligent system would carry out all the contracting officer functions. A less ambitious undertaking would concentrate on one or more of the several components of the task. If the latter course is chosen, determinations must be made as to which components of the procurement process are amenable to intelligent computer systems. An analysis of the pricing task is undertaken to this end. The following sections characterize price analysis in the Air Force, identify system requirements, and evaluate the feasibility of system alternatives. (See (9) for a discussion of the relationship between expert system design and formal task analysis.)

THE PRICE ANALYSIS TASK

An intelligent computer system designed to aid in price analysis must have the capabilities required to function within the Air Force procurement domain. Generally, there are three major functional entities involved: the user, the contractor, and the contracting officer. The user provides a set of technical specifications and a cost estimate of the proposed procurement. Based on the requirements set forth in the solicitation, the contractor submits a proposed price for providing the desired item or service. The contracting officer is responsible for taking the user's request, soliciting proposals, evaluating the proposals, establishing a negotiating position, carrying out the negotiations, and consummating a contract. Throughout this process, the contracting officer may require in-depth technical, pricing, or legal knowledge necessitating access to specialists in these areas.

The following discussion focuses on the portion of the procurement task related directly to price evaluation in establishing a negotiating position (1). The activities listed below are carried out in developing the objective price.

- Verify user requirements.
- Fact Finding.

[1]The work discussed here was sponsored by the United States Air Force Business Research Management Center under Contract No. F33615-82-C-5114.

- Price comparisons.

- Exception comparisons.

The basis for developing an objective price is the user's technical specifications and the required delivery schedule/period of performance. Next, the following fact finding activities are undertaken:

- Eliminate sources;

- Evaluate prior buys;

- Request and receipt of field reports;

- Identify facilities to be provided by the government;

- Identify relevant outside influences;

- Evaluate time pressures; and

- Document objective development activities.

As a result of fact finding, it is determined which of the following procedures is appropriate for establishing a government position:

- Competitive pricing;

- Published catalog, market or regulated pricing;

- Prior quotes and prices for similar items; or

- Cost analysis.

Once the government objective is established, the proposals/bids are evaluated in terms of this objective price, the prices proposed by the other contractors, and the exceptions taken by the contractors to the solicitation specifications.

Price analysis is defined generally as determination of a fair and reasonable price for the buy. The task may be as simple as comparing two numbers and choosing the smallest in a competitive pricing situation or as difficult as constructing a price based on full costs generated from engineering specifications. The information gathered during fact finding indicates which type of analysis is appropriate as well as provides data useful for carrying out the analysis.

As is the case with the overall procurement function, the price analysis function has access to specialists functions. For example, field personnel can provide information as to the level of compliance with Cost Accounting Standards Board (CASB) requirements and technical specialists can provide evaluations of proposed work processes and material and labor specifications. The system design problem is choosing which tasks to include as part of the price analysis function and which to treat as specialty areas to be called by the price analysis system when needed (6).

Another design issue is the relationship between price analysis and cost analysis. Price analysis includes comparisons of a proposed price with an objective price. As discussed in (1) cost analysis requires the objective to be constructed using engineered costs for direct material, direct labor and overhead. The quantity and unit prices for all direct materials are needed as well as the related overhead rates. Ideally, cost analysis is undertaken to determine the validity of cost estimates of individual components and should be a major input to price analysis. Thus both capabilities are needed.

Information gathered during fact finding determines the extent to which cost analysis is feasible. If cost analysis is to be undertaken, the contractor must provide adequate data. This is usually found on DD Form 633. The evaluation requires a detailed analysis of the direct and allocated costs associated with the proposal. An analysis of these costs and the process used by the contractor to put together the proposal are used to derive an objective negotiation position.

CHARACTERIZING AIR FORCE PROCUREMENT ACTIVITIES

Differences across commands or procurement types is another relevant design issue. For example, what are the similarities and differences between Systems Command and Logistics Command price analysis? Does base level pricing have any commonalities with central procurement pricing? Are different systems needed for buying facilities? This section addresses these issues as they relate to the feasibility of constructing expert price analysis systems. This section evaluates three levels of buying activity, Air Force Systems Command central procurement, Air Force Logistics Command central procurement, and Air Force Logistics Command base procurement, in terms of the following:

- Type of analysis generally undertaken;

- Types of procurement;

- Types of accounting systems encountered;

- Availability of data;

- Expertise of personnel;

- Utility of historical data; and

- On-line computer support.

At the Air Force Logistics Command base level pricing function[2] (5) price analysis is generally undertaken because of the inability to obtain extensive data from the contractor. The types of procurement at the base level are varied and include construction and engineering services, basic services, and commodities procurement. There is generally a large volume of low dollar value buys. The types of accounting systems generally used by the contractors are poorly developed, nonstandard, and provide little support for the price analysis. Thus, very little data is provided to the price analysis. Historical data is the primary factor in establishing an objective price. Personnel are not specialist and little if any specialist assistance is available. They are also under time pressure to process a high volume of actions. On-line computer support is minimal.

Both price analysis and cost analysis are undertaken by AFLC central procurement (7). There appears to be a large diversity in the size of contracts handled with the major type of activity being procurement of spares. They are confronted with many diverse contractors having somewhat unique accounting systems. Thus, there may be little standardization of data. The data available tends to be contractor specific and is generally provided at the discretion of the contractor. There is some field support from DCAA, especially for the larger buys. Historical data is of limited use in determining an objective price because of the relatively dynamic procurement environment. Personnel are fairly well trained in the general procedures of price and cost analysis with some specialty assistance available. One-line computer is limited to spread sheet types of programs such as COPPER IMPACT and some procurement history.

The central level procurement facility of the Air Force Systems Command is primarily concerned with large dollar value buys from a relatively small number of contractors. Cost analysis is the primary form of analysis (4). The major types of procurement are:

- Provisioning spare parts;
- Contract modifications;
- Follow-ons; and
- New equipment.

Air Force Systems Command contracts primarily with 25 defense contractors. There are government teams on site at each major facility (AFPROs). The accounting systems are very sophisticated but also very diverse reflecting the internal accounting/estimation system of the contractor. A great deal of data is available as the result of the on-site personnel as well as the sometimes extensive history of contracts with the Air Force. Because it is confronted with the most sophisticated environment and the dollar values are large, the Air Force Systems Command procurement activities have developed highly sophisticated analysis procedures. Historical data is of little use in establishing an objective price.

CHARACTERIZING SUPPORT REQUIREMENTS

An ideal cost/price analysis system would have the following capabilities:

- Specify and support specific company or company type models;
- User-friendly interfaces for computer-based systems;
- Standardization within companies across contracts and across companies for the same contract;
- Identification of cost-estimating relationships and cataloging and retrieval of forward pricing agreements; and
- Access to field data available.

Such a system is not feasible at this time. It would be very costly to implement and support, and the requisite data bases and logic capabilities are currently not available. The approach advocated is to construct subsystems that can eventually be joined to provide a total system. These need to be evaluated at the different functional levels as well. Another system design issue has to do with the level and sophistication of the "intelligence" which can be implemented in the system (2). The following alternatives are considered:

- Intelligent manual;
- Deductive system; and
- Data rich system.

System Alternatives:

Intelligent Manual - An interactive computer system which contains no analytical capabilities is referred to as an intelligent manual. Such a system can be operationalized at several levels. The most rudimentary application is an on-line reference manual

[2]Referred to as base level pricing. AFLC is evaluated because of the availability of the command to the research team. We have no reason to believe that base level pricing under other commands is a great deal different.

which would point the user to what information might be needed but would not contain any of the information. A second alternative is to provide a spread sheet which would provide for the aggregation and manipulation of data as well as providing simulating capabilities. This is similar to the current COPPER IMPACT system. A slightly more sophisticated system provides a series of question and answer procedures to aid the user in using the stored information. It is in essence an elaborate indexing scheme connected with the underlying manual. Taking the development a step further, by providing a structured trace of the user responses to the system's questions a descriptive model of the contractor's bid can be constructed. A more sophisticated system would contain capabilities for constructing normative models of the contractor's bid based on the descriptive models. Another slightly different but not unrelated objective is a computer-aided tutorial system.

Simple Deductions - A system capable of making simple deductions on its own requires some reasoning capabilities. One way of designing such a system is to construct a subsystem containing a control structure, one having a capability for making historical deductions given specified relationships, and specialists that can be called when specific expertise is needed. In the case of price analysis, the specialists would include accounting, management, auditing, and overhead allocations. The user would be required to provide the system with input data and also respond to requirements which could not be handled by the system. These circumstances would most likely be encountered where the price analyst either interfaces with other specialists, needs information not contained in the system's data base, or where very sophisticated, unstructured reasoning is required.

Data Rich Systems - A data rich system would be the ultimate in intelligent systems for contract price analysis. It would have the capability to read the contractor's proposal and, based on the historical and analytic data in the system, analyze the contract and formulate a government position. This requires that the system have access to the technical specifications of the buyer, a history of the activity in purchasing related items, a history of the contractor's performance on other contracts, a history of similar contractors and similar buys as well as the logical reasoning capabilities required to analyze the current contract in light of these considerations.

SUPPORT ALTERNATIVES

The next question is what type of assistance is feasible for the three levels of price analysis being considered. First, a realistic view of the viable system characteristics is required. In the short term, an intelligent manual is a realistic alternative. It can be implemented fairly quickly, will not require a great deal of personnel retraining to implement, and does not require an extensive historical data base. A prototype of the proposed system is presented in Ramakrishna, et. al. (8).

The types of assistance that could be provided within the intelligent manual alternative at the base level are:

- Provide an intelligent manual for price analysts which would guide the analysis by providing question sequences and elaborating and explaining issues surrounding the questions;
- Provide general and specific indices on-line;
- Make available data bases of historical contract data for the base, region, and Air Force; and
- Make available very general models of contractor types.

Potential areas of assistance at the Air Force Logistics Command central procurement level are:

- Provide general and specific indices on-line;
- Make available historical data bases of historical contract data;
- Specify general parameters for analysis; and
- Provide crude cost modeling of the contractor's estimation systems.

Possible assistance at the Air Force Systems Command central procurement level include:

- Provide on-line historical data bases;
- Provide guidance in establishing parametric and predetermined rates;
- Provide access to previously established parametric and predetermined rates; and
- Provide contractor specific cost models.

The greatest benefit of implementing an "intelligent manual" system will be experienced at the base level. Two major objectives could be achieved. First, the buyer would be provided with price analysis assistance which is not currently available. Instead of having to call in a price analyst who is not always available, the buyer will be able to carry out the task. The system will provide structure as well as general data requirements. In other

words the skill level required to do price analysis would be reduced. The second objective is to expedite evaluation process. The system could be designed to take the responses provided by the buyer and construct the Post Negotiation Memorandum as well as provide an audit trail of the steps taken by the buyer in evaluating the proposal. Also, necessary indices as well as pertinent DOD regulations would be readily accessible. Analytical tools and spread sheet capabilities would be made viable. Our evaluation of the base pricing domain is that many of these capabilities are not currently available to the base level buyer within an efficient medium.

The implementation of an intelligent manual will not be as advantageous to the AFLC central procurement level because they currently have access to more sophisticated analysis aids. However, they would benefit from having access to on-line data access as well as easy access to spread sheet capabilities and analytic models. There are also benefits in enhancing the educational capabilities for teaching novice buyers the more sophisticated price analysis procedures and requirements. Again, an audit trail would be provided as well as assistance in completing the Post Negotiation Memorandum.

With respect to the pricing functions performed at the Air Force Systems Command level, we do not think that any system developed initially as a prototype, or even the first full-scale expert system for pricing, will provide much support because of their current level of sophistication and the complexity of their environment. The preliminary systems can grow into the kinds of systems that would be useful at this level. This growth will depend on the acceptance of the system by the pricing community.

The current level of sophistication at the Air Force Systems Command level is desirable at the other levels and can be facilitated by the proposed system. For example, parametric estimators and cost estimation ratios would be useful at all levels especially at the base level where little pricing assistance exists.

Implementation of the intelligent manual system would allow data to be gathered and technology to be disseminated which would be used to construct such a system in the future. The relationships established from evaluating the first system will provide the basis for constructing a simple deductive system. This, in turn, will provide the basis for constructing a data rich system for price analysis. Each level provides the building blocks for the next more sophisticated system.

CONCLUSION

We propose that the Air Force should undertake a long-range program of providing intelligent computer system support at all levels. In particular, we perceive that base level buyers who carry out their tasks without specialist assistance require the most immediate support and propose an instructional expert system for this purpose. We also propose an intermediate term program for implementing a simple deductive system which can be used as the foundation for the long term objective of implementing a data rich intelligent system which will carry out the price analysis function.

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CONTRACTOR "HUNGRINESS" AND THE RELATIVE PROFITABILITY OF DOD BUSINESS

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ABSTRACT

Lately, DoD-contractor profitability has been very much an issue. Some feel low profits may convert defense business into a 'market of last resort.' Others allege defense contractors earn 'excessive' profits. We address the contradiction between these viewpoints. Specifically, we examine data covering 20 years, and study how the profitability of DoD contracts is influenced. We ask how profitable contractors are in their DoD versus commercial business segments, and whether the risk levels faced are equivalent. Our conclusions are that Program Managers (PM's) take advantage of the bargaining power they hold to buy goods at substantially lower profit margins when capacity utilization is low. The returns earned by contractors on DoD business are measurably lower than the returns on commercial business during periods of low capacity utilization. Also, the volatility of returns is higher for DoD business which means the risks are viewed by management as being somewhat higher.

INTRODUCTION

The importance of profit in the relationship between the DoD and defense contractors is formally recognized in the Defense Acquisition Regulations:

> It is the policy of the Department of Defense to utilize profit to stimulate efficient contract performance. Profit generally is the basic motive of business enterprise: [2]

This profit policy is designed to insure that the best and most efficient industrial capability will continue to be attracted to DoD work. The policy recognizes that the DoD must actively compete with the commercial market to attract this capability.

Lately, though, the sufficiency (or largess) of contractor profitability has been very much at issue. Col. J. R. Woody, for example, has reacted with alarm to reports of relatively low realized returns and generally higher risks faced by contractors. [1, 4] He feels there is a chance that this situation might convert the defense business into a "market of last resort." [9] There is also concern that if this attitude prevails among financial institutions defense contractors may have difficulty obtaining necessary credit.

On the other hand, it has been widely alleged by organizations such as the General Accounting office (GAO) that defense contractors earn "excessive" profits. [7] The striving for competition in weapon systems acquisition is, in large part, attributable to a growing sense of futility--a feeling that efforts to control acquisition costs through audits, negotiation and administrative pressure fail to reduce this "excessive" profit.

Much of the apparent contradiction between these viewpoints can be attributed to the difficulty researchers have in measuring the profitability of a portion of a firm's business. Thomas [6], for example, has shown how terribly equivocal the process of allocating corporate overhead to divisions can be. Some of the rest, we feel, can be attributed to the fact that the different studies have been conducted at different times, and competitive conditions change through time. There is good reason to believe the relative profitability of defense business may also vary with conditions.

It is well-understood that when the economy slackens, and excess manufacturing capacity grows, (real) prices tend to drop and profit margins weaken. [5] When demand falls, firms (particularly those with larger fixed costs) tend to engage in vigorous price competition. [3] Any positive contribution (selling price less variable cost) can help offset fixed costs. The amount of profit reduction experienced should therefore be inversely related to the decline in capacity utilization.

It is also undeniable that the DoD is a powerful buyer. The amount of bargaining power held by Program Managers (PM's) is particularly great in heavily defense-oriented industries such as aerospace. This means PM's should be in an ideal position to take advantage of lulls in capacity utilization--to drive "hard bargains," and buy goods at lower profit margins. If this argument holds, the profits earned by contractors on DoD business should be measurably lower than profits on commercial business during periods of low capacity utilization.

However, when the industry is busy--when there is sufficient total business to require utilization of a large portion of capacity--the profitability of DoD business must at least reach parity. Otherwise, industry might have no incentive to accept DoD orders. It is this observation we seek to test.

AN EMPIRICAL EXAMINATION

In the pages that follow, we will report on the steps taken to test the hypothesis that the state of capacity utilization in the aerospace industry is a determinant of the relative profitability of DoD business to commercial business. We concentrated on firms in the aerospace industry because aerospace firms account for the largest dollar value proportion of defense acquisitions. Included were certain firms known to be significant aerospace suppliers, but categorized by The Value Line Investment Survey as "multiform," "electrical" or "electronics."

We will begin with a description of the data examined, and then move to the analysis and its results. Finally, we will discuss some implications.

DATA

The data examined in this study lie in two categories; corporate data and capacity utilization data. The relevant corporate data, including financial performance indicators and, for reasons soon to be made clear, the volume of DoD business, were extracted from Value Line. (Actually, Value Line indicates the percentage of each company's revenues which derive from "government business." We used this as a surrogate for "DoD business.") Two profitability measures were catalogued--return on sales and return on net worth.

Capacity utilization information was obtained from the Federal Reserve Board. Unfortunately, capacity utilization figures for individual firms are not available. These data are therefore for the aerospace industry as a whole.

The time frame covered by this analysis is the last twenty years; so all relevant data were collected for 1963 through 1982. The percentage of government business was not reported for every firm, every year. Also, there was significant entry and exit of new and old firms during the twenty years. Neither of these factors constituted a problem, however, since each year's data set was certainly representative of the industry, and included approximately 25 firms--a sufficient number to provide statistical confidence in the results.

PRELIMINARY ANALYSIS

No source of financial information routinely reports the aerospace industry's net rates of return on the specific segments of interest--DoD versus commercial. Only the amount of profit earned by the firm as a whole is available for analysis. It was therefore necessary for us to use regression analysis as a disaggregation technique. We will describe the procedure used and display the results.

For each of the twenty years, firms' percentages of government business were used as an independent variable, and the two profitability measures were treated as dependent variables. Thus, 20 regressions were produced, tracking return on sales as a function of percent of government business through time. Another 20 regressions tracked return on net worth as a function of the same independent variable. Each regression was then evaluated at 0% government business and at 100% government business. The ratio of the latter to the former yields the relative profitability of government (DoD) business to commercial business, as indicated by the chosen return measure.

To help reduce the volatility introduced by the accounting principle of periodicity, and to widen the time perspective associated with capacity utilization, we used a resistant time series smoother followed by a simple Hanning running average. [8] Thus, the profitability ratios for both the sales and net worth bases, as well as the measure of capacity utilization, were smoothed. These data are listed in the table below.

Year	Ratio of Profitability of DoD to Commercial Business as a Percentage on Sales (R:S)	Net Worth (R:NW)	Capacity Utilization (CU)
1963	29.7	99.2	83.0
1964	34.4	94.8	83.7
1965	41.8	92.4	86.0
1966	48.5	91.7	88.3
1967	50.8	91.3	89.1
1968	48.9	89.5	87.0
1969	41.6	85.2	80.0
1970	30.2	75.5	72.2
1971	21.6	64.7	69.3
1972	18.8	60.6	69.7
1973	19.1	63.5	70.7
1974	23.2	74.1	71.3
1975	35.5	92.4	71.7
1976	53.7	109.1	72.2
1977	67.4	115.0	74.8
1978	71.1	106.1	79.1
1979	67.0	88.2	81.2
1980	60.2	79.3	80.6
1981	57.0	79.3	78.1
1982	56.9	79.3	73.9

Table 1 Smoothed Data Set

A summary explanation of the data set contained in Table 1 might be helpful. The profitability measures show how the industry's return on the respective bases compared for DoD versus com-

mercial business each year. For example, in 1982 the smoothed profit rate as measured on sales (labeled "R:S" for "Ratio: Sales") was 56.9% as high for DoD business as it was for commercial business. During the same year, the smoothed return on net worth for DoD business was 79.3% as large as the same figure for commercial business (R:NW). Note that the smoothed capacity utilization figure (CU) reached a low of 69.3% in 1971 after a high of 89.1% in 1967. In 1982 the smoothed utilization rate was down to 73.9%. The profitability ratios reached their high points in 1977 (on net worth) and 1978 (on sales). The "lows" both occurred in 1972. Figure 1 shows these data graphically through time.

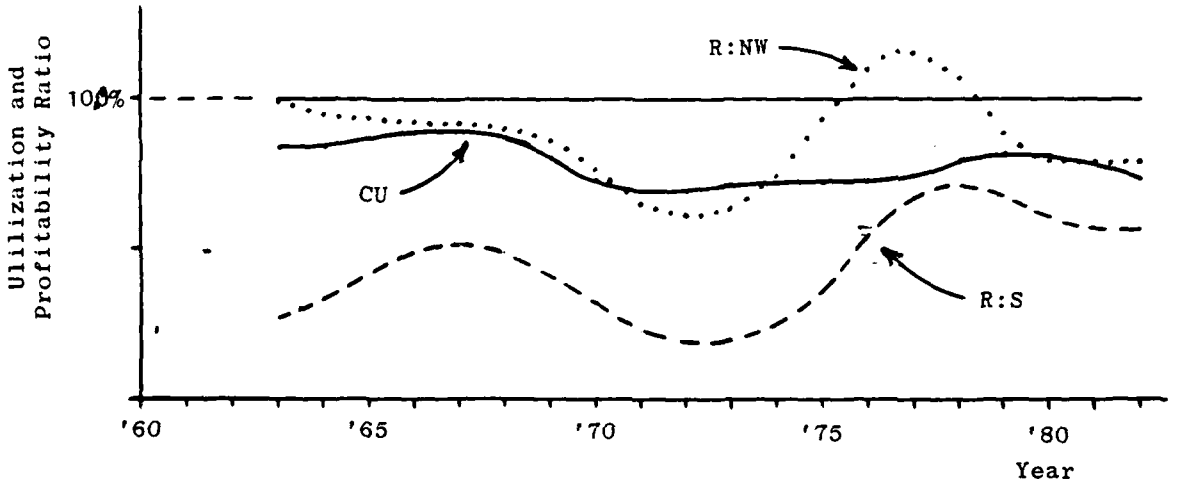

Figure 1 Ratios and Utilization Through Time

During only one period, 1976-78, has the return on net worth been higher for DoD business than for commercial. The return ratio on a sales basis has never begun to even approach 100%. The mean value of R:S is 43.9%, while the average of the R:NW values is 86.6%. Capacity utilization has averaged 78.1%.

Next we turned to the task of seeing whether there is a statistically significant relationship between CU and/or R:S and R:NW. Again, the appropriate methodology was felt to be regression.

ASSOCIATIVE ANALYSIS

To test for association between the two dependent variables and the independent variable, CU_t we ran regressions of two forms:

(1) $R:S = f(CU)$,

and, (2) $R:NW = g(CU)$.

The results were:

(1) $R:S = -34.5 + 1.00\ CU$,

and, (2) $R:NW = 12.8 + 0.94\ CU$.

To interpret and illustrate the use of these regressions, at a capacity utilization rate of, say, 85%, Form 1 would tell us to expect a profitability ratio based on sales of about,

$$-34.5 + 1.00\ (85\%) = 50.5\%.$$

Form 2 would have us expect a profitability ratio based on net worth of,

$$12.8 + 0.94\ (85\%) = 92.7\%.$$

These were roughly the conditions of the mid to late sixties. But if CU were to drop to, say, 70%, we would anticipate,

$$R:S = -34.5 + 1.00\ (70\%) = 35.5\%,$$

and, $R:NW = 12.8 + 0.94\ (70\%) = 78.6\%$.

This is more like the 1973-75 period. The reader might like to note that the smoothed capacity utilization rate in 1982 was 73.9%. The regressions predict R:S = 39.4% and R:NW = 82.3%. The actual values were R:S = 56.9%--higher than anticipated, and 79.3%--a bit lower than expected.

Both forms of the regression easily pass one-tailed statistical significance tests at the .05 confidence level. The T-ratio values were 1.83 for Form 1 and 1.97 for Form 2. The critical value of "T" is 1.73 with 18 degrees of freedom.

These regressions constitute strong support for the original hypothesis that PM's are able to

use their bargaining power to advantage during industry lulls in capacity utilization, but that they must reach parity with commercial business during busy periods. However, the last portion of that statement must be qualified. The DoD never reaches parity on a sales basis, so the proportion of the DoD procurement dollar which goes to contractor profits is never as high as is the case for commercial buyers. The approximate smoothed capacity utilization point at which parity could be expected on a net worth basis would be 92.8%; but at no time during the last 20 years have we reached that point. This implies the 1976-78 period was abnormal.

Next we turn to an analysis of the relative risks of doing business with the DoD versus commercial segments of the aerospace industry. Here the results are less clear.

RISK ANALYSIS

"Risk" can be defined and measured in several ways. One view is from inside the firm--through the eyes of management. This perspective of risk concerns itself with the volatility of earnings. Earnings measures based on sales are generally less important to management than returns on net worth, so we will adopt the latter as our metric for risk measurement from the viewpoint of the firm.

Management must budget cash flows and exhibit appealing pictures of net income growth. These tasks are made easier if earned returns are stable and predictable than if returns are volatile. All things equal, management would prefer stable returns. Said another way, if the earnings rates on a particular line of business are more volatile, management will seek a higher average rate of return as compensation.

We have established above that average returns (as measured on net worth) have been generally lower on DoD business during the last 20 years than the returns on commercial business have been. At this stage, however, we need to compare volatility.

Returning to the preliminary analysis, we arrayed the dis-aggregated returns on net worth for 0% government business in one group and for 100% government business in another. Next, we calculated the standard deviations of the two groups, as indications of their volatility. The standard deviation of returns on DoD work was 4.2%; the same number for commercial business was 3.2%. Not only are returns lower for DoD business, but the risks must be viewed by management as being somewhat higher. This observation explains the necessity of reaching (or exceeding) parity with commercial profitability when capacity is pushed. All things equal, management's preference from a risk/return viewpoint would be for commercial work.

Another measurement perspective for risk is to view volatility of returns through the eyes of the financial markets: in this case, the market for equity securities. Two measures are relevant--total risk and "systematic" risk.

Total risk is simply the volatility of returns to the equities market. Value Line measures this with a "Price Stability Index" (PSI), on a scale of zero to 100. The higher the number, the more stable the firm's stock price and, therefore, total returns to the market.

The analysis method used here was to take the most recent PSI and "percent government business" figures for the firms in the industry, and to again run a regression. The coefficient was -0.38, with a T-ratio of -2.68. This implies, for example, that if a firm's percentage of DoD business were to rise by 10%, its PSI would decline by about 3.8 points. Total risk, as seen through the financial market's eyes, is also higher.

Total risk is a relevant factor to small investors who may hold the securities of only a few firms, but institutional investors and mutual funds are able to hold shares of a sufficiently large number of companies so as to diversify away part of the risk. The portion of total risk which cannot be diversified away is termed "systematic risk" and can be measured by a stock's "beta." This measure (also reported by Value Line) indicates the extent to which the returns from holding a particular firm's stock are correlated to the returns from holding all other securities.

By now the pattern will be familiar. We ran a regression to see whether "beta" can be associated with the percentage of DoD business. But here the coefficient was trivially small and statistically insignificant indicating no association.

The signals deriving from the risk analysis section are slightly mixed, but interpretable. It is a firm's beta which requires higher financial returns in the securities markets. We found the betas for aerospace firms to be higher than the market average, indicating aerospace is a riskier industry, but the magnitude of beta was independent of the percentage of DoD work undertaken. This means that the amount of DoD business done by a firm should not have an impact on its ability to raise equity capital. However, total risk was positively associated with the percentage of DoD business, meaning the ownership of high DoD-percentage firms' securities is likely to be concentrated in the hands of institutional investors.

CONCLUSIONS/SUMMARY

Several conclusions which have implications for acquisition management can be drawn. However, the real objective of this study has been to examine carefully the available data so as to provide answers to the following questions:

(1) Is the profitability of DoD contracts influenced by the state of capacity utilization in the industry?
(2) How profitable are the major aerospace contractors in their DoD versus commercial business segments?
(3) Given risk levels faced by contractors, is the return earned on DoD business equivalent to that of commercial work?

The answer to the first question is "yes." Program Managers (PM's) are able to take advantage of the large amount of bargaining power they hold to drive "hard bargains"--to buy goods at substantially lower profit margins--when capacity utilization is low, but must pay higher prices when capacity is "pushed." This causes profits to rise when the industry is busy, and to fall during slack periods.

The profits earned by contractors on DoD business are measurably lower than profits earned on commercial business--particularly during periods of low capacity utilization. Figure 1 reveals 1976 through 1978 to have been the only time period covered by this study during which DoD-related returns have exceeded those on commercial business. Even though DoD-related profits increase relative to commercial-work profits as capacity utilization rises, we would not expect the two profit rates to be equal to one another until the 92.8% point is reached (on a smoothed basis). At no time during the last 20 years has this occurred.

The lower returns found for DoD business might be acceptable if the attendant risks were lower. However, none of the three risk measures used shows DoD work to be less risky than commercial. Management is apt to prefer commercial work because the volatility of returns on net worth is lower. Total market risk, as measured by the PSI, is also lower for firms with higher proportions of commercial business. Beta is comparable for the weightings of the two segments, though, which implies higher financial returns are not necessary to attract equity capital.

In short, there appears to be reason for concern but not for alarm. Capital generation should not be an especially difficult problem for the aerospace industry, but the distribution of shares of stock of those firms who tend to specialize in DoD work must be more concentrated in the hands of larger investors. The more knotty task will be to find some way to improve management's outlook on the risk/return relationship for DoD business. This might be done in either of two ways. One would be to reduce our voracity for "hard bargains" when the industry is slow. The other is to be willing to allow higher profit levels when capacity utilization is high.

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NOTE:

THE AUTHORS WISH TO EXPRESS THEIR APPRECIATION TO LT. DAVID BRITT, WHO SPENT CONSIDERABLE TIME AND EFFORT GATHERING AND ANALYSING DATA. WE ARE ALSO INDEBTED TO NAVAIR'S COST ANALYSIS DIVISION FOR PROVIDING THE FUNDING UNDER WHICH THIS WORK WAS DONE.

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INDEPENDENT COST ESTIMATES: A CASE STUDY JOINT VERTICAL LIFT AIRCRAFT (JVX) PROGRAM

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ADP002797

ABSTRACT

In 1982, the Army was intrigued with a concept known as the Joint Vertical Lift Aircraft (JVX). Because of the nature of the program, an Independent Cost Estimate (ICE) was performed to "double check" the Program Office estimate. While the Army appears to have lost some interest in the program, this cost study illustrates the process of independent cost estimating.

INTRODUCTION

The Estimates and Studies Division (DRDAV-BE) of the Army Aviation Research & Development Command (AVRADCOM), now part of the Army Aviation Systems Command (AVSCOM), became associated with the JVX Project Management Office (PMO) in February 1982. During the latter part of May 1982, the division was asked to perform a Baseline Cost Estimate (BCE) for JVX. This BCE was completed in about two weeks and during subsequent briefings on the estimate, a request for a "double check" was made. It was decided that the double check, in the form of an ICE, would be done by a contractor and it would be needed in time to be used for FY84 budget exercises.

A competitive procurement process was used to select Management Consulting & Research, Inc. (MCR) to perform the ICE. Guidance was to use data bases already in MCR's possession to complete the initial ICE. MCR selected professional cost analysts and engineers from the MCR staff, and also used Trainor Associates, Inc. (TAI) as a subcontractor to support the rapid-response ICE. MCR was not shown the BCE so as to ensure total objectivity.

Following delivery of an initial ICE draft report, AVRADCOM performed a variance analysis between the BCE and ICE. To perform this analysis, a series of special cost displays were requested, in addition to the basic DA PAM 11-2 and 11-3 documentation normally required for Army BCEs and ICEs. Subsequent to examination of four R&D alternatives and sixteen procurement configurations, a revised configuration was costed by both groups.

The JVX program has now been transferred to the Navy, though it continues to encompass Army and Air Force requirements as well as Navy and Marine Corps. This paper describes some of the methodological problems of performing the JVX Independent Cost Estimate.

In July 1983, Under Secretary of the Army, James R. Ambrose, told Army magazine, "It is fair to say that the Army has lost interest in the JVX. The primary reason is the lack of a defined special electronics mission aircraft (SEMA) package." While the Army originally was designated to lead JVX development because of its rotor technology and modern technology engine (MTE) experience, the project was transferred to the Naval Air Systems Command by the start of 1983. The JVX was originally defined as a tilt-rotor utility and transport aircraft with multiple missions including amphibious assault, combat search and rescue, special operations and electronic warfare.

SYSTEM DESCRIPTION

Development of vertical take off and landing (VTOL), particularly tilt-rotor, technology has been underway for nearly 30 years. The tilt-rotor concept is one method of achieving the efficient VTOL capability of a helicopter while having the high-speed capability of a fixed-wing turboprop. Tilt-rotor research and development began with the XV-3 in the 1950s, proving the basic concept and identifying several technical shortcomings and potential problems in aircraft flight and aeroelastic stability. The 50's technology was refined with more analytical and wind tunnel work in the 60's and early 70's. In 1973, after a competitive design study, Bell Helicopter Textron (BHT) was awarded a contract to build and flight test two XV-15 research aircraft under a joint Army/NASA program. The two aircraft were built and flown in 1977 and 1979. The Navy entered the XV-15 program in 1979. Proof-of-concept evaluation testing began in 1980 and continued through 1982. This year, Bell Helicopter, Textron, Inc. and Boeing Vertol Co. received an $18M contract for preliminary design, including mock-ups, simulation, design trade-off studies, wind tunnel and critical structures tests, and logistics and cost analyses.

COST ESTIMATING PROCEDURES

Since this ICE was for several alternative system options and service-unique configurations and since the system data provided was for the preliminary designs only, no precise individual system description was available. Information provided to MCR included briefing slides included in the RFP and briefing slides provided by the JVX PMO during an initial two-day meeting. This is typical of preliminary design cost estimates.

The major groundrule for the ICE was to provide estimates of the JVX configurations as they were known in May 1982. The difficulty presented by this groundrule was for AVRADCOM to recall what the exact configurations were at that time. The MCR ICE team was presented with the same information (or as close to the same as possible) provided to the AVRADCOM BCE team in May 1982.

MCR developed the ICE estimate from scratch in seven weeks using a team of 11 professional engineers/cost analysts. Cost estimating methodologies employed for the JVX ICE ranged from using aggregate-level Cost Estimating Relationships (CERs) to the use of pricing techniques for specified equipments.

A major problem of the study was to "grow" an XV-15 experimental tilt rotor in the 15,000 pound gross weight class to a JVX potentially in the 40,000 pound class. To accomplish this, it was necessary to develop parametric, analogue, and engineering estimates for various cost elements and hardware components. Where estimates were made at a level higher than the standard DA PAM 11-2 and 11-3 cost elements, a procedure for disaggregation to the standard elements was developed. Where a particular cost display element (e.g., Government Test Effort) required for the ICE did not completely match an 11-2 and 11-3 element, a lower level element was identified so a crosswalk could be made. Most estimates were made at WBS level four or below and aggregated to a higher level for display purposes.

Escalation indices used to inflate prior year data to constant FY82 base-year dollars varied by the particular subsystem being costed (e.g., engine indices are different than airframe indices).[1/] The only requirement for displaying then-year dollars for JVX cost is for R&D profiles, in which case DARCOM Inflation Guidance[2/] was used for FY 83-90, though a risk assessment (TRACE analysis) showed potential escalation above these levels.

1/G. Kreisel, "Escalation Index Tables," WN-8129-3, Management Consulting & Research, Inc., 30 April 1982, was used.

2/DARCOM Inflation Guidance, letter dated 5 May 1982.

Procedurally, five specific tasks had to be performed for an adequate Independent Cost Estimate:

- Task 1: Ground Rules/Assumption Identification
- Task 2: Data Collection and Normalization
- Task 3: ICE Data Analysis
- Task 4: ICE Preparation
- Task 5: ICE Documentation

The objectives of these were as follows:

TASK 1: Develop a detailed plan to clarify and definitize the approach based on specific ground rules and assumptions necessary to complete the estimates. For example, it is necessary to specify compliance with AR 11-8, DA PAM 11-2 and 11-3, MIL-STD-881A, and MIL-STD-1388, as well as base year (82) dollars, inflation indices, sunk cost identification, government in-house costs, data bases to be utilized, Cost Estimating Relationships (CERs) to be tried, models or logical relationships (analogs) which make sense, and Work Breakdown Structure elements and their level. Both a Hardware Breakdown Structure and a Cost-Element Structure had to be defined and agreed to so that the estimate could be validated. Detailed engineering assumptions had to be specified (e.g., no nacelle change was made for the T64 engine, fly-by-wire was assumed rather than fly-by-light, engine MQT was 300 vice 150 hours, composite structure assumptions were detailed, etc.).

TASK 2: Accomplish any additional data collection, perform preliminary analysis to achieve normalization and formatting, and facilitate the use of this data by the MCR project team. Organizationally, MCR uses an engineering team, cost estimating team, and a data base control team in developing program cost estimates.

TASK 3: Assess the adequacy of the data as collected in Task 2, identify and accomplish refinements in the data to make it useful to ICE subteam members, and identify and initiate additional data collection, qualification, or clarification if necessary. The data base control team had to process and interact with both other teams to ensure consistency in estimating definitions and methodology.

TASK 4: Prepare an estimate satisfying all JVX requirements including independence of costs for four R&D and sixteen production con-

figurations, and an assessment of the validity of the design-to-cost goals. Methodology was not specified nor was any benchmark cost such as DTC. Thus, the ICE estimate was totally independent and at the discretion of MCR.

TASK 5: Document the ICE to include all groundrules and assumptions, raw data collected, reduced and normalized data, models, CERs and techniques employed, time-phased costs by cost element and specific matrix format, and summary briefing charts. The documentation included MCR Cost Data Sheets, and Variable Explanation Sheets as noted in Figure 1.

ESTIMATE METHODOLOGY

Basic estimates were made for airframe, engine avionics and mission equipment, and integrated logistic support. A good, professional cost analyst always uses several different estimating techniques and models so as to convince himself of the validity of his estimate. While we cannot reveal the complete estimating methodology, examination of the airframe estimate illustrates the approach.

The Airframe R&D cost estimate was developed separately for prototype manufacturing and all other. Costs were then allocated to the research and development cost elements (development engineering, production engineering and planning (PEP), tooling, prototype manufacturing, data, system test and evaluation, system/project management, training, facilities, and other).

Prototype manufacturing cost estimates were made by using rotary wing CERs, fixed wing CERs, analogy to BLACKHAWK actuals, and simple cost per pound weight scaling techniques. In addition, adjustments were made for composites and aerodynamic weight reductions. To ensure the most current, design-sensitive, and comprehensive CERs, several alternatives from the MCR CER library were examined. One main set selected, estimated costs by weight group (including wing, rotor, tail, body nacelle, drive controls, etc.). Eleven weight groups, a subset of MIL-STD 1374A, were used. The wing equation illustrates the weight group usefulness because the JVX is analogous to a fast helicopter combined with a slow fixed wing aircraft. The rotary CER wing group equation was found to predict 30 percent higher than its fixed wing counterpart. This was useful because the JVX had a stringent wing rigidity requirement which undoubtedly would cost more. The combination of engineering judgement and proper use of CERs is what distinguishes a professional cost analyst from a mathematician. Assumptions about fabrication vs. assembly were made based on analogy to recent Army system developments. Because of multiple configurations for Army, Navy, Air Force and Marine Corps requirements, a common/peculiar weight analysis was run. This is engineering judgement, not mathematics.

The net effect of developing several estimates for the same cost element was a more reasonable baseline estimate, plus an uncertainty bound with documented rationale. Examination of

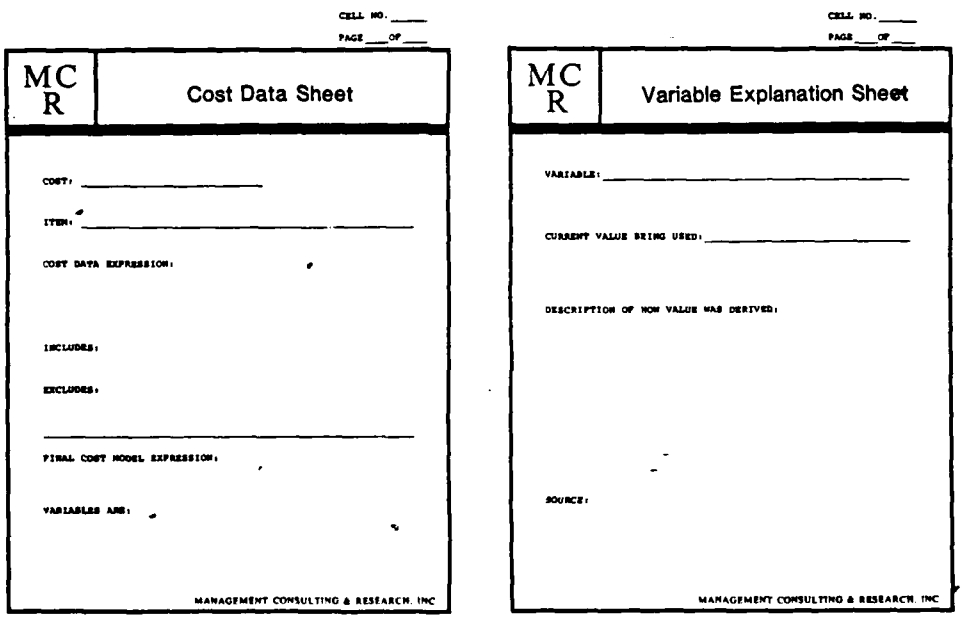

Figure 1

alternative CERs also helped define several cost driver parameters which could be examined in depth. In addition, it is clear that parameters such as AMPR (or DCPR or unit) weight, max speed, and technology indices are extremely useful in sizing airframe costs.

Other hardware elements were similarly estimated, though the propulsion systems were "grown" from existing engines, and most of the avionics were estimated based on catalog "off the shelf" prices. A few pieces of equipment were estimated by "designing" them, estimating engineering hours, and then costing the required labor. The MCR Life Cycle Cost Model was used to combine all cell costs into a cost matrix, Figure 2.

CONCLUSION

An independent cost estimate (ICE) should be and can be done without any knowledge of the baseline cost estimate (BCE). Even with new technology systems, a logical organized approach can produce a credible, documented cost estimate in a short period of time. Critical to producing a valid estimate is a staff of trained cost analysts supported by engineers and business analysts who can think logically. Documentation of any estimate should consist of variable explanation sheets for each cost element and hardware element (cell) defined on a cost data sheet. No single estimating technique should be used exclusively. The intent is to be approximately right, rather than precisely wrong.

ALTERNATIVE/OPTION

JVX COST MATRIX — MANAGEMENT CONSULTING & RESEARCH, INC.

RESEARCH AND DEVELOPMENT PHASE — LIFE CYCLE COST MODEL — AUGUST 1983

(MILLIONS OF CONSTANT FY 83 DOLLARS)

TILT-ROTOR WITH T64-416 TRANS NTE (TR-RD-3)	(1) AIRFRAME	(2) ENGINE	(3) COMM/NAV	(4) MISSION KITS	(5) ARMOR/ ARMAMENT	(6) GFE	(7) OTHER	(8) TOTAL	(9) PERCENT
1.0 RESEARCH AND DEVELOPMENT									
1.01 DEVELOPMENT ENGINEERING									
1.02 PROD ENG & PLANNING (PEP)									
1.03 TOOLING									
1.04 PROTOTYPE MANUFACTURING									
1.05 DATA									
1.06 SYSTEM TEST & EVALUATION									
1.07 SYSTEM/PROJECT MANAGEMENT									
1.08 TRAINING									
1.09 FACILITIES									
1.10 OTHER									

Figure 2

AD P002798

AN INTELLIGENT MANUAL FOR PRICE ANALYSIS[1]

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The Ohio State University

ABSTRACT

We investigated price analysis as performed in the United States Air Force (USAF) and the environment in which buyers at bases make decisions about procurement actions. Based on this study, we evaluated the "intelligent manual" approach for guiding a buyer through the decisions and actions necessary to conclude a buy. An intelligent manual is a computer-based consultant that provides advice and pointers on the use of existing information in response to user queries.

Our prototype intelligent manual is constructed as part of the "ZOG system." ZOG is an active, large-network, menu-selection system. We present the design of the interactive intelligent manual (based on our analysis of pricing) and discuss its short-term and long-term implications for procurement in the USAF. We identify how this system would be the basis for future intelligent, problem-solving expert systems that automate significant components of the pricing task.

INTRODUCTION

Proposals submitted by contractors are analyzed to determine if the proposed price is "fair and reasonable." This determination must be made under a variety of conditions--for large contracts, for example, the contractor is often required to submit data that may be used to justify the proposed price. The performance of this function at different levels of the procurement process is reported in Dillard et al (2) (also presented in this symposium). In that article, we identify base level pricing[2] as a major problem area characterized by limited data, limited analytic tools available to the personnel in charge of negotiating a contract, and a wide variety of types of procurement. Also, contractors use poorly-developed, non-standard accounting systems that provide little support for a buyer attempting to perform a reasonable job of analysis. In addition, the lack of continuity of personnel, the lower level of training provided to contracting personnel at the base level, and the frequent need for hurried decisions make it difficult to perform price analysis in the best possible manner.

Price analysis at the base level cannot be viewed independently of the "procurement" activities of the buyer. The information gathering and other routine activities of the buyer while processing a purchase request or generating a solicitation provide information that is needed for later analysis. A system designed for only the price analysis component of this complex activity would probably not be useful to the buyer. We therefore view price analysis in the context of procurement. Figure 1 displays our model of procurement and the role of price analysis in this context.

The architecture of an intelligent manual has four components shown in Figure 2. They are:

- The Task Support System. This component supports the basic task by providing an appropriate organization for the overall task. The organization is obtained from an analysis of how experts perform the task and is designed to support the expert's performance.

- The Guidance System. This component provides explanation and guidance to performing the basic task. The structure of this component parallels the structure of the Task Support System so that a novice, on requesting help, is given the appropriate explanation and is guided to perform the appropriate activities.

- The Task Action System. This component consists of the programs and tools (such as statistical analysis programs, text editors, learning curve programs, data bases, etc.) that are necessary for performing the analysis called for in the Task Support System. These programs can be invoked from the Task Support System (as well as the Guidance System); the input data required by these programs is provided via the Task Support or Guidance Systems, and the generated output data is accessible from the Task Support or Guidance Systems.

[1]The work discussed here was supported by the United States Air Force Business Research Management Center under Contract No. F33615-82-C-5114.

[2]Our suggestions are based on base level pricing as performed in the United States Air Force Logistics Command (AFLC), but they appear to be of general validity.

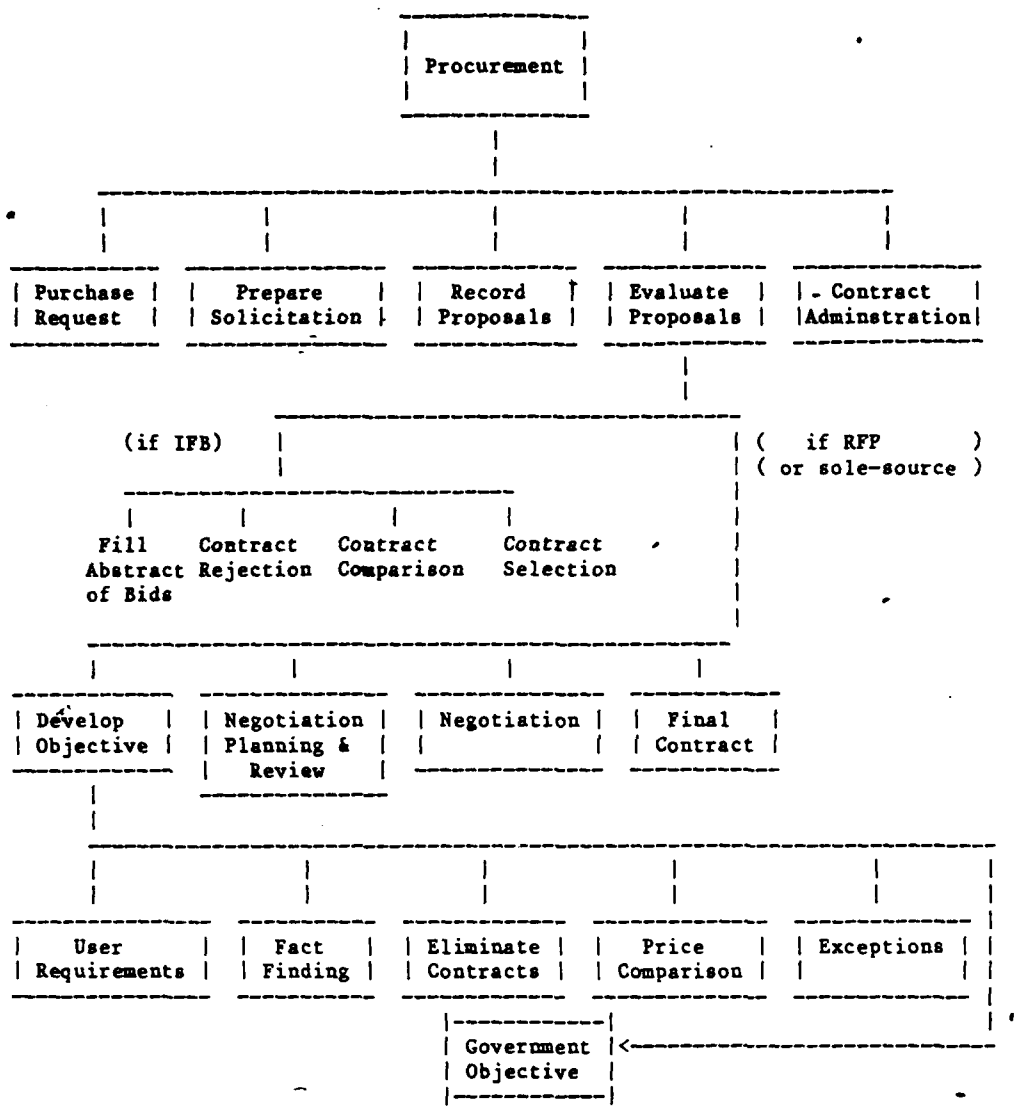

Figure 1: The Procurement Context of Price Analysis

- The External Interface System. This component uses the results of the user's interaction with the above three systems to generate appropriate output. For example, this system may generate a structured document that documents the user's decision (such as a Price Negotiation Memorandum) or an audit trail report that specifies the actions performed by the user and the possible reasons for these actions. Many different kinds of output are possible and all of them must be based on information gathered from the user's interaction with the other three components.

In this paper, we describe the implementation of an "intelligent manual" for use by personnel not generally trained in price analysis for base level procurement. We believe that such a system would be of the greatest benefit for these personnel (other kinds of expert systems may be more appropriate for personnel at other levels of procurement and these are discussed elsewhere). Such a system would satisfy two major objectives:

- It would provide a buyer with price analysis assistance that is not currently available.
- It would provide the buyer with the appropriate structure to perform the task in accordance with DOD regulations and expedite the evaluation process.

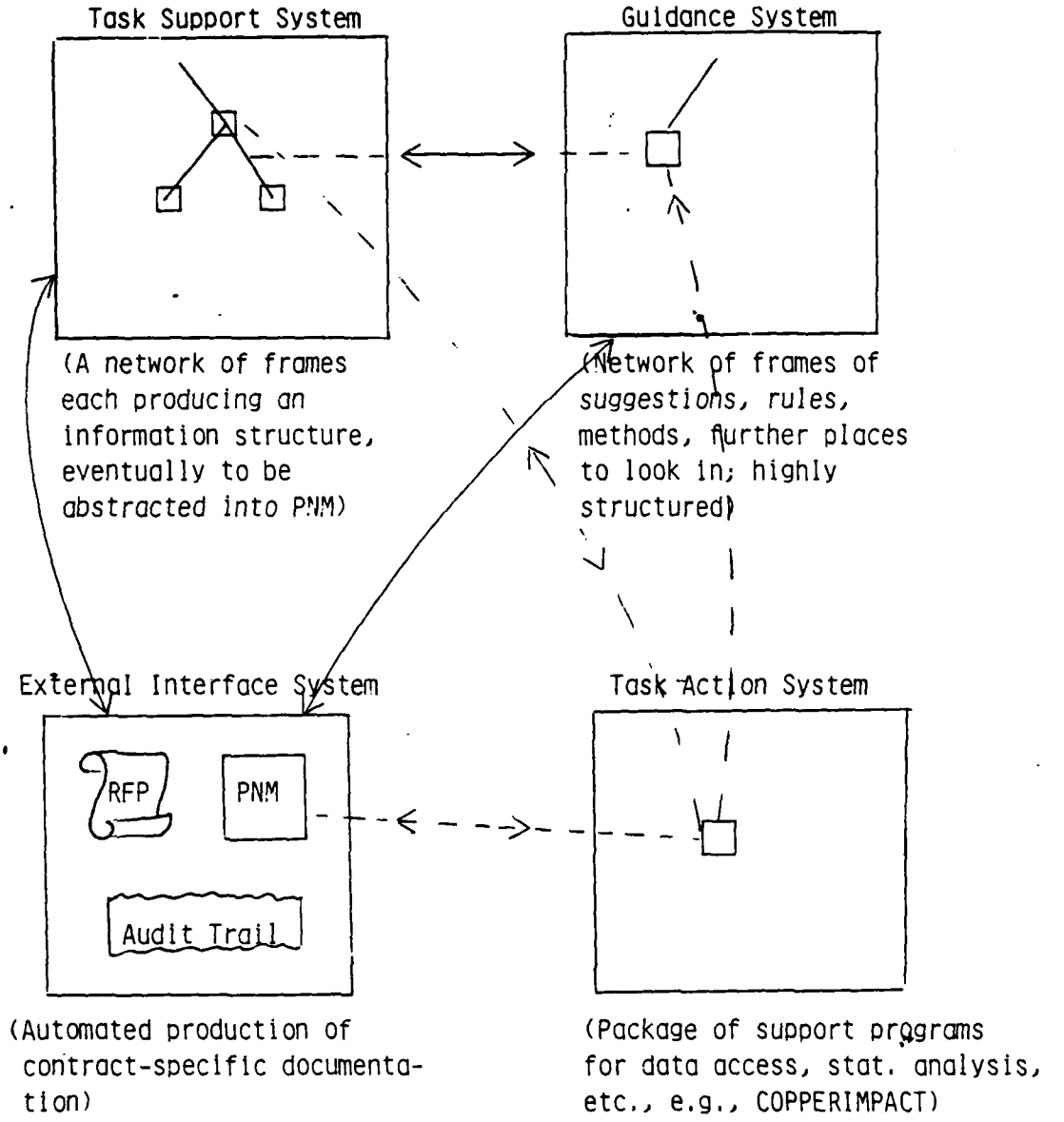

Figure 2: The Architecture of an Intelligent Manual

The Task Support System for price analysis should be based on an analysis of how experts perform price analysis. (It should be noted that in the USAF, "price analysts" do not perform price analysis--they advise buyers performing price analysis or else perform cost analysis; the only personnel actually performing price analysis and making procurement decisions purely on price analysis are buyers, and usually base level buyers. Thus the experts to analyze for designing the Task Support component are buyers.) We must also locate this performance within the context of procurement described earlier.

Price analysis, or the determination of a "fair and reasonable price," can be viewed as the task of Developing a Government Objective. There are two general methods for developing this objective:

- By determining the lowest price proposed in a truly competitive environment, or
- By developing a price based on a knowledge-based analysis of the item.

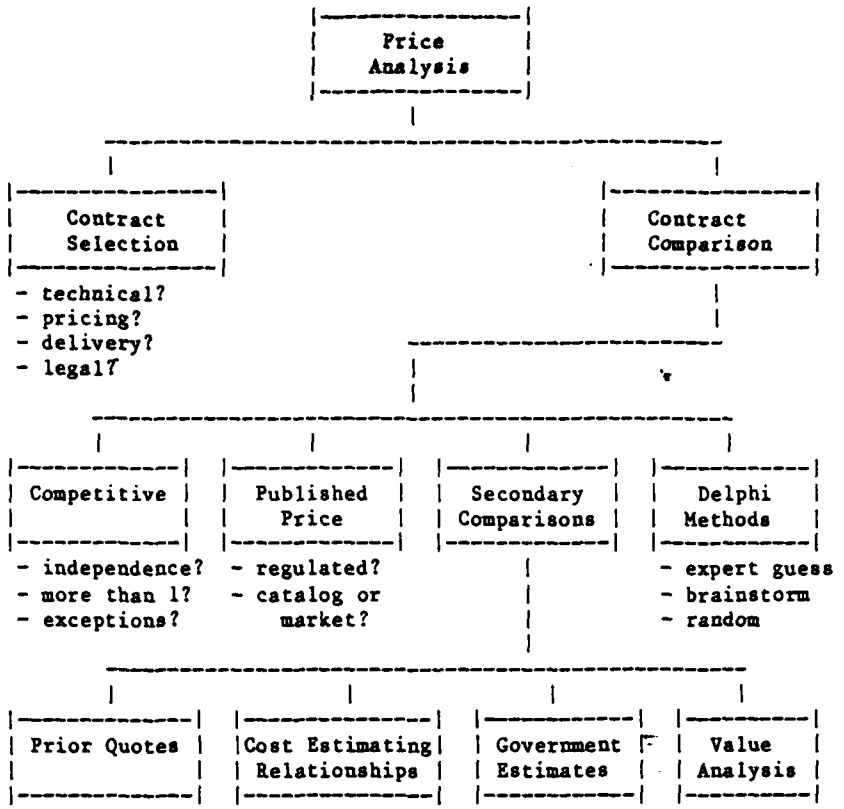

Figure 3: Developing a Government Objective

However, in practice this government objective must be realized in a variety of ways. For example, contractors may not bid on a particular solicitation for reasons that have little to do with the item being procured (for example, if the contractor already has too many orders), thus causing a truly competitive situation to appear non-competitive. Such reasons make it necessary to modify the above methods in actual application.

Figure 3 represents the model of price analysis underlying our intelligent manual. The interleaved negotiation process that a buyer is engaged in requires a "Contract Selection" stage in which some contracts are identified as serious contenders. Further analysis is restricted to these contracts. There are four classes of analytic tools needed for price analysis. "Competitive" and "published price" are the two approaches most commonly preferred and used. Buyers at the base level do not often employ cost analysis and other sophisticated techniques available to contracting officers at more complex levels of procurement. Based on our study of the pricing function, we concluded that these techniques ought to be available to buyers at this level. We have therefore included these capabilities under the category of "Secondary Comparisons," along with the use of "Prior Quotes" (also used heavily by base level buyers). We have also included techniques such as "Value Analysis" that are viewed askance by the sophisticated pricing community as well as by auditing agencies--these techniques are a last defense against merely accepting whatever is offered by a contractor. "Delphic Methods" are methods even further removed from the pale of pricing legitimacy--the buyer may determine his objective by asking a possible expert in the domain (say the using agency) how much the item "ought" to cost, or may simply brainstorm with colleagues (other buyers) to determine a price.

THE ZOG SYSTEM: A BRIEF INTRODUCTION

The system described here is constructed on top of the ZOG system. ZOG has been described elsewhere (5, 6), and has been applied in a number of different data base and project management situations (7, 3, 4, 1).

ZOG is a large data base (potentially very large) of information organized as a network of frames. A ZOG-user moves from frame to frame using the computer terminal to view the contents of a frame at a time. Frames are designed to be displayed on a single screen; by convention, every frame has a one-line

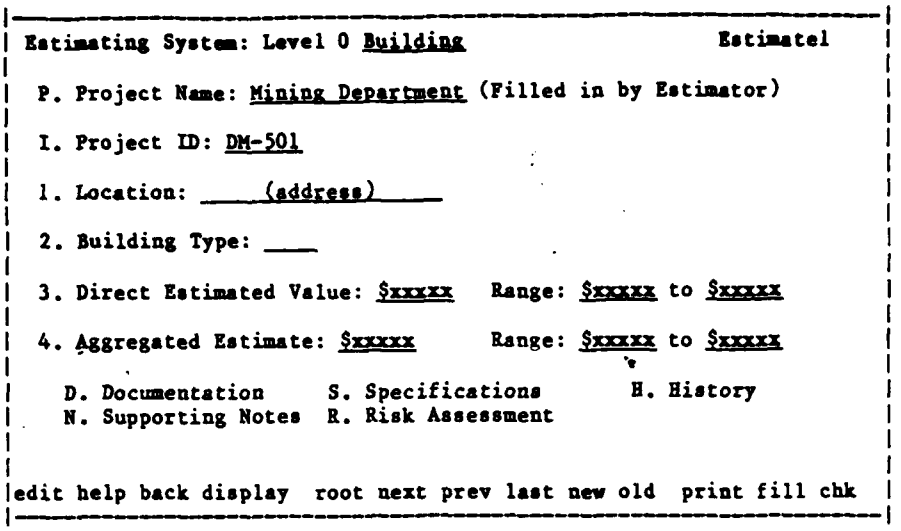

Figure 4: An Example ZOG Frame Estimate1

Title at the top of the screen, a few lines of Text below the title, a set of numbered (or lettered) menu items of text called Selections, and a line of ZOG commands called Global Pads at the bottom of the screen.

Frames are interconnected by the selections. When the user selects an item (by typing its number or letter, or in more advanced ZOG systems by touching the screen location of the item), ZOG "moves" the user to the frame "pointed to" by the selection. This new frame is now displayed on the screen, replacing the frame from which the selection was made. The new frame will have the same general format; it will usually contain new information and further selections that lead to more detailed information. Occasionally there may be "dead-ends"--frames that have no selections. Basically, the frame network is a hierarchical information structure with extensive cross-referencing as well as mechanisms for moving directly from frames deep down in the hierarchy to frames much higher up. The network of frames is often termed a ZOGnet.

Selections and frames may have associated "Actions" that activate programs (or other entities) on behalf of the user. These Actions are executed when the frame is displayed or when a selection is made by the user. (These Actions implement the connecting link between the Task Support System and the Action Support System of our intelligent manual).

Figure 4 shows an example ZOG frame. This frame called Estimate1 (see the upper right hand corner of the frame for the Frame-Id) is the initial frame for a ZOGnet that was used for estimating the cost of a new building for the Mining Department. There are lettered selections P and I that identify the project by Project and Identifying number, a set of numbered selections that point to frames giving further information (and provide a brief summary as well); there are more lettered selections D, N, S, R, and H that provide further information appropriate to the global level of cost estimation implied by the contents of this frame. The global pads at the bottom fall into three groups--the set edit, help, back, display helps the user move around the ZOG system (e.g., back will always move to the previous frame seen by the user); the set root, next, prev, last, new, old helps the user move in special ways around this particular ZOGnet (e.g., old will take the user to a previous, saved estimate for this building); the set print, specs, fill, chk allows the user to apply certain functions to this frame (e.g., fill will prompt the user to fill up blank spaces in selections of this frame). These global pads are invoked by typing the first character of the name of the global pad (e.g., f for the fill global pad).

THE ZOG-PRICING GUIDE: EXAMPLE AND DISCUSSION

The ZOG-based pricing guide is intended to guide the user (a buyer or a price analyst) through a series of questions that must be raised in a procurement situation. If the buyer cannot answer a particular question, the system will simplify the question into simpler questions; at the lowest level (at the level of primitive concepts) the buyer will be directed to a tutorial section of the ZOGnet that teaches the buyer the necessary concepts and provides examples.

Every frame in the ZOGnet is constructed to contain four parts: an Information component that provides the user some information; an Action component that instructs the user to do

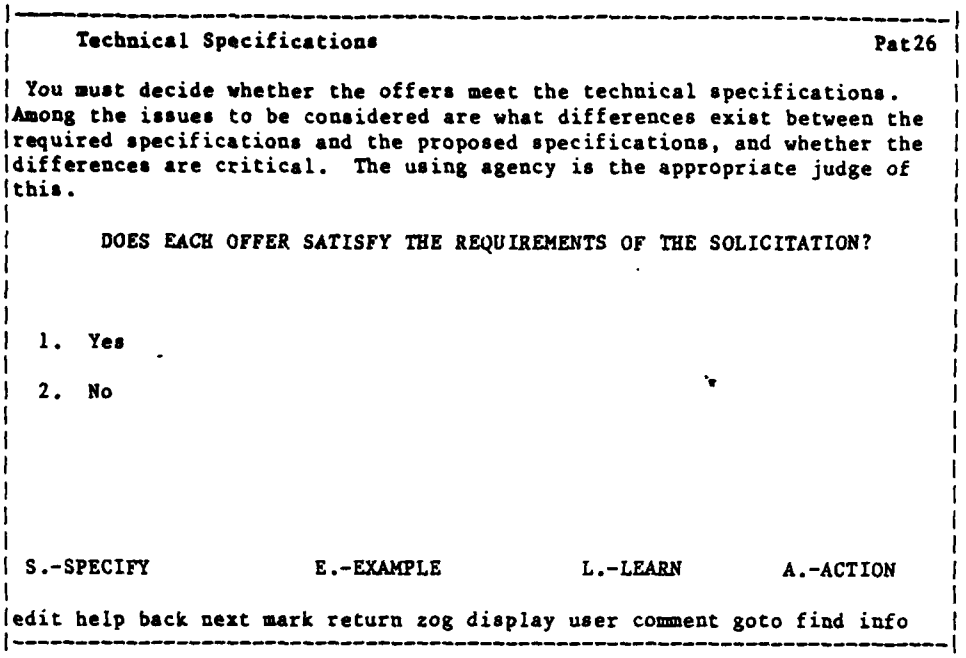

Figure 5: A Decision-Option Frame

something; a Decision component that poses a question to the user that must be answered with reference to the contract(s); and an Option component that provides the user with a set of possible answers to the question.

The Decision and Option components determine the structure of the network. Most questions will have "Yes/No" answers, though others may have slightly more complex answers. In any case, the questions are formulated so that they can be answered from a small menu (otherwise this approach cannot succeed). Figure 5 shows the first question that the buyer is confronted with by the system: "Is the price proposed for a contract fair and reasonable"? The answers can be Yes, No, or Not Sure. Such a frame is called a Decision-Option frame--there are no Actions and there is no information presented with the frame. If the user answers "yes" or "no" (selects menu items 1 or 2, respectively), the user will be taken to appropriate Review-Action frames (see Figure 6) that give the user the opportunity to review the decision (by reading the information presented) and take an action. In the case that the user is "Not Sure," the user will be taken through a sequence of Decision-Option frames that will elaborate the question asked in Figure 5. These will ultimately terminate in some other Review-Action frame (or frames). If the user is totally confused as a result of unfamiliarity with the domain ("er, um, what's a proposal?") he will be taken to a further section of the ZOGnet that is organized differently as a "tutorial" or a "learning net."

CONCLUSION

The major implications of such systems for DOD (and other government) procurement are:

- A reduction of the skill level necessary to perform routine procurement tasks.
- The need for appropriately structured knowledge bases that contain a wide range of needed information.
- The need to maintain such systems up-to-date with respect to the latest rules and regulations.

In the long-term, problem-solving expert systems can be constructed to perform more of the pricing task and to provide more aid to other levels of the price analysis function. This will depend on the effective implementation of the knowledge bases mentioned above, and the effectiveness of the procedures for maintaining and updating the system.

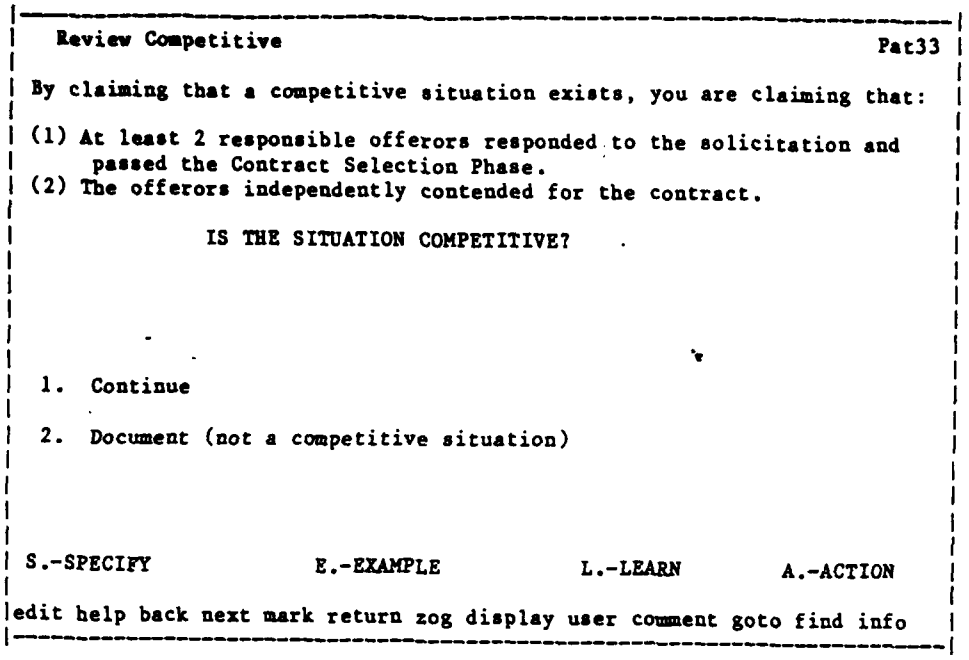

Figure 6: A Review-Action Frame

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AD P002799

ON "BEFORE" AND "AFTER" COST COMPARISONS

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ABSTRACT

Comparisons of *a priori* cost estimates with *a posteriori* payments is about as pervasive as it is instinctive. A new result of mathematical optimization and probability theories leads to the unexpected conclusion that such comparisons, even for many idealized engineering designs, appear to be invalid. The paper demonstrates that "before" and "after" costs are unit samples from populations with different probability distributions.

INTRODUCTION

Comparisons of *a priori* cost estimates with *a posteriori* payments is about as pervasive as it is instinctive. In virtually every project of engineered construction there are any number of circumstances that intervene between the time preconstruction estimates are made and the time after construction when payments are made. These can include design changes; construction alternatives; and unstable monetary system; and environmental, labor, or managerial changes. These circumstances (always seemingly unique to each project) distort such "before" and "after" cost comparisons. Still, many seek insights and conclusions from cost comparisons. One feels that somehow an experienced "eye" can compensate for the disparities attributable to the intervening changes. Of course, there is some merit to such feelings and, beside, the data may be the best available. However, there is a tendency to overlook the fact that the history of science is cluttered with examples of contradictory conclusions which were supported by the same experimental observations.

Imagine an idealized project of engineered construction for which there are no change orders, design changes, and so on -- only the customary uncertainties of relevant "before" and "after" costs. These circumstances are about as favorable as can be hoped for as a basis for making conclusions from "before" and "after" comparisons. Yet, an analytic result appears to have the shocking implication that even under these idealized conditions, a basis to support such cost comparisons is fundamentally inadequate. The paper demonstrates that *for a simple (but fairly general) analytic formulation of an engineering design these a priori and a posteriori costs can be regarded as unit samples from populations having different probability distributions.*

TEXT

Geometric programming is a newer mathematical format for solving constrained and unconstrained non-linear optimization problems. It is popular among engineers because of the aptness of its format for problems of interest to them and the design oriented insights it provides [1, 2, 3].

Imagine that the costs of each of the (major) design components are expressed in terms of cost parameters and design variables. For example, the pre-design cost of a simple structure, a dam, say, is expressed as a function of its height (the design variable). The relevant costs are the construction cost (an increasing function of dam height) and overtopping costs (a decreasing function of height). The sum of these is the total cost to be minimized by an appropriate choice of dam height (subject to constraints) [2, 3]. Another example: imagine a fixed tonnage that is to be transported periodically by a (to be designed) fleet of ships. At one design extreme, a single gigantic ship can be used or, at the other extreme, a number of small ships. Smaller ships can be propelled at higher speeds but at increased building costs. Larger ships move at lower speeds but entail lower building costs [4]. The design of this fleet and the structural design are only two oversimplified examples of engineering problems that have been formulated as geometric programs.

For ease of discussion, we represent the sum of the costs of the design components (and any constraints) by the symbol

$$P(\underset{\sim}{c};\underset{\sim}{x})$$

where $\underset{\sim}{c}$ signifies the various cost coefficients and $\underset{\sim}{x}$ the various design variables (dam height, ship speed, etc.) whose values are to be determined such that $P(\underset{\sim}{c};\underset{\sim}{x})$ is minimized. Specifically, the symbol $P(\underset{\sim}{c};\underset{\sim}{x})$ is the *primal* problem of geometric programming [1].

It is a mathematical fact that to a proper primal geometric program there corresponds a *dual* geometric program denoted symbolically by

$$D(\underset{\sim}{c};\underset{\sim}{w})$$

where $\underset{\sim}{c}$, as above, signifies the various cost coefficients and $\underset{\sim}{w}$ are "weights." In part, at least, these $\underset{\sim}{w}$ are positive fractions of unity representing the proportion of the total resources (costs) to be allocated to the

various components that compose the design. Again, $D(\underset{\sim}{c};\underset{\sim}{w})$ is a symbol for equations (3), (4) and (5) in the Appendix. Examination of those equations indicates that the algebraic structure of the dual is a product of exponentiated cost coefficients and weights. In particular, there is no explicit dependence upon the design variables $(\underset{\sim}{x})$.

A basic theorem of geometric programming [2, 3] asserts that at optimality (denoted by an asterisk) the minimum value of the primal equals the maximum value of the dual. In symbols

$$\min P(\underset{\sim}{c};\underset{\sim}{x}) = P^*(\underset{\sim}{c};\underset{\sim}{w}^*) = D^*(\underset{\sim}{c};\underset{\sim}{w}^*) = \max D(\underset{\sim}{c};\underset{\sim}{w}).$$

The basic special case, for which equations (4) and (5) uniquely determine the "weights" $(\underset{\sim}{w}^*)$ independent of the cost coefficients $(\underset{\sim}{c})$, is called a *zero degree geometric program*. In view of the ubiquitousness of zero degree programs, the precision of the mathematical results available for them, and for ease of discussion, the results to be described apply to that special case [5]. Mathematical extensions to higher degree geometric programs appears in [6].

To support the introductory assertions concerning *a priori* and *a posteriori* sums, a class of non-linear optimization formats known as geometric programs were described as being especially suited for engineering design problems. The primal problem is one of minimizing a polynomial-like function of cost coefficients and design variables $(\underset{\sim}{x}$'s). Typically, costs are not known with precision until the job is complete. This implies that values of the design variables must be chosen before costs are known in order for the work to proceed. Of course, since the choice of design variables depends upon the costs, this further implies that an *a priori* optimal design choice based upon cost estimates is improbable. Finally, having chosen the design value, the $(\underset{\sim}{x}$'s), the primal function (i.e., the total cost estimate) can be regarded as a linear function of the component costs. Application of the well known central limit theorem points toward the assertion that *a priori cost estimates can be regarded as samples from a normal tending probability distribution* [5, 7].

Now, the dual problem corresponding to the primal problem also represents the total cost since at optimality the primal and dual have the same value. The dual function depends upon the cost coefficients ($\underset{\sim}{c}$'s, as in the primal), and the weights ($\underset{\sim}{w}$'s). In the zero degree case at hand, the mathematical structure of the dual function is as an exponentiated product of cost coefficients and weights. Recall, that the primal problem required a choice of design variable values ($\underset{\sim}{x}$'s) in order for the design to proceed. This is not so for dual problems. That accounts for the colorful descriptions as "here and now" and "wait and see" problems, respectively. After the design has been executed, and the costs determined, the "weights" (being actual proportions of the total cost) are known and the dual evaluated. However, *these a posteriori costs can be regarded as samples from a lognormal tending probability distribution.* This follows since the lognormal probability distribution has similar limiting properties for exponential products of random variables as the normal distribution does for sums [5, 6, 7, 8].

CONCLUSION

We have shown that *for a simple (but fairly general) analytic formulation of an engineering design these a priori and a posteriori costs can be regarded as unit samples from populations having different probability distributions.*

Samples from a population and its probability distribution may be compared meaningfully. However, small samples from different populations pose an added impediment to reaching conclusions from cost comparisons. This tends to explain why experienced engineers often express a grudging respect for the complexities and nuances of estimating beforehand costs and assessing proper payments afterwards. The perennial quest for alternatives and modifications in contracting modes and practices are an implicit consequence.

The references cited provide more rigorous mathematical support for interested readers. A happy feature of the project cost assertions is that they tend to improve with increasing design complexity. This follows since increased design complexity is represented by increased numbers of cost coefficients in both primal and dual functions. The precision of both probabilistic limit theorems cited improve with increased numbers of random coefficients.

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ADP002800

COST REALISM: ASSURING MORE REALISTIC CONTRACTOR COST PROPOSALS

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ABSTRACT

Unrealism in Defense contractors' cost proposals, especially for RDT&E programs, often contributes to cost growth as well as to other problems. The Defense Department is therefore concerned with achieving greater cost realism. A methodology has been developed for achieving greater realism of contractor cost proposals. This methodology defines cost realism as an evaluation criterion stated in the solicitation which compares the offeror's proposed cost with a detailed Government estimate for each contractor and then scores the degree of realism. The methodology constitutes a source selection cost evaluation process involving (1) determination of cost evaluation factors; (2) preparation of instructions to be included in the solicitation concerning the cost evaluation factors; (3) preparation of Government estimates for each offeror; and (4) scoring each offeror for cost realism and Government estimated cost. The methodology is a synthesis and improvement of the best techniques and procedures currently being used in source selection cost evaluation (especially those of NAVELEX).

INTRODUCTION

Unrealism in Defense contractors' cost proposals, especially for RDT&E programs, often contributes to cost growth as well as to other problems. Cost growth may require drastic changes in system design and program scope. It also may lead to schedule slippages and program cancellations. The Defense Department is therefore concerned with achieving greater cost realism. Science Applications, Inc. (SAI) has undertaken to study the subject of contractor cost realism for the Navy Office for Acquisition Research.

How realistic are contractor cost proposals? This is not easy to determine. The complexity and risks inherent in Defense systems make contractor cost estimation, not to mention Government review and evaluation of the costs, difficult. Some optimism may be warranted (e.g., in engineering hours required, in number of test articles, and in number of tests), but when does optimism become unrealism? In some cases, the contractor may purposely propose an unrealistically low cost in order to "buy-in" and thereby improve its business base and cash flow.

SAI has collected data on proposed costs and Government estimates for eight programs from the Naval Electronics Systems Command (NAVELEX) which provide some insight into the degree of realism found in contractor cost proposals. In developing its estimates, NAVELEX evaluated the contractor cost proposals in detail, required the contractors to justify their data and estimating rationale, developed their own estimates based almost entirely on the contractor's data, and compared these estimates with the cost proposals. The data showed that one out of three original offers was more than 20% low, and one out of six best-and-final offers was more than 20% low. Offers more than 20% below the NAVELEX estimate certainly raise a question as to cost realism. Interestingly enough, less than one-quarter of the original offers but nearly half of the best-and-final offers were within 3% of the NAVELEX estimates, apparently as a result of the detailed Government cost evaluation and the fact that cost realism was an evaluation criterion.

Of course, the Government must also guard against unrealistically high cost estimates. This situation will most probably occur if there are few technically qualified contractors and if a contractor already has an especially good business base. High cost estimates do minimize the likelihood of an overrun, but the Government could probably have bought the system for less.

How do we achieve greater cost realism? This poses another difficult question, especially since there are often disincentives to realistic cost proposals in source selections for cost-reimburseable contracts. These disincentives occur because cost is generally a secondary consideration, especially for RDT&E contracts. Additionally, the Government often tends to award to the contractor with the lowest cost proposal, if technical and other factors are not too different; or at least, the contractors may perceive that the Government has such a bias.

The Defense Department needs to shape, refine, and implement acquisition policies and practices to encourage and achieve more cost realism. In particular the source selection procedures should be improved so as to:

- Encourage realistic bids,
- Discourage awards to low bidder on RDT&E contracts, unless realistically low, and
- Discourage success orientation bias.

It is primarily through the source selection cost evaluation process that the Government can direct efforts to give greater assurance that cost proposals are reasonable, defensible and realistic. In a general sense, then, cost realism may be defined as that part of the source selection process directed at giving

greater assurance of the reasonableness and defensibility of contractors' cost proposals.

SAI has developed a recommended methodology (i.e., techniques and prodedures) for achieving greater realism of contractor cost proposals which can be used by the Navy, as well as other Services. This methodology constitutes a source selection cost evaluation process involving four interrelated steps:

(1) Evaluation: Determination of cost evaluation factors;
(2) Solicitation: Preparation of instructions to be included in the solicitation concerning the cost evaluation factors;
(3) Government Estimate: Preparation of Government estimates for each offeror; and
(4) Scoring: Scoring each offeror for cost realism and Government estimated cost.

This recommended methodology is a synthesis and improvement of the best techniques and procedures currently being used in source selection cost evaluation (especially those of NAVELEX). This methodology suggests a more specific definition of cost realism as an evaluation criterion stated in the solicitation which compares the offeror's proposed cost with a detailed Government estimate for each contractor and then scores the degree of realism. This methodology is discussed in the following sections.

EVALUATION FACTORS

Generally, the two most important source selection factors or criteria are technical and cost. In RDT&E competitions, technical is far more important than cost. Additional evaluation criteria may include management, supportability, and schedule. Each evaluation criterion may have several sub-criteria.

In evaluating cost, the most important factors are the likely cost to the Government and the realism or reasonableness of the contractors' bids. The former we will term the Government estimated cost (or estimated cost) sub-criterion and the latter the cost realism sub-criterion. Both sub-criteria are important because, from the cost perspective, the award of a contract should be made not just on the basis of a low cost, but a realistically low cost. Other cost sub-criteria might include Design-to-Unit-Production-Cost (DTUPC) and/or Life Cycle Cost (LCC).

In a sense, all cost evaluations will address the realism or reasonableness of contractors' bids. For example, cost evaluators will normally check for completeness, accuracy and reasonableness of the bids. However, if the contractors are to be encouraged to make more realistic bids, it is very important to make cost realism an explicit evaluation sub-criterion. Cost realism can be assessed on the basis of the difference between the proposed cost (the bid or offer) and a Government estimate of the realistic cost for that contractor. The smaller this difference, the more realistic the cost. Therefore, a realistic Government estimate for each contractor is of critical importance, as discussed later.

Estimated cost can be assessed on the basis of the Government estimate of the realistic cost for each contractor. The lower the Government estimate, the better. This evaluation sub-criterion also requires that a realistic Government estimate be developed.

Although DTUPC and LCC may be important in RDT&E competitions, they should generally be given relatively little weight compared to cost realism and estimated cost. This will assure that cost realism and estimated cost have sufficient weight in the overall source selection evaluation.

Prior to issuing the solicitation, weights for each of the criteria and sub-criteria should be determined. For RDT&E programs, cost will usually be weighted much lower than technical. For example, cost might be 20 to 30% and technical 50 to 70% of the total score, with other criteria making up the difference. Deciding on the weighting of cost and the breakout between cost realism and estimated cost should be based on experience and an analysis of the effects of different weights and scoring rules on the overall scores for hypothetical proposals. Such an analysis should consider the trade-off between cost and technical scores (e.g., the degree of cost realism that could be traded for a certain degree of technical superiority).

Making cost realism an explicit evaluation criterion has great merit. It places contractors on notice that cost realism will be examined and could be a deciding factor in the award. The Government source selection team is also on notice to address cost realism specifically. The actual evaluation of cost realism can be done at many levels of detail depending on the procurement and the personnel available. Regardless of the level of detail, the key point is to make cost realism an evaluation factor which the contractors know can influence the award.

Furthermore, a detailed cost evaluation, such as that required for assessing cost realism can help in negotiation and is likely to result in best-and-final offers which are more realistic than the original offer.

SOLICITATION

The solicitation, in the form of an RFP or

RFQ, is the formal document specifying the Government's requirements associated with an impending procurement, as well as such matters as the terms and conditions and evaluation criteria. It is important to inform the prospective offerors in the solicitation that, among other factors, they will be evaluated on the basis of cost realism and that an unrealistic offer may be grounds for rejecting the proposal. Knowing that they may be penalized for unrealistic offers will certainly encourage the offerors to be more realistic. Whether they will in fact be more realistic depends on how the offerors weigh the penalty for being unrealistic against other factors, such as a belief that the award will be biased toward the low offer despite any unrealism.

Since the cost proposals must be evaluated by the Government in some detail in order to determine whether they are realistic and complete, it is important that the solicitation specify a work breakdown structure (WBS) tailored to the procurement and specify the type of data required to backup the cost proposal. By specifying a WBS, consistency among offerors is increased and the WBS can be tailored to break out those areas in which cost visibility is desired, such as areas where risk is considered greatest. Thus, a well structured WBS can simplify the job of cost evaluation.

By carefully specifying the type of cost proposal backup data, the job of cost evaluation can also be greatly simplified. Examples of some of the backup data that might be requested are: a list of material high dollar items; a list of all tools, test equipment and facilities; and monthly manloading charts by functional labor categories.

It should be noted that the Government has a legal right to detailed cost and pricing data. Furthermore, DOD Directive 4105.62 states that the "burden of proof of cost credibility rests with the offeror."

GOVERNMENT ESTIMATE

The key to assessing the realism and reasonableness of cost proposals is the development of a realistic Government cost estimate for each offeror, which can be compared against that offeror's proposed cost. While a cost proposal can be analyzed and its realism judged on a piecemeal basis (e.g., examining a few major cost elements and commenting on the degree of realism), such an approach is generally not sufficient. The Government should make an estimate of what it considers to be the most likely cost for each offeror. Since the Government estimates are compared to the offeror's proposed costs to determine the overall degree of cost realism and since the Government estimates for each offeror are compared to each other to evaluate estimated cost, the Government estimates themselves must be realistic and reasonable.

Basically, two types of Government estimates are used in source selection evaluations -- (1) Government "proposal-based" estimates based on evaluation of the offerors' cost proposals and (2) "independent" estimates based on parametric and analogy techniques and not on offerors' cost proposals. Sometimes a source selection will use both types of estimates, sometimes only one, and sometimes a blend (i.e., independent for some cost elements and proposal-based for others). For the purpose of evaluating cost realism and estimated cost, emphasis should be on the proposal-based estimates since these more clearly reflect differences between offerors, as well as the specific requirements of the program. However, it is desirable to make independent estimates for a program as well, since these can be used to cross check the proposal-based estimates.

Developing proposal-based estimates requires a detailed analysis of direct and indirect costs. Direct costs are direct labor, direct material, and other direct costs which are specifically and uniquely attributable to a particular product or service. Direct costs are the "nucleus" around which total contract price is built since the indirect costs (overhead, G&A, and fee) are generally a function of direct costs.

As mentioned above, it is desirable to make independent estimates to cross check with the proposal-based estimates. Such estimates made prior to receipt of the contractors' proposals can be compared with the contractor proposals to indicate areas where the detailed cost evaluations should be directed (i.e., areas that have the greatest potential payoff). This would reduce the amount of analysis and time required during the detailed cost evaluations. Independent cost estimates prepared for budget purposes or program review purposes may only require updating and tailoring to the specific requirements of the solicitation.

Technical risks must be considered in preparing the Government estimate. Engineers from the program office source selection organization and the Defense Contract Administration Service (DCAS) may assist in the risk assessment and cost evaluation. It also helps if some of the cost analysts preparing the Government estimate have an engineering background.

Since there are technical and program (e.g., schedule) risks and uncertainties associated with any program, as well as uncertainties in cost estimating data and techniques, there is often considerable uncertainty in the Government estimate. Therefore, it is important

to take into account the uncertainty associated with the Government estimate when judging the realism of the offeror's proposed cost. The greater the degree of uncertainty in the Government estimate, the more admissible are greater differences between the proposed cost and the Government estimate.

It is also important to achieve consistency in the Government estimates for different offerors. All offerors are proposing to the same requirements, but their approaches will differ and the requirements will not be specific in all areas.

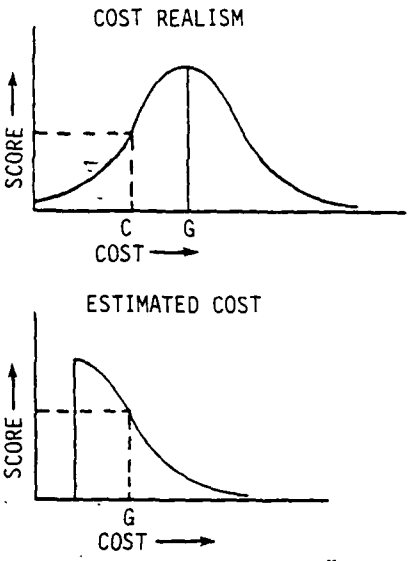
SCORING

Considerable information is developed on the strengths and weaknesses of each of the offerors' proposals during the source selection evaluation of technical, cost and other factors. This information needs to be summarized and structured in such a way as to provide the Source Selection Authority (SSA) with a sound basis for making an award. Generally, the offerors are scored or ranked for each of the evaluation sub-criteria, which are then weighted to produce an overall score. The evaluators may assign numerical scores (e.g., zero to 10) or adjectival scores (e.g., exceptional, acceptable, etc). Sometimes, the adjectival scores are converted to numerical scores so that an overall score can be developed. Certain evaluation sub-criteria -- particularly those related to cost -- may not be scored at all, at least not numerically. However, in such cases a narrative evaluation would generally be provided.

Numerical scoring of both cost realism and estimated cost appears to have considerable merit. Nevertheless, it is presently discouraged by some Defense organizations. The advantage of scoring cost numerically, assuming an appropriate methodology is used, is that it provides the SSA with a clearer understanding of each offeror's relative ranking than an adjectival or narrative ranking does alone. However, the SSA needs sufficient flexibility and discretion with any scoring system to award to the offeror who provides the best value, all factors considered. That is, the SSA does not want to be driven to an irrational decision based on an overly elaborate and too inflexible scoring system. Careful selection of evaluation criteria weights and scoring rules for each criterion can minimize any problems.

The value of quantitative cost evaluations in source selection can be shown through an analogy with cost-effectiveness analysis. Cost-effectiveness techniques were developed as a means of quantifying, to the extent possible, various complex problems. Cost-effectiveness analysis has sometimes been criticized because it takes into account only quantifiable factors. This is an unfair criticism because it was never intended to take into account all factors, nor was it intended to drive decisions. Rather, cost-effectiveness analysis provides input to "decision makers" who must also consider the assumptions and caveats associated with the quantitative (cost-effectiveness) analysis, as well as the many non-quantifiable factors. Likewise, numerical scoring of cost can be a useful input to the SSA -- the source selection decision maker -- which is considered along with many other factors.

The basic notion for determining a numerical score is very straightforward: for cost realism, the greater the difference between the Government estimate (G) and the offer (C), the lower the score; for estimated cost, the greater the Government estimate, the lower the score. This is shown graphically below:



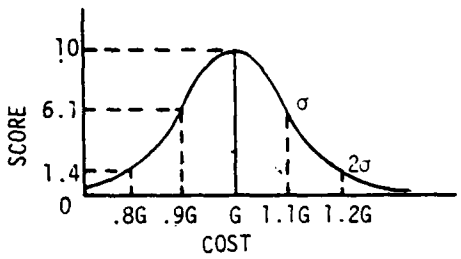
We refer to these curves as scoring rules and prefer smooth continuous curves based on a normal curve, as shown above. However, the curves could be some other shape (e.g., a triangle or trapezoid).

Cost Realism

In the case of cost realism, if the difference between G and C is zero, the score is a maximum - say 10. As the difference increases the score is reduced and approaches a minimum - say zero. For the same difference above or below G, we prefer to assign the same score (i.e., symmetry is assumed).

With a normal curve shaped scoring rule, the score depends on one factor, the "spread" of the normal curve as represented by the standard deviation, σ. There is a 68% likelihood that the difference between C and G will be between 0 and σ and a 95% likelihood that the difference will be between 0

and 2σ. For convenience we will define the spread as 2σ. For example, if 2σ = 20% of G, then an offer 10% higher or lower than G would receive a score of 6.1 and an offer 20% higher or lower would receive a score of 1.4. This is illustrated as follows:



The equation for the scoring rule is:

$$\text{Score} = 10e^{-\left(\frac{C-G}{G}\right)^2/2\sigma^2}$$

If the spread of the scoring rule is too small, there will not be sufficient differentiation between offers. And, if the spread is too large, even very unrealistic offers could still receive scores well above zero and large differences in realism will result in only small differences in score.

A spread (2σ) of 15 to 25% appears to be reasonable for defining a cost realism scoring rule. Offers more than 15 to 20% from a carefully prepared Government estimate, relying primarily on the offerors' own data, certainly raise a question as to cost realism. Of course, what is realistic will depend to some extent on the nature of the development program -- the risks involved, how much of the system has been previously designed, etc. It seems reasonable to assume that offers more than 15 to 25% from the Government estimate, depending upon the particular program, are unrealistic and should receive close to a minimum score. The low end of this suggested range, 15%, would apply only if the program was well defined, there were few risks or unknowns and there existed a good data base on which to base cost estimates.

A range of 15 to 25% for the scoring rule spread is supported by data for eight NAVELEX source selections. Cost realism (i.e., C - G) was determined for 19 offers made on eight programs. A normal curve fitted to a histogram of the data resulted in a 2σ of 26%. The average difference between C and G was 9%, and 84% of the time the difference between C and G was less than 25%.

Two things determine how cost realism will affect the overall proposal evaluation score: spread and weighting. First, the spread of the scoring rule should provide a reasonable differentiation of scores for contractors with differences in C - G, as mentioned above. Second, the weighting of cost realism relative to technical and other factors should be reasonable. Analysis and tradeoffs of the effects of different scoring rule spreads and different weights should be made as discussed later.

Uncertainty

The cost realism scoring rule is first of all a scaling rule -- the greater the difference between C and G, the lower the score -- but it should also take into account the uncertainty in the Government estimate. Ling and Wallenius [1] point out that any cost realism scoring rule can make two kinds of errors:

> Type A error -- assigning a higher score than warranted to an improbable proposed cost, and
>
> Type B error -- assigning a lower score that deserved to a highly plausible proposed cost.

Type A errors result if the spread in uncertainty is less than the spread in the scoring rule. This does not appear to be of concern as far as scoring is concerned. Although various offers may be unrealistic -- clearly more or less than they would have been had the offerors been realistic or more careful -- the scoring rule should differentiate among these unrealistic estimates, at least to a point.

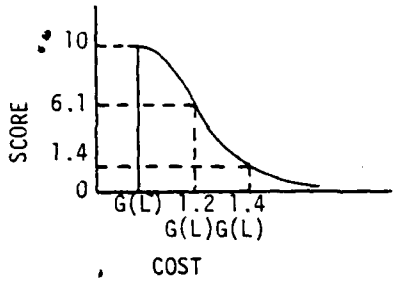
Type B errors result if the spread in uncertainty is greater than the spread in the scoring rule. This is undesirable because offers with a reasonable likelihood of matching the Government estimate would receive a score close to the minimum. If the spread (2σ) in the scoring rule is 15 to 25%, then the uncertainty spread (2σ) would have to be greater than 15 to 25% for a type B error to occur. Generally, we believe the uncertainty spread will be less than this since the Government estimate is based primarily on the offerors' own data and the stated requirements in the solicitation (e.g., no scope changes or redirections).

In conclusion, unless there is concern that the uncertainty spread is greater than the scoring rule spread, it does not appear necessary to determine uncertainty in the Government estimate for a particular program or to adjust the spread of the scoring rule accordingly. Benefits other than to cost realism scoring may, however, derive from determining the uncertainty. An uncertainty assessment would clearly lead to a better understanding of the cost estimates and would highlight certain areas warranting closer attention in the source selection evaluation.

Estimated Cost

It was mentioned above that the basic notion for scoring Government estimated cost is very straightforward: the greater the Government estimate, the lower the score. As a practical matter, we prefer to assign the maximum score - say 10 - for the offer with the lowest Government estimated cost, G(L). As the difference between the estimated cost (G) for any offeror and the lowest estimated cost (G(L)) increases, the score is reduced.

With a normal curve shaped scoring rule, the score depends on one factor, the spread of the normal curve. For example, if 2σ = 40% of G(L), then an offer 20% higher than G(L) would receive a score of 6.1 and an offer 40% higher would receive a score of 1.4. This is illustrated below:



If the spread is too small, there will not be sufficient differentiation between offers. And, if the spread is too large, even very expensive offerors (as measured by the Government estimates) will still receive scores well above the minimum.

At what point should the Government estimate for an offeror be considered too high relative to the Government estimates for other offerors? Given that all offerors bid to the same set of requirements, their costs should not differ widely except possibly to account for such factors as variant design approaches, labor and overhead rates, and efficiencies. It seems reasonable that there would be a much greater likelihood that G would be reasonably close to G(L), say within 10 to 20%, than far from G(L), say 50 to 100%. To test this, we examined Government estimates for eight NAVELEX programs. A normal curve fitted to a histogram of the data resulted in a 2σ of 41%. The Government estimate or estimates which were not the lowest were 16% greater on average than the G(L) for each program. Half the time the Government estimate that was not the lowest was within 10% of G(L) and two-thirds of the time within 20%. The greatest difference from G(L) was a little more than 40%. Therefore, a spread of 30 to 50% seems reasonable.

Analysis and tradeoffs of the effects of different scoring rule spreads and different weights should be made, as discussed next.

Combined Scores

The overall cost evaluation score depends on the scores and weights for cost realism and Government estimated cost. The overall source selection evaluation score depends on the scores and weights for each factor -- cost, technical, management, etc. The cost evaluation team with assistance from the technical team, as appropriate, should analyze the effects of different cost scoring rules and different weights. It is especially important to examine the tradeoffs between the cost and technical scores. For example, if one offeror has an estimated cost 20% greater than that for another offeror, how much better would his technical score have to be to offset his cost disadvantage. If such trades are not reasonable, then the spread of the scoring rule or the weights require adjustment.

Since the scoring rules and weights must be established before the solicitation is issued, these analyses and tradeoffs must also be done before the solicitation is issued.

Tabular and Graphical Displays

Despite the advantages of numerical scoring and the suggestions for avoiding or minimizing the chances of being driven to irrational decisions, some Defense organizations and source selection teams may prefer not to score numerically.

In these cases, it is suggested that key cost data be presented to the SSA in a tabular form such as shown below:

CONTRACTOR	C	G	$\frac{C-G}{G}$%	$\frac{G-G(L)}{G(L)}$%
A				
B				
C				
.				
.				
.				

The percentage columns provide a clear, convenient display of the degree of realism of each contractor and the estimated cost premiums compared to the lowest cost offeror (as estimated by the Government). While this tabular display is simple and may appear trivial, it can be of great value to the source selection team and the SSA. Graphical presentations of key cost data may also be useful. Even when scoring numerically, it would still be useful to provide the SSA with tabular and graphical presentations.

CONCLUSIONS

This report has developed and recommended a source selection cost evaluation methodology involving four interrelated steps:

(1) Evaluation: Determination of cost evaluation factors;

(2) Solicitation: Preparation of instructions to be included in the solicitation concerning the cost evaluation factors;

(3) Government Estimate: Preparation of Government estimates for each offeror; and

(4) Scoring: Scoring each offeror for cost realism and Government estimated cost.

This recommended methodology synthesizes and improves the best techniques and procedures currently being used in source selection cost evaluation.

It is believed that application of this methodology will encourage contractors to make more realistic offers since they will be on notice, though the solicitation, that cost realism will be examined and could be a deciding factor in the award. The contractors will know that the numerical scoring procedures will reduce the likelihood of awards to low offers on cost reimburseable contracts unless realistically low.

REFERENCE

[1] Ling and Wallenius, Cost Realism , Technical Report #400, Department of Mathematical Sciences, Clemson University, December 31, 1982

INDUSTRIAL PREPAREDNESS

Panel Moderator: Mr. William K. Takakoshi
Deputy for Industrial Resources
Office of the Assistant Secretary of the Army
(Research, Development, and Acquisition)

Panel Members: Mr. Jed DuBreuil
Staff Director for Industrial Policy
Office of Under Secretary of Defense for
Research and Engineering

Mr. Rod Vawter
Office of the Mobilization Concepts
Development Center
National Defense University

Mr. Bruce Waldschmidt
Industrial Base Team Chief
Office of the Deputy Chief of Staff of the
Army for Research Development and
Acquisition

Papers:

Impact of Corporate Resource Allocation Decisions on National Security Objectives: Dissynergism in Aerospace Industrial Resource Planning
by O. M. Collins

Two-Step Industrial Preparedness Planning: Balancing Funds and Production Capability
by Kenneth B. Johnson

Readiness Planning in a Peacetime Environment
by George T. Nickolas

ADP002801

IMPACT OF CORPORATE RESOURCE ALLOCATION DECISIONS ON NATIONAL SECURITY OBJECTIVES: *DISSYNERGISM IN AEROSPACE INDUSTRIAL RESOURCE PLANNING*

Lt Col O. M. (Mike) Collins, AFPRO-Pratt & Whitney Aircraft

ABSTRACT

The purpose of the proposed paper is to assess the impact of corporate resource allocation decisions in the US aerospace industry on long-term national security objectives. The data presented demonstrates the dissynergy that exists in one critical area of national interest as the result of inconsistencies between corporate and defense strategic resource planning objectives. The DOD Industrial Base and Preparedness Program will be evaluated as a basis for (1) creating a credible defense industrial resource planning system to parallel existing force and technology planning systems; and, (2) integrating corporate and defense long-range planning objectives. Based on the analysis, a recommended policy and organizational approach is presented in terms of the following parameters: acquisition efficiency and industrial preparedness.

INTRODUCTION

The purpose of this paper is to assess certain economic and financial trends resulting from resource allocation decisions by corporate executives in the US aerospace industry. The data to be presented will highlight the dissynergy that has developed relative to the allocation of capital investment resources between defense and commercial industrial segments. It is the hypothesis of this paper that the identified dissynergy is the result of increasingly divergent strategic objectives between Government and corporate decision makers. For the purpose of resolving this area of conflict, the Department of Defense (DOD) industrial base and preparedness planning function will be evaluated as the possible vehicle for integrating corporate and DOD industrial resource planning systems to ensure continued support of long-term US national security objectives.

The primary objective of present US national security and DOD policies is the deterrence of military conflict along the entire spectrum of war. Should deterrence fail, the nation should then be appropriately positioned to bring all of its national resources to bear to positively determine the outcome. Successful accomplishment of these objectives is clearly dependent on the implementation of selected technology investment strategies and production of the necessary military hardware to build required force structures and war-fighting capabilities. Sustaining such deterrent and war-fighting capabilities over the long-term is inevitably linked to the effectiveness and efficiency of the US industrial base.

Recent Defense policies concerning the efficiency and effectiveness of the weapons acqusition process have centered on former Deputy Secretary of Defense Frank Carlucci's cost reduction initiatives under the Defense Acquisition Improvement Program (DAIP). In addition, the Deputy Secretary issued further policy guidance in March 1982 expanding the Industrial Preparedness Planning (IPP) Program to include peacetime acquisition efficiency and effectiveness as an IPP objective, thus, linking industrial base and preparedness planning policies with DAIP. Other objectives in the new IPP program concern the more traditional requirements to maintain a surge production capability for critical military items and provide the foundation for possibly transitioning to an industrial mobilization posture in the event of a protracted conventional war.

Accordingly, the DOD concept of industrial responsiveness, as postulated by the 1980 Defense Science Board Study, combines the objectives regarding the increased efficiency of the peacetime acquisition process through reduced program unit costs and lead times and the objectives regarding the ability of industry to accelerate production rates to meet surges in demand (under both peacetime and wartime conditions). The primary shortcoming with these current DOD industrial base policies is that they do not specifically address the establishment of a long-range planning function that systematically links manufacturing resource, technology development, and force planning objectives to yield the greatest marginal benefits in terms of total military capability (including both deterrent and war-fighting factors). Another glaring deficiency is the lack of formal, long-range cooperative planning being accomplished between the industry and DOD acquisition communities to ensure the continued availability of critical strategic resources. Current IPP procedures focus primarily on the short-term production surge and industrial mobilization capabilities of the industrial base for specific military end-items using the DD Form 1519 "DOD Industrial Preparedness Program Production Planning Schedule." Without an effective long-range planning process to provide visibility into policy and programmatic options concerning the optimum peacetime use of those industrial resources

supporting national defense, the chances for a true synergistic relationship between DOD and the aerospace industry in meeting long-term cost reduction and preparedness objectives will continue to be significantly constrained.

POLICY-RELATED PROBLEM

The predominant problem in trying to implement the new industrial base, preparedness, and DAIP policies is the continuing lack of stability in the DOD acquisition process. Like a conditional probability, stability in the budget process is a clear prerequisite for the actual implementation of industrial productivity and other measures directed at reducing acquisition costs. Short-term reductions in real program costs through the introduction of new manufacturing equipment, methods, and processes are dependent on long-term improvements to the industrial base.1/ Any short-term program cost savings not based on well planned, longer-term improvements to the efficiency of the industrial base are random and difficult to predict.2/ And these long-term improvements are dependent on the ability of DOD executives to significantly reduce business uncertainty in the acquisition process and provide credible incentives for corporate decision makers to direct productivity-enhancing capital allocations into defense-related production lines.

Another constraint impacting the relationship between the new cost reduction and preparedness policies is that DOD policy also requires the US defense industry to be domestically self-sufficient in the production of military items identified as being critical for wartime use.3/ Under wartime scenarios where the length of the presumed conflict exceeds two or three months, combat sustainability for US tactical and mobility air forces is directly linked to the production acceleration capabilities of key defense prime contractors and their vendors. And, if some amount of production capacity is retained as a buffer for production surge and mobilization reasons, this added capacity then becomes an additional constraint against achieving the objective of minimum unit production costs for the peacetime acquisition program. The amount of such buffer capacity required for retention to support preparedness objectives is related to the wartime scenario thought to be most likely to occur and for which the Services are required to use as a wartime materiel planning baseline. And, since wartime planning scenarios are somewhat dynamic over time, an additional element of instability is also built into existing industrial preparedness planning mechanisms.

From the peacetime acquisition efficiency perspective, continued instability (budgetary, requirements, and technical) in the DOD acquisition process is the basic reason for the continued lengthening of acquisition lead times and increasing real program cost growth of five percent per year for aerospace weapon systems.4/ This institutional instability will continue the cause and effective relationships that discourage both productivity-enhancing capital investments in defense production lines and the entry of new firms into the defense subcontractor/supplier base. And, without sustained manufacturing productivity growth and the addition of new firms competing for DOD's business (especially at the subcontractor/vendor levels), we can expect continued upward pressure on future real weapons costs.

Given some degree of improved stability over the long-term, the key to meeting defense industrial resource management challenge is planning.5/ Unless joint DOD and industry resource base planning is effectively accomplished in advance of the annual Program Objective Memorandum (POM), implementation of the various cost efficiency and preparedness initiatives become budget-limited. In the case of multiyear procurement, inadequate planning in advance of the annual POM submission limits the potential program savings due to shortfalls in funding to cover possible cancellation charges for recurring costs. This same problem impacts the implementation of all the other productivity and preparedness initiatives. The procedural problem is that weapon system program managers have not been effectively integrated into a formal planning process that identifies and analyzes alternative productivity and preparedness business strategies in advance of the POM submission.

Current DOD industrial base policy initiatives had their genesis in numerous DOD studies between 1975 and 1981. These studies focused on symptoms that foretold an erosion of the defense industrial base. These symptoms included long peacetime material lead times, low levels of real profits (return-on-sales) for defense contractors, a nonexistent production surge capability, increasing unit production costs for military hardware, declining US industrial productivity growth, and loss of the US international competitive advantage in high technology markets. The trends identifying these symptoms are clearly cited in numerous places, foremost being the DOD Profit '76 Study, the 1976 and 1980 Defense Science Board Studies of Industrial Readiness and Industrial Responsiveness, respectively, and the December 1980 Congressional hearings on the "Ailing Defense Industrial Base" before the House Armed Services Committee.

The trends that have received the most notoriety relative to the cost efficiency of the DOD acquisition process are those concerning depressed US industrial productivity growth and low rates of capital expenditures to sales, especially within the US aerospace industry.6/ As a result, policy solutions to incentivize corporate capital investments have been promulgated in two specific areas: (1) Changes to contractual policies relative to negotiated profit objectives and progress payment rates to increase the cash flow of defense contractors; and, (2) The provision of Government "seed money" as direct performance incentive payments to specific contractors to bring high technology industrial modernization to the factory floor. The second approach is known as the Technology Modernization (Tech Mod) Program, and generally utilizes discounted cash flow procedures to determine the financial incentive which should be paid to the defense contractor for making stipulated, cost reducing capital investments. While these approaches are obviously valid, their implementation is being constrainted by numerous interdependent factors.

The overriding problem with the new capital investment incentive initiatives is that they are focusing on the wrong basic objective and using some assumptions that may not be valid. The primary objective of DOD's new Industrial Modernization Incentives Program (IMIP) is to maximize industrial productivity growth.7/ Instead, the policy objective should be to reduce unit production costs (given the required level of product quality to ensure operational effectiveness) and/or improve production surge capabilities for critical pieces of military hardware. Under this slightly modified philosophical approach, an appropriate capital investment incentive could more easily be tailored as one option in the implementation of a comprehensive effort to improve overall industrial responsiveness. In other words, the implementation of a capital investment incentive should be a means to an end and not an end in itself.8/ Furthermore, any such decision involving the use of appropriated funds to increase the efficiency of a specific contractor's production capability should be analyzed and justified based not only on the cost reduction potential, but also on the effort's contribution toward meeting industrial preparedness objectives.

To ensure proper accountability, faith alone may not be adequate for those public officials who are bound to be second-guessed. A high probability of success should exist concerning expected cost efficiency benefits before any government funded capital investment incentive is contractually implemented—unless offset by overriding industrial preparedness of mobilization benefits. The problem again is the non-existence of any planning mechanisms that permit benefits measurement and tracking, including the measurement of manufacturing productivity changes, at the weapons program and industrial plant levels.

Without a clear audit trail for cost reduction benefits, the only available statutory and policy basis for enhancing one contractor's production capability over another's is linked to the industrial and emergency preparedness sections of the Defense Production Act of 1947 and Presidential Executive Order 11490. Otherwise, with the NATO participating countries operating under a waiver to the Buy American Act9/, greater cost reduction potential could possibly be achieved by opening up more weapons programs and military hardware items to the market forces of international competition.

In addition to the problems that currently exist relative to the implementation of DOD's new productivity enhancement and preparedness policies, there is also a problem of dissynergy between aerospace industry and DOD objectives regarding strategic resource management. The problem of dissynergy in pursuing productivity-related cost reduction goals will be quantitively defined using corporate capital investment trends. The preparedness issue will be defined as a direct by-product of decisions made relative to peacetime acquisition programs.

THE CAPITAL INVESTMENT ISSUE

Present DOD policies to encourage productivity-enhancing capital investments have generally considered the capital investment decision to be a relatively simple function of interest rates (i.e., DOD profit policy in Defense Procurement Circular 76-3), projected sales (hence, the appeal of multiyear procurement), or coverage of the risk of program cancellation (DAR 3-815).10/ In addition, these DOD policies assume that a direct relationship exists between added cash flow or added profit dollars and increased corporate expenditures for productivity-enhancing production assets. Unfortunately, recent data indicate that this assumed relationship does not exist unless the capital investment incentives are specifically targeted to defense production lines.

To actually achieve the desired productivity growth through the application of advanced manufacturing methods or technology, other interdependent, structural factors must also be satisfied first before a firm's productivity growth and the corresponding program cost reduction can be attained. The most

significant of these other factors include market share for a given type of product, utilization of existing plant capacity, presence or absence of competition, degree of product differentiation, current business backlog, and hourly labor rate structures.11/ These factors define the state of the total aerospace market over time and the dynamic relationships that exist between the overall market structure and the microeconomic factors of production relative to individual DOD weapons programs being produced at specific industrial plants.

Aside from the persisting business uncertainty associated with the instability of the DOD budgetary process, the most pervasive structural problem in incentivizing a more efficient acquisition process in the aerospace sector is the market structure itself. Over the last twenty-five years, this sector has evolved into two separate subsectors--one supporting commercial work, and the other supporting defense-related products. The problem is that each subsector is defined by a separate set of market characteristics. Each set of market characteristics reflects the manner in which the public and private interests have been defined in terms of Government regulation, business risks, the payment for those risks, degree of labor intensiveness, and the management of production assets (including working capital and cash flow).

A key difference between the commercial and defense subsectors is the practice of pricing production units based on discrete annual increments under defense contracts versus pricing based on projected total, multiyear product demand for commercial systems. These differences were not particularly important twenty-five years ago when the Defense Department controlled 80 percent of the high technology, defense-related aerospace market (Figure 1).

Today, however, DOD controls only about 40 percent of the total aerospace market, and considerably less within many of the key defense corporations. And, it is in these corporate boardrooms where capital investment allocations are guided by corporate strategic planning objectives. Accordingly, corporate capital allocations directed away from defense production facilities can clearly have a long-term impact on the ability of Defense executives in acquiring the required military hardware to satisfy national security objectives.

In the area of capital expenditures, the DOD perspective concerning the low level of capital expenditures in the aerospace sector was largely influenced by the 1975-1979 Federal Trade Commission (FTC) data which showed the aerospace sector to be investing in new plants and equipment at a considerably lower rate than the rest of the US manufacturing sector. The primary reasons given for this low level of capital expenditures were low profit on sales as compared to the rest of the US durable goods sector and low levels of corporate cash flow as the result of using a part of the corporate working capital to support work-in-process on defense contracts.12/

This data was revised during 1981 by the FTC, and Figure 2 provides the revised data which shows a completely diffferent story (the reasons for the revision of the FTC data are not published in any public record). While the 1981 data indicate a sharp drop, the revised data show that the aerospace industry has exceeded the rest of the US manufacturing and durable goods sectors since 1974 and was investing in new plants and equipment at twice the level of these two overall sectors in 1980. The obvious queston is, "Why is there a manufacturing productivity problem in the aerospace sector if this industry is investing at a significantly higher rate than the rest of the US economy?"

FIGURE 1

MARKET SHARES IN AEROSPACE SECTOR

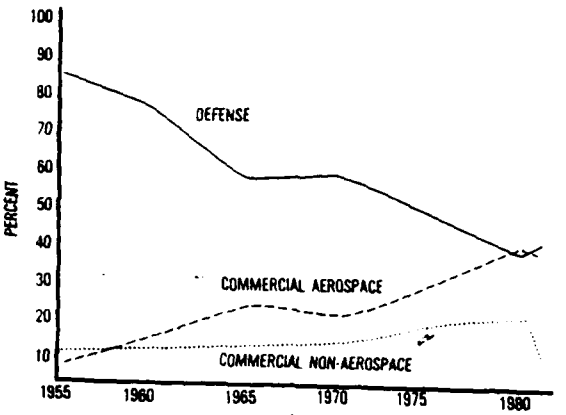
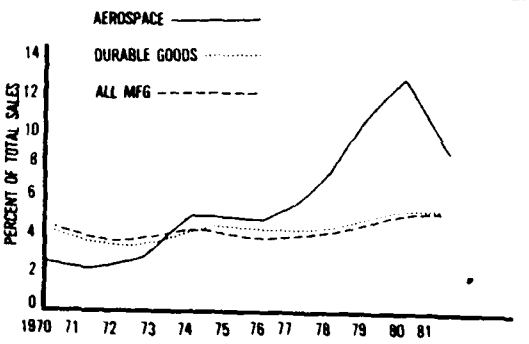


FIGURE 2

CAPITAL EXPENDITURES FOR NEW PLANT AND EQUIPMENT

(AS A PERCENT OF TOTAL SALES)

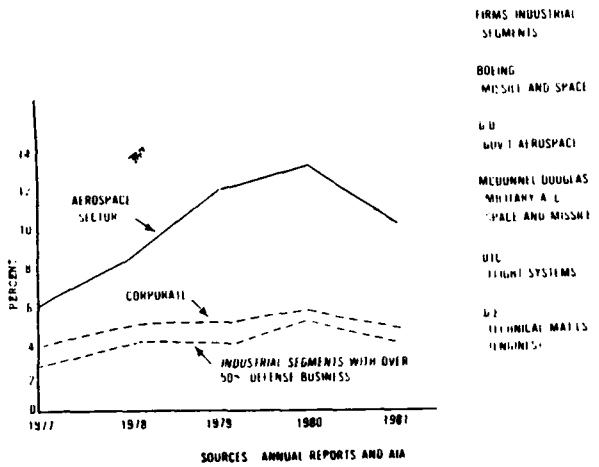


SOURCE: AEROSPACE INDUSTRIES ASSOCIATION FACTS AND FIGURES 1981/82

while there is no specific data to show that the defense subsector is experiencing a lower rate of productivity growth than the commercial subsector in terms of real value added per labor hour, one reason for the assumed lower rate of productivity growth in the Defense subsector can possibly be seen in Figure 3. Here, the overall rate of capital expenditures to sales is compared for the aerospace sector, five key defense contractors, and the defense-oriented industrial segments within these five corporations. While it is evident that the more defense-related elements of the aerospace sector have traditionally received lower allocations of corporate capital investment funds, the interesting point from this chart is the

FIGURE 3

CAPITAL INVESTMENT TRENDS
AEROSPACE SECTOR



SOURCES: ANNUAL REPORTS AND AIA

significant difference in the ratio of total capital expenditures to sales between the overall industry and these five traditional defense contractors. These five firms represent over 40 percent of the total value of Air Force Systems Command's (AFSC) 1982 contract awards. Though the overall industry data includes corporate data from computer firms (IBM and Honeywell), a financial firm (AVCO), and aerospace conglomerations (LTV, TELEDYNE, and Textron)13/, the data also includes the traditional aircraft and missile producers--thus, a possible indication of the relative labor intensiveness structurally required in producing aircraft and missile systems.

The above aggregated data for these five leading defense contractors is even more revealing when broken out at the corporate and corporate industrial segment levels in terms of return-on-sales, return-on-assets, and the capital expenditures to sales ratio. Before 1977, there were no public data sources to gain visibility into corporate resource allocation trends below the corporate level. Since 1977, public corporations have been required to disclose certain data at the corporate industrial segment level as well as for the corporation as a whole. Figures 4-1 through 4-5 provide the five-year trends for each of these five firms at the corporate level and the defense-related industrial segments as indicated. The percent of Government work to the total business base for each category in 1979 is summarized in Table I.

The five-year averages for the data in Figures 4-1 through 4-5 are summarized in Table II. The overall inference to be drawn

FIGURE 4-1

BOEING

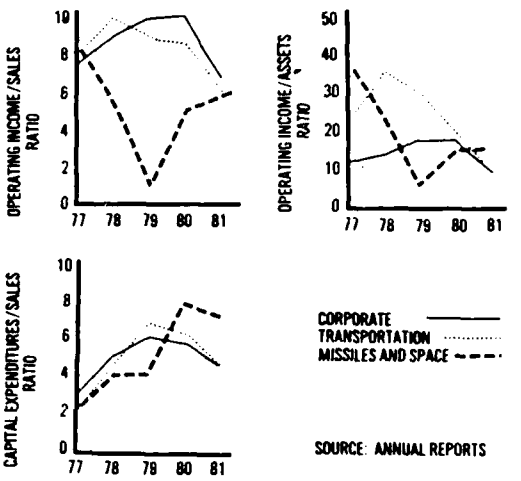


FIGURE 4-2

GENERAL DYNAMICS

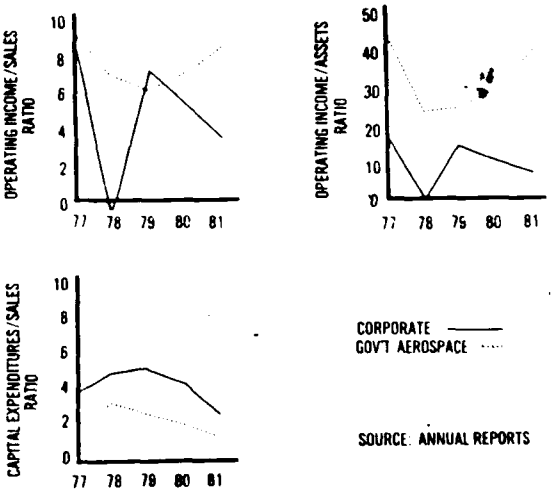


FIGURE 4-3

GENERAL ELECTRIC

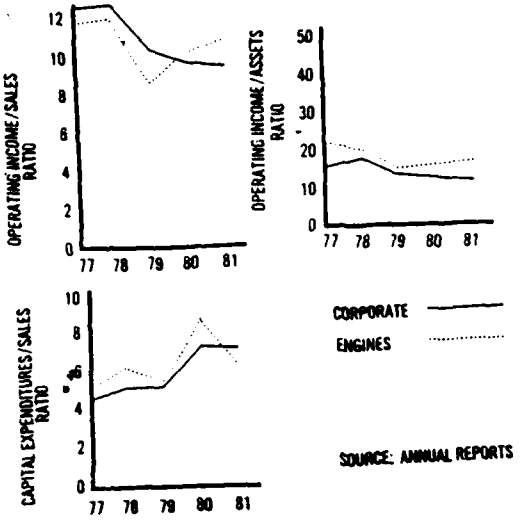


FIGURE 4-5

UNITED TECHNOLOGIES

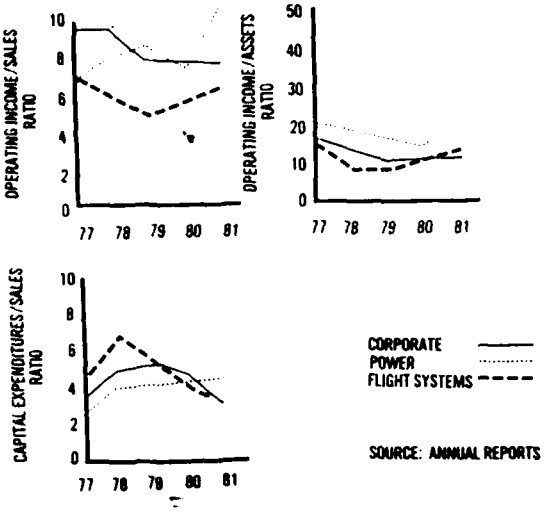


FIGURE 4-4

MCDONNELL DOUGLAS

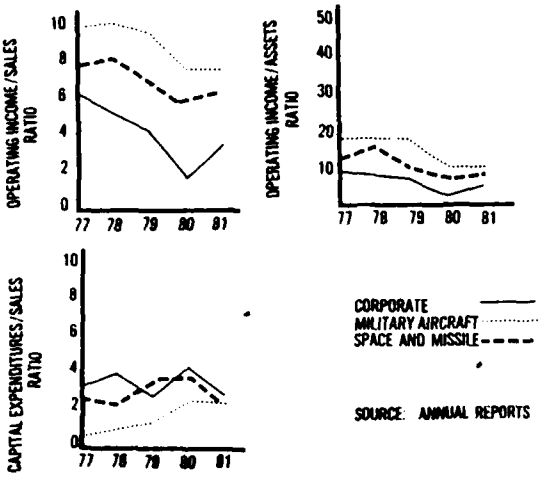


TABLE 1

PERCENT OF GOVERNMENT BUSINESS TO TOTAL SALES

(1979 DATA)

McDonnell Douglas	
Corporate	57%
Military Aircraft	100%
Space and Missiles	100%
General Electric	
Corporate	15%
Technical Materials (Engines)	48%
Boeing	
Corporate	19%
Transportation (Aircraft)	11%
Missiles and Space	100%
United Technologies	
Corporate	23%
Power (Engines)	40%
Flight Systems	57%
General Dynamics	
Corporate	67%
Government Aerospace	100%

Source: Standard & Poor's

TABLE II

FIVE-YEAR AVERAGE FINANCIAL RATIOS

(1977-1981)

	Operating Income to Sales (%)	Operating Income to Assets (%)	Cap. Expen. to Sales (%)
McDonnell Douglas			
Corporate	4.2%	6.4%	3.5%
Military Aircraft	8.9%	14.6%	1.6%
Space and Missiles	7.1%	11.2%	3.0%
General Electric			
Corporate	11.1%	14.7%	6.1%
Engines	10.7%	18.1%	6.5%
Boeing			
Corporate	8.9%	14.3%	5.1%
Transportation (Arcft)	8.4%	24.5%	5.1%
Missiles and Space	5.3%	20.3%	5.3%
United Technologies			
Corporate	8.4%	13.9%	3.7%
Power (Engines)	8.2%	18.1%	3.9%
Flight Systems	5.8%	11.3%	4.6%
General Dynamics			
Corporate	4.9%	10.4%	4.2%
Government Aerospace	7.5%	33.4%	2.1%

from these data is that while returns-on-sales and returns-on-assets are generally higher for the defense-only industrial segments, the ratio of the capital expenditures to sales is generally the lowest for the defense-only segments. The corollary is that business segments with balanced mixes between defense and commercial work receive higher relative levels of corporate capital expenditure allocations, e.g., the engine producing segments of United Technologies and General Electric. While the sample in this paper is obviously small, the same inference is supported by data recently published in the AFSC Profit '82 Study which performed similar analyses of the top 15 AFSC contractors.

This inference concerning the inverse relationship between percent of defense business at the corporate industrial segment level and the segment's capital expenditures to sales ratio is even further reinforced by reviewing the 1981 data from Figures 1 and 2. While the Defense Department's share of the total aerospace market increased by 12 percent from 1980 to 1981, the aerospace industry's rate of capital expenditures to sales declined by about 30 percent--an indication of the significant impact of commercial sales and backlog trends on corporate strategic planning and capital allocation decisions. For the most part, corporate decisions to invest on the defense side are apparently more related to "getting the next contract" as a function of long-term survival than to becoming more efficient on current contracts14/; thus, a significant dissynergy between DOD and corporate strategic planning objectives. This line of logic may well explain the upward capital expenditure to sales trend for Boeing's defense-only missile and space segment since this segment's operating returns have generally been below the overall corporate average.

In addition to DOD's documented budgetary instability, another reason for the dissynergy between DOD and corporate resource planning objectives is probably related to DOD's cost-based approach used in negotiating annual contracts. Currently, about 90 percent of the total dollar value of DOD contracts is awarded annually as a result of contract negotiations in lieu of the preferred policy approach of awarding contracts using a purely competitive approach with sealed bids. The reason for this trend is that follow-on procurements for major weapons programs are generally sole-sourced to a single prime contractor following an initial com-petitive source selection. Under the negotiation approach for awarding defense contracts, the final negotiated contract price is based on the expected costs to perform the contract, plus an additive amount for profit based on contractor's perceived business and technical risks and other factors [one being the unused special profit factor for productivity growth in DAR 3-808.8(a)]. If a defense contractor desired to make a cost-reducing capital investment in one year, the Defense Department's negotiator would then use the reduced cost base as the negotiation objective in the second year, thus reducing the contractor's absolute profit dollars in the second and following years and preventing the attainment of the desired return-on-investment. An alternative approach has been proposed to use the existing policy guidance in DAR 15-107 to negotiate advance agreements to essentially estalish multiyear pricing agreements to share the potential contract savings associated with contractor financed, cost-reducing capital investments.15/ This approach can either be combined with existing cost sharing language in the Value Engineering (VE) section of DAR, or could be implemented separately. The benefit of using the VE section is that VE provides an institutional vehicle for incorporating specific cost reductions into the contracting process and tracking the identified cost savings.

With the above economic and financial data and trends as background, the issue concerning previously defined industrial base problems seems to now focus on a new issue. That issue is whether or not the Defense Department can achieve greater levels of efficiency and effectiveness in the acquisition of military weapon systems by continuing to focus on piecemeal fixes to specific contract clauses or by gaining better economic leverage with those firms that comprise

the defense subsector of the aerospace industry.16/ The key is, again, planning--joint DOD/industry planning in advance of the annual POM submission to match peacetime and surge production requirements with the efficient use of available production capacity.

INDUSTRIAL BASE PLANNING CHALLENGE

A decision to establish a credible industrial planning process must come from the highest levels within each military department and be supported throughout the acquisition management hierarchy. However, in making such a decision, certain management philosophies must be firmly understood. For example, will the desired industrial planning process support a proactive or reactive acquisition management philosophy?17/ If the decision is to pursue purely reactive goals, then the current DD Form 1519 planning process is probably adequate. This planning procedure focuses on the collection of information defined by past production history and in terms of a point-solution wartime scenario.

If the decision is to establish a proactive acquisiton management philosophy, managers at all levels must be involved to plan and shape future industrial base resources to match future force and technology objectives. Thus, the present "hidden agenda" objective of maintaining maximum short-term budgetary flexibility should be subrogated to the long-term objective of incentivizing the creation of a defense production capability primarily characterized by maximum economic efficiency and constrained only by those objectives concerning the maintenance of excess capacity for production surge and mobilization reasons.

So, given a decision to pursue a proactive acquisiton management philosophy regarding the defense industrial base, what can DOD acquisition executives do over the long-term to cause aerospace corporate executives to create a more efficient and effective market structure at both the prime contractor and subtier levels? First, a credible industrial planning process should be established to guide the development of production base resources in transitioning from the present to the future. The basic policy objective for the shorter-term should be the enhancement of DOD's ability to translate national industrial resources into increased military capability by delivering the funded Five-Year Defense Program and be prepared to surge production to support potential military and political crises. Instead of basing the maintenance of a production surge capability on a point solution surge scenario, the degree of surge capability should be based on a conscious management decision to be prepared to surge the peacetime production rate of a given weapon system or piece of equipment by some factor within a stipulated time period. For example, such a decision might be to include the necessary fiscal resources in the FY 86 POM to be prepared to surge the peacetime production rate of the F-16 aircraft on 1 Oct 86 by a factor of two between 1 Oct 86 and 30 Sep 87.

For the longer term, the industrial planning process should ensure the availability of industrial base resources to satisfy stipulated military force and technology objectives. For AFSC, a planning process called Vanguard currently exists to provide integrated program planning, investment, and force structure acquisition strategies as a tool to guide the budgetary and technology planning processes. An implicit assumption currently in all force and technology planning processes is that the necessary industrial resources, i.e., strategic and critical materials and a reliable vendor resource base, will always be available to produce the required military forces and weapons technologies.

This assumption is particularly erroneous in today's economic and political environment which encourages businessmen to take maximum advantage of their ability to rapidly shift capital around the world as well as among industrial sectors; thus, the potential for sectoral deindustrialization resulting from increased world-wide capital mobility.18/ Without an institutional process for achieving some degree of congruence between corporate decision makers and DOD decision makers, the Defense Department may be forced to accept the reality of having to rely substantially on an international, or foreign, industrial base with all its corresponding political uncertainties. The policy and statutory basis for such planning system is linked to the DOD Industrial Base and Preparedness Program, which has been greatly revamped over the past year and a half.

A PROPOSED INDUSTRIAL BASE PLANNING SYSTEM FOR THE AEROSPACE SECTOR

Under the old IPP program, the Services conducted piece part planning relative to the aerospace sector. Except for the setting aside of industrial equipment in Plant Equipment Packages, none of the recommendations from the past IPP were ever implemented relative to the aerospace sector. While there are many reasons why the old IPP Program did not work relative to this industrial sector, the basic problem was that the planning was not perceived as being important by the program management community. Since the old planning looked only at wartime support, it did not receive high priority with program

and logistics managers who were primarily concerned with cost and schedule parameters relating to peacetime production and support. In addition there was no conceptual integration between the program and logistics managers and their industrial counterparts in terms of implementing the war plans.

The primary difference in the new planning program introduced by Deputy Secretary Carlucci's memorandum of 6 March 1982, which was described earlier, is the conceptual expansion of IPP objectives to include the efficient and effective acquisition of the peacetime Five-Year Defense Program. The impact of this new industrial planning guidance can be significant. To be effective, program and logistics managers should be tasked in advance of the annual POM submission to prepare an Industrial Base and Preparedness (IBP) Plan. The purpose of the IBP Plan should be to integrate the industrial base policy objectives into their acquisition planning activities. The purpose of each IBP Plan would be to identify the optimum program structure for efficient peacetime production and effective surge/mobilization support during the planned funding period. The program managers' planning should utilize a total system perspective at the industrial plant level by integrating all appropriate industrial resource allocation decisions concerning labor, materials, and machines. The result of the planning should be the identification of those targets of opportunity in the IBP Plan for achieving maximum peacetime program cost efficiency, subject to the constraint of ensuring an adequate surge production capability for selected weapon systems. Where a specific program manager is forced to compete with other DOD programs at a specific contractor's plant, the IBP Plan should be coordinated by all applicable DOD agencies. Where more than one DOD agency is relying on production resources at a given production plant, it may be more appropriate to create a jointly funded Industrial Base Contract, fashioned after the traditional facilities contract, to integrate the annual planning and implementation of all industrial productivity and preparedness improvements.19/

Under the new industrial planning policy as defined in the FY 84-88 and FY 85-89 Defense Guidance documents, the key document is the preparation by each Service of an annual Production Base Analysis (PBA). The publication of each Service's PBA is intended to be the end result of the annual industrial planning process. Each Service's PBA should provide its military and civilian leadership and the Office of the Secretary of Defense with the necessary information to identify which industrial bottlenecks and areas of inefficiency should have fiscal resources allocated to them during a future funding period for the greatest marginal enhancement in total military capability. Information should be analyzed from available economic and financial data bases relative to the overall defense industrial base, e.g., the Defense Economic Impact Modeling System, and key defense contractors and their industrial sectors, e.g., Dunn and Bradstreet or Standard and Poor's. Such data should be integrated with data from in-house sources and contractual industrial planning assessments with key defense contractors, as well as program manager IBP Plans, to identify specific cost and lead time reduction opportunities at the industrial plant and weapons program levels. The planning documentation should also identify those measures that should be implemented to support defined surge and mobilization production requirements. The output of each annual planning exercise should result in the identification of specific projects and acquisition strategies that should be advocated during the POM preparation process. Following are some examples of the types of projects and business strategies that could be incorporated into the POM for the planned funding period:

a. Materials Management

(1) Identification of materials and components where economically ordered quantities could be optimized through the use of multiyear prime contracts and/or multiyear subcontracts. The prime contractor's Make or Buy Plan should be used as the decision document in determining the most effective allocation of work to critical subcontractors and vendors. The POM should then include any up-front funding requirements to cover outyear cancellation charges for recurring costs.

(2) Identification of materials and components that are common to more than one program and which could practically be acquired under a single acquisition contract and provided as Government Furnished Material.

(3) Identification of materials and components that should be prestocked in a buffer inventory in semifinished condition to enhance the program and logistics managers' ability to surge production to meet a variety of potential industrial base contingencies ranging from international materials embargos and domestic labor strikes to an intense military conflict.

(4) Identification of value engineering opportunities where less expensive materials could be substituted without loss

in weapon system performance.

b. Subcontractor/Vendor Base:

(1) Identification of those locations in the subcontractor/vendor base where DOD is forced to rely on sole domestic and foreign sources and the reasons for such situations.

(2) Identification of those cases where prime contractors should be directed under DAR 3-216 to use dual sources or where it is necessary to direct the prime to use a specific source in order to maintain a critical domestic production capability.

c. Plant Capacity:

(1) Identification of annual production rates that best contribute toward optimum plant capacity utilization and the impact on program unit costs and lead times.

(2) Identification of plant rearrangement and productivity enhancing capital investment alternatives (for both government-owned and privately-owned production assets) for reducing program costs and lead times. These alternatives should be expressed in terms of each alternative's contribution to both cost efficiency and surge objectives. The selected alternative should also discuss which contractual strategies are the most appropriate, e.g., a formal Tech Mod project versus a simpler award fee arrangement.

(3) Identification of that domestic production capacity that could be effectively transformed to support a mobilization contingency.

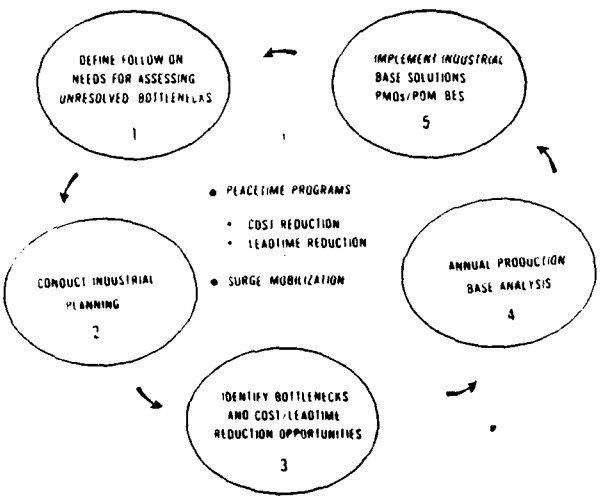
The final product of each annual planning effort should be the prioritization of proposed industrial base projects and the analysis of each proposal in terms of program cost and lead time reduction under peacetime conditions and/or improvement to required surge/mobilization production capabilities. Figure 5 provides a pictorial description of the annual planning cycle that the Air Force currently plans to use.20/ Each planning cycle should begin with (step 1) the initial definition of unresolved industrial bottlenecks from the previous planning cycle and the identification of economic and financial trends obtained from available data bases. A combination of in-house and contractual planning studies as defined above should then be accomplished (steps 2 and 3) to develop corrective industrial base projects. The completion of IBPs by program managers should be accomplished during steps 2 and 3 of the planning cycle. After the appropriate cost and lead time reduction options relative to both industrial base projects and program acquisition strategies have been included in PBA (step 4), approved projects and acquisition strategies should then be incorporated into the appropriate budgetary documents and program directives (step 5).

The planning should support the individual weapon system program manager by integrating those acquisition strategies and industrial base projects that possibly cut across numerous defense and commercial product lines at the plant (prime and subtier) level to reduce peacetime program costs and lead times. The identification of appropriate acquisition strategies relative to the materials and capacity management planning objectives should focus on those strategies that enhance business base stability and productivity growth. Business base stability strategies include the identification of multiyear procurement opportunities for an entire weapon system as well as for critical components or pieces of supporting Government Furnished Equipment. Business base stability can also be enhanced by the application of not only optimum program production rates, but also the allocation of production rates among competing programs within a given plant to optimize overall plant utilization.

The two primary contracting tools available to achieve optimum plant capacity utilization are the DAR 3-216 negotiation exception and the prime contractor's Make-or-Buy Program. The DAR 3-216 negotiation exception permits the contracting officer in the system program office to negotiate with specific contractors to maintain "an industrial mobilization base which can meet production requirements for essential military supplies and services."

FIGURE 5

INDUSTRIAL PLANNING CYCLE



This negotiation exception has been used primarily in the past to support munitions programs by maintaining one or more planned producers (prime contractors) at minimum sustaining rates based on cost trade-offs against war reserve materiel inventory objectives. Since the maintenance of efficient operating rates during peacetime is critical to the efficient acquisition of the Five-Year Defense Program and the effective transitioning to a surge/ mobilization posture, this DAR negotiation authority is the one contracting tool currently available that can significantly enhance DOD's ability to implement the new DOD productivity and preparedness policies. Its prudent use offers the potential for not only incentivizing the desired market structure in terms of peacetime plant capacity utilization and modernization, but also the maintenance of appropriate levels of excess production capability for surge and mobilization, and the creation of required levels of competition at the subtier levels using the prime contractor's Make/Buy program.

While it is desirable to think of the US aerospace industry as being responsive to the free enterprise system and receptive to unlimited competition, the economic reality is that it is not.21/ The long-term impact of the Defense Department's stimulus to the industry in terms of increasing regulation, profit limitations, and business base instability has been an industry response in terms of consciously planned growth into other markets to minimize the overall impact of defense business on corporate financial performance. Another corporate strategy has been the conscious shift of work from in-house to the subcontractor base to shelter the prime contractor against the risk of program instability.22/ After all, it is much more appealing to cancel a subcontractor than to lay-off workers or divest physical capacity in the event of a program cancellation or significant program reduction. However, as a major production program phases out of production, the tendency still exists to pull work back in-house from the subcontractor/vendor base to stabilize internal capacity utilization as much as possible.

The missing link is the degree to which corporate decision makers will be willing to integrate their corporate strategic planning activities with the proposed defense industrial planning activities. The importance of future technology developments and industrial resource availability to long-term national security is obvious. Therefore, it is essential to improve long-term Government/industry planning interfaces; because, while "technology is the engine for managing the transition from the present to the future, strategic planning is the guidance system."23/

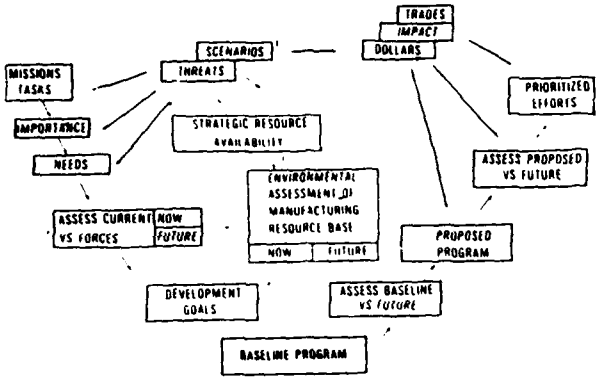
CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the establishment of a credible industrial planning system should be viewed as a "means to an end," not an "end in itself." The planning system should be one vehicle for integrating policy and program acquisition decisions to accomplish the goal of efficiently and effectively acquiring the DOD peacetime program, as well as the objectives relating to the maintenance of viable surge and mobilization production capabilities. The long-term success of the industrial planning function will depend to a large extent on the ability of the overall weapons acquisition process to effectively integrate the planning functions and the acquisition/contracting functions--both on the government and industry sides.

The long-term result of effectively integrating an industrial planning program with ongoing force and technology planning programs will be the development of strategic plans that identify those levels of production capacity which should be efficiently maintained. Using the AFSC Vanguard process as a model, technology and force planning can visibly be integrated with the proposed industrial planning process. The long-range industrial planning would flow from identified threat scenarios and identified bottlenecks and constraints for strategic manufacturing resources (Figure 6). Based on identified out-year production capability shortfalls (using available long-range procurement plans like the Five-Year Defense Program), an environmental assessment of projected economic, political, and technological factors would be required to match the projected manufacturing resource base with production requirements for both peacetime and wartime force structures.24/ The environmental industrial resource assessment should be compiled using economic forecasting services that are commercially available, e.g., Data Resources Inc., Wharton, or Chase Econometrics. In addition, the assessment should be prepared for enough

FIGURE 6

AFSC VANGUARD PROCESS



in advance so that it could be used by program managers in preparing their proposal annual IBPs.

The need for the environmental assessment of out-year economic planning baselines is clear. The question is "who would be responsible for preparing the assessment in a timely manner?" A recommendation from numerous past studies (the most recent being the HQ AFSC Affordable Acquisition Approach Study) has been the creation of a Long-Range Planning Group either centralized at the DOD level or decentralized within one of the military departments. A fundamental task of such a group could be the annual preparation and dissemination of the environmental assessment for use by the Services in preparing their annual IBP Plans and PBAs.

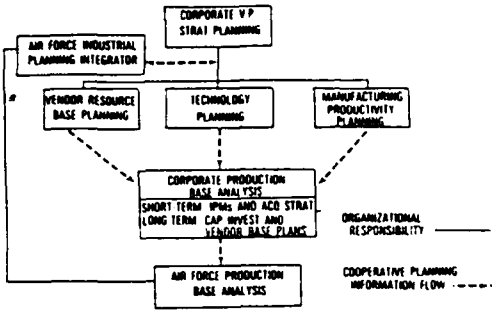
From the long-term planning standpoint, the outputs from the environmental assessment would represent inputs to identified developmental goals and proposed program actions, e.g., manufacturing technology, to resolve identified shortfalls in the out-year manufacturing resource base. Furthermore, since business uncertainty is related to the institutional instability in the DOD budgetary process, the presence of a long-range industrial resource planning process should in itself reduce the perceived business uncertainty of the overall acquisition cycle to a certain extent. Furthermore, the actual availability of credible industrial planning information may act as a disincentive to the adjustment of short-terms budgets where the adjustments can be readily translated into long-term program cost growth or reduced strategic responsiveness.

For the industry side, changes in strategic planning logic are required. Inefficient government-owned production assets will be disposed of; therefore, contractors currently possessing these assets should buy these assets and modernize them or be willing to dispose of them. Since 50 percent to 60 percent weapons production costs are normally incurred by subcontractors and vendors25/, future weapon system acquisition strategies should focus on the establishment of multiple sources, especially at the subcontractor levels, to mazimize the economic benefits of competition. The message that should be communicated to industry through the source selection and contract award processes is that only efficient and productive capacity will be sustained over the long-term.

A possible joint DOD/industry organizational approach is presented in Figure 7 to integrate DOD and proprietary corporate strategic planning objectives regarding the US manufactuirng resource base. The Industrial Planning Integrator could either be assigned to a local contract administration organization or to the program manager's staff. In either case, he/she would be responsible for supporting the preparation of specific IPBs for those program managers relying on a given contractor's production resource base. Applicable proposals from each IBP would then be incorporated into the appropriate Service's PBA. The Industrial Planning Integrator could also perform as the linking pin between specific weapons program or contract administration offices and the above suggested Long-Range Planning Group.

The options for DOD policy makers to incentivize long-term acquisition efficiency and provide short-term production surge capabiltity are becoming increasingly constrained. The potential for 100 percent progress payment rates that currently exists under the flexible progress payment policy provides an upper limit on the amount of cash flow that can be generated by defense contracts. The changes in profit policy since 1977 to incentivize capital investments have not only been ineffective in actually increasing realized profits, but have also not generated increased productivity-enhancements by the major defense contractors.26/ Also, for the large defense contractors, defense contracts are now generating much higher returns-on-assets for equivalent returns-on-sales than for corresponding commercial work. The higher than average returns for General Dynamics (Figure 4-2) may provide insight into the quantitative relationships between negotiated profit objectives, actual financial returns, and the degree of Government-furnished plants and equipment.

PROPOSED MANAGEMENT STRUCTURE
AIR FORCE-INDUSTRY COOPERATIVE PLANNING



Finally, there is an awakening among some DOD leaders that the inherent macro-economic purchasing power of the defense acquisition dollar should be used as the carrot to incentivize an efficient aerospace market structure for future defense-related acquisitions than to continue the practice of focusing on ineffective, piecemeal changes to departmental contract clauses.27/ The challenge for both industry and Defense leaders is clear; i.e., the redirection of currently diverging long-term objectives. While the proposed industrial planning mechanism is clearly complex, it may be the *only reasonable approach to ensure* the long-term strategic availability of those domestic production and technological resources required to efficiently and effectively support long-term national security objectives.

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TWO-STEP INDUSTRIAL PREPAREDNESS PLANNING: BALANCING FUNDS AND PRODUCTION CAPABILITY

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AD-A102802

ABSTRACT

The Industrial Preparedness Planning program provides data relative to the capability of the production base to accelerate and expand production during a national emergency. Planning data also includes identification of Industrial Preparedness Measures (IPMs) which can be funded during peacetime to compress production build-up time. However, determining what IPMs to fund can be difficult since:

- Build-up times for components of end-item weapons vary by substantial margins, and
- Available funding is usually inadequate.

This difficulty could be minimized by adjusting IPM data for pacing components to correspond to a common build-up time based on an affordable funding level. Formalizing the adjustment of IPM data in this manner as a second step in the Industrial Preparedness Planning process would facilitate effective prioritizing of peacetime funding for IPMs. This would insure funding of only those IPMs for potential production bottlenecks to support a balanced production response capability.

INTRODUCTION

This paper describes and justifies a two-step planning process which can be readily adapted to the Industrial Preparedness Planning program. If utilized, a two-step planning process would facilitate prioritizing of scarce peacetime funds for production bottlenecks and minimize potential imbalances in production capability for components of end-item weapons. The paper discusses generally how Industrial Preparedness Planning is currently conducted, the difficulty in determining effective priorities and levels of funding, the problem of imbalance in production capacity for components of end-item weapons and the major benefits of institutionalizing a two-step planning process in the Industrial Preparedness Planning program.

THE NEED FOR TWO-STEP INDUSTRIAL PREPAREDNESS PLANNING

The Industrial Preparedness Planning program is authorized by Department of Defense Directive. [1] The program is implemented by policies and procedures of each military department and by tri-service policies and procedures for conventional ammunition. [2] The Industrial Preparedness Planning program produces among other things, the following data: [4]

- Mobilization production plans projecting production build-up times for selected weapons including components thereof. Build-up time is the time it takes for the production base to accelerate and expand production to a level supporting wartime consumption. Mobilization production plans would be used in accelerating and expanding production during a declared national emergency (M-Day).
- Industrial Preparedness Measures (IPMs). IPMs are specific actions designed to compress production build-up times. Examples of IPMs are acquisition of standby production equipment for production base bottlenecks, expansion of production lines and stockpiling of long lead-time materials and components. IPMs can be purchased after mobilization is declared (Post M-Day) or during peacetime (Pre M-Day).

Once obtained, this data is evaluated to determine levels of funding for budgetary purposes. However, determining what constitutes effective Pre M-Day funding levels can be difficult for the following reasons:

- Build-up times for components of end-item weapons vary (sometimes by substantial margins) since the production base for some components can be compressed more than others. Build-up times are influenced by several factors which are discussed later in this paper.
- Full funding is rarely available during peacetime. Usually, available funding is seriously inadequate.

Additionally, the potential exists for inaccurate application of scarce IPM funds thereby creating an imbalance in production capacity among components of end-item weapons. The problem of imbalance in capacities for components required for end-item assembly has been documented by the General Accounting Office. [3] Such an imbalance would occur if IPM funds were applied (1) at different build-up time levels for components or (2) to non-pacing components. Both situations would lead to wasting scarce funds which could be diverted to other critical programs. In order to be fully effective, available Pre M-Day funding should be applied to a uniform production capability level. Therefore, the Industrial Preparedness

Planning program could be improved by institutionalizing a second step to evaluate components in order to balance available funds and production capability.

DESCRIPTION AND ILLUSTRATION OF THE SECOND STEP

The second step of Industrial Preparedness Planning should consist of the formal revision (adjustment) of planning data for pacing components of end item weapons based on allocated funding and a common build-up time. This would have the dual effect of balancing both potential production capability and the budget for IPMs. The second step should include the following three substeps:

- Determine the allocated or probable funding level for each weapon.
- Establish a common build-up time planning baseline for components of end-item weapons on which to base Pre M-Day IPM funding. This baseline should be established by making cost and time trade-off evaluations of the planning data to determine an approximate baseline within allocated funding limits.
- Formally adjust the planning data for pacing components to correspond to the planning baseline established above.

To illustrate the above, the following charts portray hypothetical build-up times based on Post M-Day and Pre M-Day IPMs along with associated information for a weapon with six major components. A "component" in this example is a major part of the weapon which has a separate production base i.e. fuze, guidance system, explosives, etc.

CHART I

HYPOTHETICAL PLANNING DATA
(Dollars in Millions)

Component	Post M-Day IPM Time	Pre M-Day IPM Time/Cost
A	6 mos.	5 mos./$2M
B	9 mos.	6 mos./$8M
C	12 mos.	6 mos./$9M
D	13 mos.	8 mos./$7M
E	15 mos.	9 mos./$8M
Identified funding from unadjusted planning data	- - -	$34M

Build-up times for major components typically vary by significant margins. Chart I illustrates this by portraying a variance of several months in component times. Factors which influence build-up times are as follows:

- Complexity of weapons and associated manufacturing processes.
- Competing priorities of the product mix of each plant.
- Degree of availability of plant capacity including potential for expansion.
- Various lead times for different kinds of equipment.
- Availability of critical materials and skilled labor.

The example in Chart I indicates that total identified IPM funding resulting from Industrial Preparedness Planning data is $34M. However, it's apparent that if the full $34M was spent on IPMs, the resultant production base would have serious imbalances (component A would have a build-up time of 5 months compared to 9 months for component E). The result would be a waste of scarce funds that could be utilized on other critical programs. It is at this point in the planning process that a second step would be exceptionally beneficial.

CHART II

SECOND STEP ILLUSTRATED

Allocated Funding Level	Second Step *Action/Baseline
• $15M	• Adjust data for components C and D to baseline of approximately 9 months.
• $ 8M	• Adjust data for components C, D and E to baseline between months 9 and 15.

* Close coordination with planning activities would be required to determine exact baseline.

Chart II used in conjunction with Chart I illustrates how the second step would work. Chart II assumes two funding levels ($15M and $8M). Assuming a funding level of $15M, it's apparent from Chart I that there are sufficient funds to compress the build-up time for component E from 15 months to 9 months at a cost of $8M and still have ample funds left ($7M) to apply against the remaining pacing components. Components A and B do not require funding since their build-up times are no greater than component E. This leaves components C and D for evaluation. Chart I indicates that $16M has

been identified to compress components C and D to 6 months and 8 months respectively ($9M for C and $7M for D). However, it's only necessary to compress these two components to 9 months in order to correspond to pacing component E. At this point it would have to be determined if the remaining funds ($7M) are adequate to compress components C and D to a baseline of 9 months. The determination of the actual baseline would require close coordination with the planning activity who acquired the original planning data. Chart II assumes that the remaining $7M would be adequate to fund a baseline of 9 months. Therefore, planning data for components C and D would be formally adjusted to that level (i.e. to the monthly production rate equivalent to that of component E at 9 months after a decision to expand production at M-Day). If more funding than $15M was available, then similar evaluation trade-offs would have to be made.

To further illustrate how a planning baseline would be determined, Chart II also assumes a funding level of $8M as a second example. In this example, it's apparent that a planning baseline between 9 and 15 months would have to be established. If the total available funding of $8M was applied to component E, then no funds would remain to compress build-up times for the two remaining pacing components C and D, leaving them imbalanced (component C at 12 months and D at 13 months compared to 9 months for E). The actual baseline determination would, as in the first example, require close coordination with the planning activity who acquired the original planning data. If less funding than $8M was available, then similar evaluation trade-offs would have to be made.

CHART III

ADJUSTED DATA

	$15M Fund Level	$8M Fund Level
	Baseline: 9 mos	Baseline: 11 mos
Component	IPM Time/Cost	IPM Time/Cost
*A	6 mos/$-0-	6 mos/$-0-
*B	9 mos/$-0-	9 mos/$-0-
C	9 mos/$3.6M	11 mos/$1.5M
D	9 mos/$5.7M	11 mos/$2.8M
E	9 mos/$8.0M	11 mos/$4.6M
Required Funding:	$17.3M	$8.9M

*Non-Pacing Components, thus no action or funding required.

Chart III illustrates adjusted planning data based on the examples in Charts I and II. Chart III assumes for illustration purposes, that adjusted planning data resulted in the cost of IPMs exceeding the allocated funding for both baselines. This would occur if the evaluations that were conducted to determine the baseline were inaccurate. In reality, it's probable this would happen a certain percentage of the time just as it's probable that adjusted IPM costs would result in being less than allocated funding some of the time. Two solutions are available to resolve this problem and conclude the planning process:

- Request an increase in allocated funding for that particular weapon assuming the request is likely to be approved. In the first example the increase would be $2.3M ($17.3M adjusted IPM cost minus $15M allocated funding). In the second example, the increase would be $900,000 ($8.9M adusted IPM cost minus $8M allocated funding). Whether or not the request for additional funding would be approved would depend upon the priority of the weapon system, the amount of preparedness it would buy and the availability of additional funds.

- Readjust the planning data again to a higher baseline and thus, decrease the cost. This would not likely involve a major effort since a substantial amount of planning data would already exist. It's possible also that a reasonable estimate (informal adjustment) could be made from existing planning data without a formal adjustment.

SUMMARY

The Industrial Preparedness Planning program provides visibility relative to the ability of the production base to accelerate and expand production during mobilization. Additionally, it provides information on potential Industrial Preparedness Measures (IPMs) to improve the state of preparedness of the production base. A two-step planning process can be readily adapted to the Industrial Preparedness Planning program without special authority. A two-step process would facilitate prioritizing of scarce peacetime IPM funds for production bottlenecks and would effectively minimize imbalances in production capability for components of end-item weapons. The two-step planning process is summarized as follows:

- Conduct Industrial Preparedness Planning with realistic end-item weapon mobilization production requirements in accordance with established procedures. [4]

- Formally revise (adjust) the planning data for pacing components in order to balance the production base. This second step would involve the following substeps:

- Determine the allocated or probable IPM funding level for each weapon. This would necessitate weapons being prioritized and available IPM funding allocated accordingly.

- Establish a common build-up time planning baseline for components of end-item weapons based on allocated funding limits.

- Formally revise (adjust) the planning data for pacing components, thereby balancing the production base within budgetary constraints.

The following major benefits would result from adopting a two-step Industrial Preparedness Planning process:

- Uniform plans can be developed for end item weapons as well as for common components of different weapon systems.

- Realistic, meaningful and balanced IPMs can be developed with confidence since they could be tailored to match available funding.

- The possibility of creating imbalances in production capability resulting from inadvertent misdirected funding would be precluded.

- Acceleration and expansion of production during mobilization would be facilitated by minimizing imbalances in production capacity for components of end-item weapons.

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AD P002803

READINESS PLANNING IN A PEACETIME ENVIRONMENT

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ABSTRACT

The purpose of this paper is to provide the Department of Defense (DOD) personnel and the public with information on how readiness planning in a peacetime environment will enhance the ability of DOD to respond to a Vietnam-type war, quick deployment of the Rapid Deployment Force (RDF) to a world trouble spot, or the initial phase of build-up in a mobilization situation. The paper will highlight a novel way of obtaining information and of facilitating rapid acceleration of defense contractors without the formal declaration of war or a national emergency.

DISCLAIMER

The views expressed in this paper are those of the author and do not necessarily reflect the official policy or position of the Department of the Army or Department of Defense.

BACKGROUND

The United States tends to react, rather than specifically plan for a wartime military force. World War I was fought in the early stages with foreign equipment. The United States fighting men who fought in France used 4,400 artillery pieces of which only 500 came from the United States production lines, and of the over 6,000 planes flown by the US Army Air Corp, only about 1,200 planes were made in America, and those in the later stages of the conflict. (1) When the World War ended, war plans were suddenly canceled and the nation was as unprepared for peace as it was for war. Many of the ills which we faced in the early stages of World War II were caused by the way the Government treated US Industry at the end of World War I. During the 1920's and the 1930's when the private sector enjoyed periods of prosperity, the need for weapons and munitions declined. Therefore, little ordnance was produced by the United States Industrial Base. The National Defense Act of 1930 developed a coherent statement of national mobilization requirement; however, Congressional and public opinion did not permit the adoption of the Industrial Mobilization Plan in 1939 and 1940, when the preparations for war were beginning. The result was a proliferation of agencies charged with various aspects of mobilization. It was only the War Production Board in early 1942 that began the tremendous task of bringing accomplishment out of confusion.

In 1940, many of the difficulties which were encountered were caused by the failure of the Government to declare an official mobilization of our manpower and industrial resources. The Government tried to achieve wartime production quantities while acting as if we were at peace. During the warning period prior to World War II, even before the National Defense Program was inaugurated, the Government experienced many difficulties gearing up the commercial industrial base for production of war equipment, and this was during a period in which this country was not totally considered hostile to the eventual enemy. So to speak, we had carte blanche to prepare for war production without interference from foreign sources.

A good example of the problems was that the United States did not have a munitions base prior to World War II. In 1939, shortly after the President declared a "national emergency," the Chief, of Ordnance was directed by the Secretary of War (now the Secretary of the Army) to develop and establish additional munitions capacity to meet the increasing requirements caused by the build-up of the Army. Selected companies of industry and the Government met to determine the best method to develop and operate the needed munitions capacity. It was soon evident that there were few facilities available in private industry which could be converted to the manufacture of military munitions. It was also learned that any capacity available had been utilized by the British and French Governments and President Roosevelt had determined this would not be disturbed. The result was that new facilities for the production of munitions would be required and should be immediately established. This required the obtaining of land, construction of buildings, acquisition of production equipment and machine tools, training of a labor force, and the development of management and production know-how. The lessons which were learned during this period seem to have been forgotten today. Most Americans are of the opinion that American industry can mobilize for war quickly. They are not aware that it took 18 months of system development before December 7, 1941 and 2 years more before the finished ammunition was delivered from our production lines at our Army Ammunition Plants. Further, what of the time it took to convert the private companies to military production? The time to convert from consumer goods production to military production depends upon the military item to be produced, the availability of production equipment and/or the lead time required to purchase and install new equipment and train personnel. In the months prior to World War

II, the Ordnance Corps discovered that production capacity, thought to exist in certain areas of the private sector, did not exist. A few of the contractors had indicated to the Government that if they had the money they could do anything demanded of them. These contractors could not accomplish what they said they could do or what the Ordnance Corps estimated that they could do. Inevitably, this shortcoming caused production delays at both the prime contractor and subcontractor levels. In most cases, the same factors affected production: low priorities, unrealistic delivery schedules, shortages of raw materials, competition between the prime contractor of the military services for what production equipment and machine tools were available, etc. The machine tool industry did not have the capacity required to meet the tremendous demands that were required for a full scale war of the magnitude of World War II. The weapons and munitions needs ranked far down the list of critical items required for war as compared to ships and aircraft.

Those who think that the United States was able to go to war immediately must have forgotten that the National Guard and the reserve units were already called to active duty prior to December 7, 1941, and yet, these numbers were small in comparison to the 2,000,000 man Army planned in early 1940. All that our citizens can remember is that we were able to send a large number of fully supported troops to Vietnam and we did this without declaring a national emergency. We did this without mobilization or exercise of war powers during this period. They often forget that the build-up was gradual and systematic, rather than a quick surge. The war has often been referred to by the news media as a "guns and butter war." The term "surge" is a relatively new term in the Department of Defense, but it best described the way the Korean War was conducted.

During the Vietnam War, some of the industrial base was filled to capacity, to the point of need for expansion. The 1980 assessment of the ICHORD report was that the US Industrial Base had deteriorated and would further deteriorate. (1) Since that time, we have had a severe recession in which many small and medium size companies have gone out of business. One of the reasons for this deterioration can be traced to what the American Automotive Industry has labeled "world cars." American car manufacturers have increased the number of components made in Europe, South America, and Asia. This situation of going off shore for components has caused American suppliers to go out of buiness. What this has done is helped further destroy the US Industrial Base, which will be needed if we have to mobilize or surge. When these companies cease business, the equipment and buildings are lost, and especially, the skills required to manufacture these items. One such affected industry which is a key for our industrial base is the gray iron casting industry.

The Army has long been the leader in protecting the industrial base, provided in the laws to keep as many of their component producers busy and their equipment ready for emergency. The Army uses the authority of the Defense Acquisition Regulation (DAR) 3-216 to negotiate solely with the mobilization base producers who have signed agreements with the Army establishing themselves as producers in the event of National Emergency or war. When the authority of DAR 3-216 is used to negotiate a requirement with the industrial base, this precludes competition with foreign sources and provides stability to the United States base. The law provides that foreign sources, unless they are located in Canada, can not be included in the mobilization base, nor can they be allowed to compete when the negotiations are being conducted under DAR 3-216. To supplement the authority of the DAR, the US Army Armament, Munitions and Chemical Command has developed a mobilization base acquisition policy which has been approved by the Department of the Army. (2) This policy has been cited by Headquarters, US Army Materiel Development and Readiness Command (DARCOM) as an excellent policy and one that should be followed by all subordinate commands. In addition to the use of the DAR 3-216 authority to maintain the mobilization base, DOD needs a vehicle to escalate logistics operations to meet combat requirements without full mobilization, a declared national emergency, or implementation of war powers. The subject matter contained in this paper will discuss how this can be accomplished with the full recognition of the limitations existing in a peactime environment.

SURGE VERSUS MOBILIZATION

To understand the difference, let us define the terms Mobilization and Surge. Mobilization, as defined in AR 700-90, "Army Industrial Preparedness Program" is, "The act of preparing for war or other emergencies through assembling and organizing national resources; the process by which the Armed Forces or part of them are brought to a state of readiness for war or other national emergencies. This includes assembling and organizing personnel, supplies, and materiel for active military service." Surge is defined by the same AR 700-90 as: "The ability of the industrial base to rapidly meet accelerated production requirements of selected items with existing facilities and equipment in a peacetime environment (no declared national emergency). Only existing peacetime program priorities will be available to obtain materiels, components, and other industrial resources necessary to support accelerated production

requirements."

It is essential that the reader understand the difference between mobilization planning and surge. Surge is envisioned to take place in situations such as undeclared war, deployment of the Rapid Deployment Force (RDF), a need to fill NATO or friendly government requirements under treaty or support agreements, emergency requirements to fill shortfalls in our current inventory or war reserves, and a need to replace on-hand stocks due to natural disaster. The Surge concept will accelerate production of weapons systems, munitions, missiles, and secondary items critical to sustain military requirements in situations short of a national emergency or in the warning period before the President or Congress declare a national emergency or war. Whereas, Mobilization is the industrial preparedness planning promulgated by the Defense Production Act of 1950, as amended, Executive Order 11490, and the Defense Mobilization Order VII-7. All of these clearly pronounce that the facilities, machine tools, production equipment, and skilled workers necessary to produce the wartime requirements of the Department of Defense shall be maintained in a state of readiness. Mobilization is a timely response of the industrial base to support the military forces in the event of an emergency. An emergency can be either a brush fire war, calling for a partial mobilization, or an all out war calling for full mobilization. Only the President, with the consent of Congress, can declare war. The President can declare a state of national emergency and, thereby, implement mobilization. These are drastic situations which can give the world the wrong signal.

In a state of mobilization I envision problems such as the availability of equipment, tooling, skills, subcontractor capacity, etc. Congress has added to these problems by precluding DOD from establishing facilities in the industrial base to produce quantities larger than those in the 5-year Defense Procurement Plan. This is far below what is norally established as mobilization rates for most military items. Again, history indicates that many World War II contractors never got into production before the war ended or began production too late to have any appreciable affect on the outcome of the war.

Surge planning is based on the concept that deals with current industry capability. The planning requirements direct the contractor to identify the problems he would experience in achieving his maximum sustainable rate of production. The contractor, therefore, establishes and provides the Government with his optimum (maximum) sustainable rate, and then, notes impediments, if any, to achieving a greater rate; e.g., subcontractor problems or material shortages during the performance of his contract. This is a very realistic approach because the contractor establishes the known upper limit of his capacity, and then, identifies what he can do or can not do and why.

ADPA WHITE PAPER ON SURGE

Shortly after we began to develop our surge concept, the American Defense Preparedness Association (ADPA) furnished us with a draft of their proposed White Paper and Industrial Base problems. (3) The white paper supported many of the findings that had been considered in our very early planning. Some of the areas discussed in the white paper helped to mold our thinking while preparing the Data Item Description (DID). A few of the major areas are as follows:

a. Industrial Preparedness Planning Programs are voluntary.

b. Contractors mechanically fill the DOD Industrial Preparedness Program, Production Planning Schedule, DD Form 1519, and consequently in many cases, mobilization rates and schedules are unrealistic when compared to peacetime production rates, i.e. the production rates for which the contractor is facilitized, and the required mobilization rate which the contractor has agreed to achieve.

c. Alternate or second sources will not do mobilization planning if that contractor is not currently producing the item.

d. Subcontractor planning only flows down to the first level and, frequently, because of this, the subcontractor's subcontractors can not deliver sufficient supplies or material to assure the prime contractor that he will be capable of achieving the production for which he is obligated.

SURGE INITIATIVES DEVELOPMENT

During the concept development phase of the Surge Initiative, several possibilities, in addition to those of the ADPA White Paper, were considered on just how the Government would provide for surging of the contractor. Mobilization planning information, as indicated in Ichord's report, was at best questionable. Much effort was expended reviewing the type of information that would be desirable for Army Surge Planning. We looked at the problems which were experienced during the Vietnam War when contractors refused to accept contracts because they did not believe in the war or they did not want to be labeled as "Merchants of Death." Some of these contractors elected to pursue more profitable commercial business during the boom period of the Vietnam War.

The problem of placing contracts with contractors who could not meet the delivery requirements that the Army considered realistic, was also remembered. Many of these contractors had been given letter contracts at the beginning of the Vietnam War. The Government, shortly thereafter, discovered that subcontractors impeded the ability of the primes to meet delivery schedules. It was learned, during this Vietnam period, that some of these prime contractors took on more work than they could complete on schedule, but they recognized that the Army or the other Services would not terminate them because they were sole source or reprocurement would take longer. As is the case of letter contracts, delivery is at the contractor's best efforts until a schedule is negotiated during the definitization process.

One of the major considerations in the surge concept development was the identification of the contractors' capabilities. Having the knowledge that many contractors just automatically complete mobilization planning documents and could never meet the mobilization rates, it was decided to ask the contractors what they could do and not establish any rate or quantity which would be titled "Surge Rate Requirement." What we wanted was an honest assessment of the capability to which contractors would be willing to assign a particular item, retaining the opportunity to change the rate during the period of the contract. With this flexibility, we hoped that contractors would be honest with the Government in this assessment and provide a true picture of their capability and that of their subcontractors and suppliers.

PRODUCTION SURGE PLAN

The capstone of the entire program is the acquisition of the Production Surge Plan. The Production Surge Plan is obtained by the inclusion of a Data Item Description (DID) into a solicitation and resulting contract. The DID DI-P-1634 delineates the content and requirements of the plan required from the contractor. The DID becomes a line item on the Contract Data Requirements List (DD Form 1423) that converts the Production Surge Plan DID to a deliverable item in that contract. The Production Surge Plan developed by the contractor proclaims his capability to rapidly accelerate and sustain production using priorities available, including the Defense Priority System and Defense Materials System in effect at the time the contract is surged. The plan will establish data on the maximum sustained production rate, long lead time, critical and pacing items, personnel requirements to each level of production, contracts from other Army Commands, other Services, or the Defense Logistics Agency, and will describe the impact that acceleration would have on the contractor's ability to promptly accelerate to his optimum production level.

The DID requirement is required to flow down to the lowest level subcontractor necessary for the prime contractor to be assured that his projected production levels can be attained. In many cases, a subcontractor's production is limited by the capability of one of his subcontractors to furnish material or parts in sufficient quantities to meet accelerated production. The plan requires a contractor to submit changes to his plan whenever a condition occurs which would adversely affect his ability to accelerate production on the contract or would impact upon his Production Surge Plan (more than just a few percent). The changes could be a result of new vendors or subcontractors, state of the art advances, methods of producing an item, new facilities, etc. The requirement for changes to the prime contractor's Production Surge Plan flows down to the same levels that the original requirement for a Production Surge Plan reached at the subcontractor level.

TRUE VALUE OF PRODUCTION SURGE PLAN

Probably the most important aspect of accelerated production under the surge initiatives is that it is accomplished with equipment and facilities on hand at the contractor's plant, installed, and ready to operate at the time of notice to the contractor to surge. As a comparison, mobilization relies not only on the contractor's present facilities, but on production equipment packages (sometimes not in the possession of the contractors), brick and mortar additions or improvements, and emergency powers available during mobilization. There are several other important areas of concern which surge planning addresses beyond the contractor's maximum production capability. In the contractor's Production Surge Plan, he must identify what he determines to be long lead time, critical, and pacing items which would impact on his ability to produce the end item and how he intends to satisfy the requirement for these items; e.g., in-house or subcontracted. He must submit his best judgment on personnel requirements for each level of production for which he is planned and how he intends to recruit, train, and assign these people. Another very important area is his current obligations. Consideration must be given to contracts with other Government agencies and commercial firms for which the contractor and his subcontractor organizations are obligated and which would impact on his ability to surge the items on our contract to his maximum production level.

There are a few other problem areas that the contractor is required to include in his Production Surge Plan. First, the surge DID requires a list of strategic and critical

materials and precious metals by type and quantity which will be required on his contract during a surge. This listing affords the contractor an opportunity to suggest substitute materials that could be used in the event there is a shortage of these materials. Secondly, the contractor is asked for a list of tooling and equipment which, if acquired, would increase his production rates. Estimated cost and procurement lead time for these items are required for evaluation and decision-making by the Government production managers. The limitations on this estimate are that contractors may use only present physical facilities and the information generated in this estimate can not be used in establishing the production rates for his Production Surge Plan. Poor subcontracting, in-depth coordination, and planning would invite failure in the event of a "surge" and could court national disaster or substantially limit combat effectiveness and near-term readiness. In short, lives could be lost because of inability to achieve planned rates indicated by industry.

SURGE OPTION TO ACCELERATE DELIVERY SCHEDULE

A Production Surge Plan provided under a contract without a vehicle to implement that plan would be worthless. In the testing concept by the US Army Armament Materiel Readiness Command (now the US Army Armament, Munitions and Chemical Command), we discovered this shortcoming. When the decision was made that we needed a firm contractual baseline, a clause entitled "Surge Option to Accelerate Delivery Schedule" was developed. This clause provides the Government with the right, in a surge situation, to accelerate the contractor delivery schedule in accordance with the Production Surge Plan in effect at the time the contracting officer exercises the Government's rights under this clause. The acceleration will be to a rate of production the contractor has indicated in his plan, but would never be greater than the contractor established maximum rate.

OPTION CLAUSES FOR INCREASED QUANTITIES

During a surge situation (an emergency situation which is short of war or undeclared national emergency), it will be both desirable and necessary to increase the quantity of items on a contract as well as to accelerate the contract delivery schedule. To accomplish this, a Surge Option to Increase Quantities Clause has been developed. The option may be exercised during a surge situation, by written notice issued by the contracting officer, either in conjunction with or independently of the exercising of the Surge Option to Accelerate Deliveries. This surge option clause used with the Production Surge Plan will have unit ceiling/target prices and provide a delivery at a rate selected by the contracting officer which appears in the contractor's current Production Surge Plan.

The Surge Option to Increase Quantities Clause used in connection with the Surge Option to Accelerate Delivery, when exercised, can expand the contract delivery schedule both vertically (increased delivery rate) and horizontally (increased quantities). The clause provides that it may be exercised anytime prior to the final acceptance by the Government of the last scheduled item on the contract. The contractor has the option to offer varying prices for accelerated deliveries based on the quantity actually accelerated, the delivery rate of the accelerated delivery schedule, and the remaining quantity to be delivered on the contract delivery schedule. If the contractor chooses not to furnish a unit ceiling/target price, or fails to do so, the contracting officer will interpret this to mean that the unit price in the basic contract is the unit ceiling/target price for the accelerated deliveries and additional quantities. In the event of a surge situation, instant production acceleration could mean the difference between a successful or unsuccessful response to a threat by our deployed military forces.

A second Surge Option Clause to Increase Quantities is used when there is no requirement in the contract for a Production Surge Plan and also has a unit ceiling/target price established by the contractor when submitting his bid/offer. This option clause further directs the contractor to provide the contracting officer a delivery schedule, X days after award of contract, which will be applicable at the time of exercise of the option. This proposed schedule has a dual purpose. First, when the clause is exercised, the contracting officer has a definitive delivery schedule in his possession which has been developed by the contractor and becomes a contractual element. The exercised option quantities will be delivered as directed by the contracting officer according to a contractor provided schedule and a new delivery schedule is thereby established. The contractor's delivery schedule also gives the surge planners at least one piece of information contained in a Production Surge Plan; the contractor's maximum delivery rate, based on existing equipment and facilities. This information is important, for the Surge Option to Increase Quantities Clause that appears in his contract is required to flow down to his subcontractors and vendors in their contracts, and this requirement to the subcontractors to their subcontractors, etc. The shortcoming of this data is that the prime contractor's delivery schedule will not identify any constraints or bottlenecks in his production capability or in his subcontractor network. The restraint will only be reflected in the delivery rates to which the contractor would

be willing to commit. In the case of an identified critical or pacing item, identified by an unreasonable delivery shcedule offered by the contractor in response to the clause, the production planner may determine that on the next procurement, a Production Surge Plan might be appropriate to specifically identify the constraints, and the magnitude of those constraints, on the contractor's production capability.

COLD BASE SURGE PLANNED PRODUCERS

The Surge Initiatives also provided for the surging of items that are not in production (cold base). The initial ideas revolved around a contractual instrument in the possession of a Surge Planned Producer. The ADPA, in their White Paper, suggested that an unsigned letter contract should be in the possession of all the Mobilization Planned Producers. This would provide those contractors the framework of the contract which they would be awarded when in an emergency situation. This proposal was seriously considered along with other ideas.

It appeared that a Basic Ordering Agreement (BOA) in the hands of a Surge Planned Producer was the best vehicle to improve Army's readiness. These BOA's would identify the item(s) for which the contractor was the planned source and would be written broadly enough to encompass all contract types. Further analysis and discussion led towards the broadening of the use of these BOA's to include a current technical data package (TDP). Since there are regulatory requirements for a BOA to be reviewed and updated, changes to the TDP configuration could be made simultaneously. This would provide the Cold Base Planned Producer a moderately current TDP to begin his production planning during a surge situation while the Army processed the changes to his TDP or furnished the contractor a new TDP for that item. This seemed to satisfy the situation but left the developers of the surge initiatives a little uncomfortable. After much soul searching and discussion concerning this, and some questions raised during briefings on these surge initiatives, a thought occured which would improve the system. In many cases, there are current contracts for the items for which BOA's could be awarded to Cold Base Producers. During the contract life any changes approved by the design activity which also impacted on the TDP with BOA Planned Producer could be issued to the Surge Planned Producer on a cold base. When an Engineering Change Order was issued, or for that matter, anything else that triggered a change to the TDP, and the contractor producing that item was furnished the change, the same change would be furnished to the Surge Planned Producer with that item. This possibly results in a little more work for those involved, but it would raise the confidence level of the Cold Base Planned Producer of an item, and enhance that contractor's ability to start production in the shortest possible time. This would improve the Army's near-term readiness substantially.

CONCLUSION

The AMCCOM Surge initiatives can provide the Government with an understanding of the capabilities of industry to respond to the near term. The contract provisions also provide a vehicle to immediately start contractors accelerating contract production to meet critical demands of the services.

The value of the data gathered by the use of the DID for Production Surge Plan is the gathering of good data on the industrial responsiveness of US industry. If all the services and DLA were using the contract requirements, it would allow more accurate assessments of the effect of the demands of DOD in an emergency on the remaining US Industrial Base. This would allow DOD to take corrective actions to eliminate bottlenecks and production shortfalls during nonemergency situations. This would allow for systematic changes as opposed to emergency "Band-aid" reactions.

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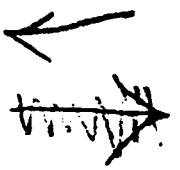

INTEGRATED LOGISTICS SUPPORT

Panel Moderator: Mr. Willard F. Stratton
Chief, Readiness Division
USA DARCOM Materiel Readiness
Support Activity

Papers:

Policy Initiatives to Achieve Readiness and Support Objectives
by Joseph D. Arcieri

1982 US Army Materiel Development and Readiness Command (DARCOM) Integrated Logistics Support (ILS) Study Finding on Contracting for ILS
by David M. Morgan

The New MIL-STDs 1388
by John E. Peer and David L. McChrystal

AD P002804

POLICY INITIATIVES TO ACHIEVE READINESS AND SUPPORT OBJECTIVES

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INTRODUCTION

The fundamental responsibility of the defense logistics community is to ensure the timely availability of the requisite support to enable our forces to effectively deter aggression, and should deterence fail, to successfully undertake military operations that prevent the enemey from achieving his goals at minimum war cost to the U.S. and our allies. In essence, this means the logistics community of organic and industrial capability, must ensure military force readiness and sustainability. This formidable responsibility imparts a concurrently dual-edged challenge: (1) obtaining affordable Life Cycle Cost/effective supportable systems; and (2) continuing improvements in the effectiveness and efficiency of our logistics systems' operations. To meet this challenge DoD has undertaken several policy initiatives to achieve more intensive and effective logistics involvement in the acquisition process. Particularly, attention has been given to changing top level acquisition policy directives and instructions, and in changes to the logistics support analysis requirements outlined in MIL-STD-1388. The purpose of these changes being to concentrate adequate management attention on the early phases of the acquisition process where the greatest influence can be made on system design characteristics.

CHANGES TO POLICY DIRECTION

The approach taken to revise acquisition policy was (1) to revise DoD Directive 5000.1, "Major System Acquisition," to clearly state the importance of readiness in the process; (2) to revise DoD Instruction 5000.2, "Major System Acquisition Procedures," to reflect this importance by making readiness and support a major element of the Defense System Acquisition Council (DSARC) considerations at program milestone decision points; and (3) to provide general and specific guidance for carrrying out an effective integrated logistics support (ILS) program to achieve readiness objectives in DoD Directive 5000.39, "Acquisition and Management of ILS for Systems and Equipment."

Some of the significant changes to these policy documents are highlighted below.

A. DoDD 5000.1

Clearly states that system readiness is a primary objective of the acquisition process, requiring resource for its attainment of equal importance to those devoted to schedule and performance objectives.

B. DoDI 5000.2

o Established the Weapon Support Improvement Group (WSIG), and made its direction a permanent DSARC advisor.

o Requires mandatory readiness and support briefing to the WSIG prior to DSARC reviews.

o Tasks the WSIG to act as the DoD focal point for identifying and encouraging approaches to improve readiness and support.

C. DoDD 5000.39

o Directs program ILS activity to begin at program initiation and to continue for the system's life cycle current rating on two main objectives: first, designing in supportability characteristics into systems and determining support requirements; and subsequently, on acquiring and deploying support resources and assessing attained fielded readiness.

o Establishes the requirement for peacetime and wartime readiness objectives and thresholds, and progress toward their attainment assessed prior to milestone decision points.

o Outlines a clear statement of the logistics considerations that must be taken in the development of acquisition strategies including reliance on contractor support and specification by the acquisition executive of the acceptable level of support to be fielded under accelerated strategies.

o Establishes requirement for post-production support planning as part of the acquisition process and the systems management of ILS for the life of a system.

o Establishes logistics R&D as part of, and independent of, individual programs.

The above changes provide the policy statements necessary to institutionalize readiness and support as integral to and a prime objective of the acquisition process. However, they do not outline for acquisition managers the critical generic activities that must be taken to ensure that readiness and support considerations impact design, that support requirements are fully identified, and that the assessment of how will the provided support meet these objectives.

CHANGES TO MIL-STD-1388 - LOGISTICS SUPPORT ANALYSIS

The revisions made to MIL-STD-1388, "Logistics Support Analysis (LSA)," provide that link between general policy direction and generic activities the must be accomplished to implement these new policies. In laying out the timing and type of LSA activity throughout the acquisition process it provides a "game plan" for achieving readiness and support objectives. Figure 1 lists some of the major LSA activities and illustrates the importance of the LSA "game plan." The significance of laying out this "game plan" can not be over stressed. It is the LSA activities conducted over the acquisition life cycle that provide the information to affect specifications and design requirements, perform and evaluate trade-offs, establish system and support baselines, identify and enumerate support requirements and test and evaluation issues, and make critical milestone decisions.

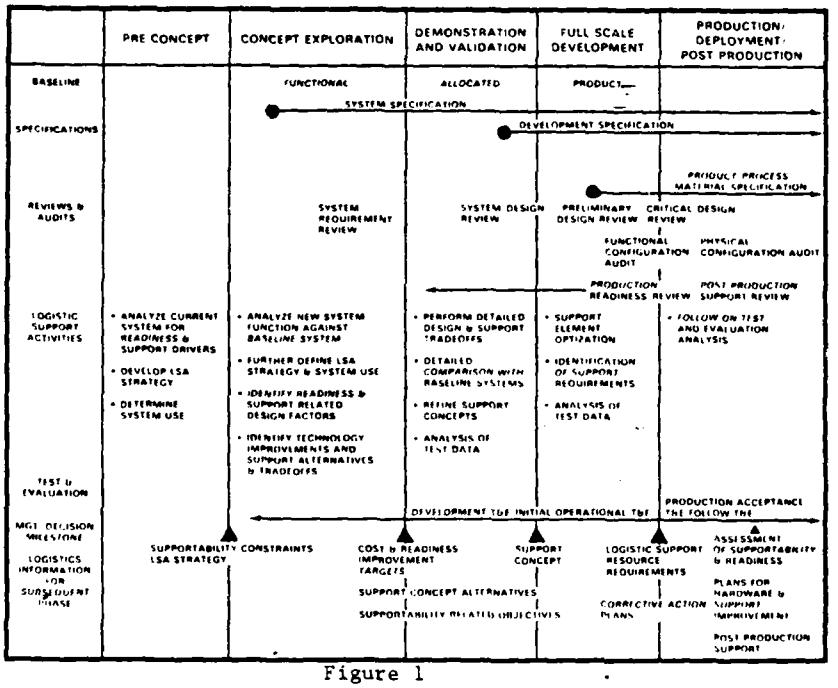

Figure 1

The approach taken in revising this MIL-STD was to build on the existing standard, add new tasks to address new policy, and restructor the standard for ease of application. Figure 2 illustrates a comparison between the old MIL-STD and the new revision.

The tasks in the revised standard are grouped by the major activity they contribute to. Task section 100 provides the tasks necessary for LSA planning, management, and review. Section 200 has a series of front-end tasks and subtasks which culminate in objectives, goals, and thresholds and constraints for design and support through comparison with existing systems; analysis of manpower, cost, and readiness drivers on present systems, and identification of targets for improvement in the new Section 300 tasks are designed to help achieve the best balance between cost, schedule, performance and supportability, and to optimize the support concept for the new system. Sections 200 and 300 tasks are heavily oriented toward influencing design. Task 303, for example, contains as subtasks ma y of the trade-offs common to most programs including system design versus support concept, and Built-in-Test and Automatic Test Equipment versus manual trouble-shooting. Section 400 tasks are aimed primarily at identifying the support and personnel resource requirements and the new system. Last, Section 500 subtasks are designed to help assess the degree to which supportability requirements have been achieved prior to production and following deployment.

SUMMARY AND CONCLUSION

DoD has taken the necessary steps to revise acquisition logistics policy and implementing instructions to provide the frame work to adequately address readiness and support during the system acquisition process. However, for these changes to be fully successful requires the development of useful analytical tools to aid in the design and managment process. Particularly, MACRO level tools that can be used early in the acquisition

process to evaluate trade-offs between readiness and performance, and between ILS elements. To accomplish this requires a continuing dialogue between all elements of logistics and development committees.

MIL-STD-1388-1 VERSUS MIL-STD-1388-1A

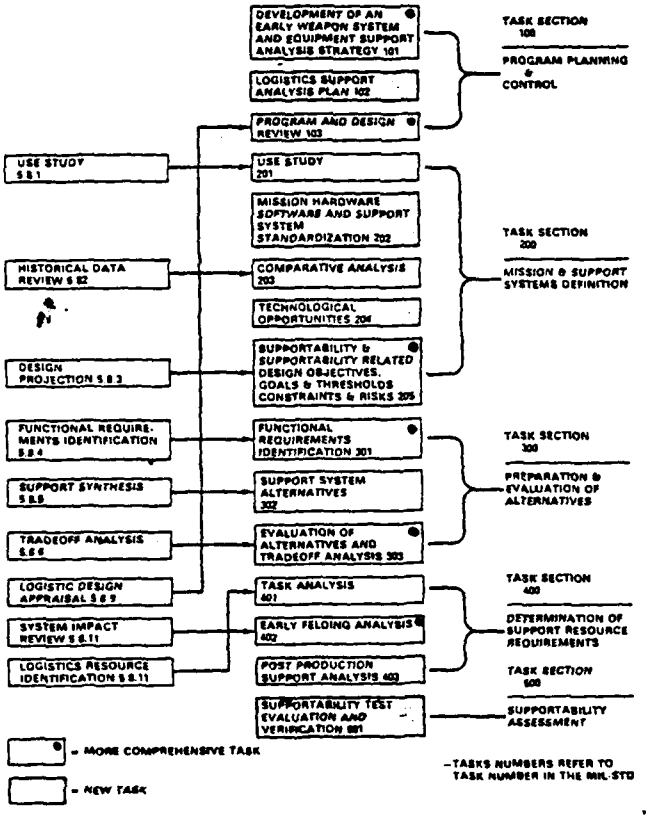

Figure 2

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ADP002805

1982 US ARMY MATERIEL DEVELOPMENT AND READINESS COMMAND (DARCOM) INTEGRATED LOGISTIC SUPPORT (ILS) STUDY FINDING ON CONTRACTING FOR ILS

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ABSTRACT

This paper gives a general overview of the objective, organization, and approach used by the 1982 DARCOM (ILS) Study. The seven high payoff areas that the study concentrated on are listed but only the results of the solicitation documents study effort are discussed in detail. Each action item developed by the solicitation documents subgroup is discussed in detail to include a description of both the problem and recommended correction(s).

INTRODUCTION

The DARCOM ILS Study was directed by the DARCOM Deputy Commanding General for Materiel Readiness on 27 May 1982. The study was conducted under the chairmanship of the DARCOM Director for Supply, Maintenance, and Transportation with the Commander, US Army DARCOM Materiel Readiness Support Activity serving as the study vice-chairman. It should be noted that the Director for Supply, Maintenance, and Transportation is the HQ DARCOM staff element responsible for ILS.

The purpose of the study was to identify actions which DARCOM could take to improve the ILS process. The study was to identify weaknesses and provide pragmatic recommendations to improve and, if necessary, overhaul the DARCOM ILS process. Also, the study was to be completed in 3 months.

A study team was established consisting of representatives of HQ DARCOM staff elements, each DARCOM major subordinate command (MSC), selected project managers (PMs), and selected DARCOM activities. After research of recent studies, e.g., Study of Army Logistics-81 (STARLOG 81), Department of the Army Inspector General on Force Modernization (DAIG FM) Report, and collective team member experiences, the following high payoff areas were identified and a subgroup was established for each:

a. Organizational Structure for ILS Management
b. ILS Funding
c. Solicitation Documents
d. Support Analysis/Data
e. ILS Policy, Plans and Procedures
f. Associated Support Items of Equipment
g. Materiel Fielding Process

In pursuit of each high payoff area, the subgroups researched available information sources and conducted visits and discussions with personnel from DARCOM MSCs, PMs, HQ DARCOM, HQDA (ODCSLOG, ODCSRDA), Logistics Evaluation Agency, and DOD schools. Defense industry input to the study was provided by a group of representatives from the National Security Industrial Association (NSIA) Logistic Management Committee (LOMAC). The NSIA LOMAC representatives provided a briefing to the entire study team which outlined industry's perspective of ILS within DARCOM and provided recommendations for improvement. Command level perspectives and recommendations on ILS within DARCOM were obtained by surveying all DARCOM MSC commanders and DARCOM PMs.

During the months of July and August 1982, the full study group met three times. The first meeting, 1-2 Jul 82, enabled the full study team to solidify the high payoff areas and identify specific issues for each payoff area. The second meeting, 22-23 Jul 82, allowed each subgroup the opportunity to present their defined problem areas and emerging recommendations and obtain input from other members of the complete study group. The third meeting, 10-11 Aug 82, was used to permit each study group to present their findings and recommendations, and to discuss and refine possible methods of implementing specific recommendations.

Subsequent to the final meeting, the subgroup reports were finalized and published. There was a total of 50 action items emanating from the seven subgroups. The problems and recommendations were documented in a "Carlucci Report" format that included:

a. Problem/Background.
b. Recommendation.
c. Advantages.
d. Disadvantages.
e. Action Required.
f. Blocks for the reviewer to indicate Approval/Disapproval.

Implementing directives to accomplish each recommended action were developed in the form of letters, memorandums, etc., for signature by the responsible individual at HQ DARCOM.

TEXT OF PAPER

The solicitation documents subgroup quickly identified 10 priority action items. These action items were--

a. Section C Integration and Clarity
b. Outmoded/Missing Data Item Descriptions (DIDs)

c. System/Development Specification
d. Supportability Weighting
e. Maintenance Concept
f. Logistic Acquisition Strategy
g. Contractor Incentives for Reliability and Support
h. ILS Standardization
i. Dedicated Logistic Prototypes
j. ILS Contracting Training

The section C integration and clarity action item stemmed from the observation that the logistic portion of Section C, Description/Specification (to include all logistic statements of work), is often not written in a clear, concise, integrated manner. This, in turn, causes a significant comprehension problem to responding contractors. This observation was validated by a review of approximately 20 solicitation documents/contracts within the CY 80-82 time frame. The review had revealed many instances where work requirements in the logistic portion of Section C were not written with the clear understanding that the contractor must be able to read and understand the logistic work requirements before the work can be performed.

The subgroup recommended that the DARCOM ILS regulation, i.e., DARCOM-R 700-15, be changed to make the ILS manager responsible for integrating the entire logistic portion of Section C and for ensuring its compatibility with the other Section C requirements; e.g., engineering, reliability and maintainability, safety, system/project management, etc. The subgroup also recommended that the ILS manager be made co-chairman of the Data Requirements Review Board (DRRB) and that the development of MIL-HDBK-245B, Preparation of Statement of Work, be monitored and applied by the DARCOM ILS community on approval.

The outmoded and missing DIDs action item stemmed from the observation that many logistic DIDs are outmoded and require extensive modification before use, e.g., Integrated Support Plan, Maintenance Support Plan, etc. In other cases, DIDs do not exist for data items needed by current policy (e.g., System Support Package Component Listing; Logistic Review Meetings, Agenda Items, and Minutes). This problem is worsened by the slow and cumbersome process for updating current DIDs and getting new DIDs approved. Also, those DARCOM personnel in the best position to see DID problems, i.e., ILS managers involved in solicitation development, are the least likely to initiate a correction.

The subgroup recommended that HQ DARCOM establish a Logistic Data Management Work Group to:

a. Update outmoded logistic DIDs
b. Develop needed DIDs
c. Perform annual review of logistic DIDs
d. Support the DARCOM Directorate for Manufacturing Technology efforts to standardize logistic data requirements
e. Support other DOD DID standardization/redundancy reduction efforts.

The subgroup also recommended that the effort by ILS managers to maintain current logistic DIDs should be a special subject for the DARCOM Inspector General.

The system/development specification action item stemmed from the observation that full advantage of the system and development specification formats found in MIL-STD-490, Specification Practices, is not taken for stating logistic design requirements. This is especially disturbing since the MIL-STD-490 format for system and development specifications offer ample opportunity for the inclusion of logistic design requirements. Examples of these are paragraphs--

a. 4.2.2.2 - Physical Characteristics
b. 4.3.2.2.1 - Protective Coating
c. 4.3.2.3 - Reliability
d. 4.3.2.4 - Maintainability
e. 4.3.2.5 - Environmental Condition
f. 4.3.2.6 - Transportability
g. 4.3.3 - Design and Construction
h. 4.3.3.1 - Materials
i. 4.3.3.3 - Nameplates or Product Marking
j. 4.3.3.5 - Interchangeability
k. 4.3.3.7 - Human Engineering
l. 4.3.5 - Logistics
m. 4.3.6 - Personnel and Training

The subgroup recommended the following:

a. Require the ILS manager to participate in the development of the system/development specification to ensure logistic requirements are adequately addressed.

b. Make development of technical logistic design requirements and incorporation of these requirements into the system/development specifications a core mission and function of DARCOM MSC ILS offices.

c. Make the development and use of procedures necessary to acquire, catalog, store, manipulate, analyze, and retrieve field feedback on logistic design shortcomings a core mission and function of DARCOM MSC ILS offices.

d. Place an appendix in the DARCOM ILS regulation describing opportunity for influencing the design through full use of MIL-STD-490 format.

e. Provide training for DARCOM ILS managers on how to influence the design logistically.

The supportability weighting action item stemmed from the observation that supportability is not separately identified and does not receive

sufficient weight in the source selection process. The weight given logistics in the source selection process is evident in Section M, Evaluation Factors for Award, of the solicitation document. Here the contractor is given a clear indication of the relative order of importance of the evaluation factors. In a recent industry survey, contractors were asked what weighting was applied to the supportability area in contract awards. Two-thirds of them estimated it to be insignificant, less than 10 percent; and one-third placed the value between 10 percent and 15 percent. The contractors surveyed had a background of repeated award experience. This continues to happen in spite of the AR 1000-1, 1 May 81, paragraph 2-21b requirement that "Logistic supportability will be a design requirement as important as cost, schedule, and performance."

The subgroup recommended the revision of the DARCOM policy and procedure documents on source selection to provide for supportability as a separate evaluation factor and 25 percent minimum weighting. The subgroup also recommended that ILS participation be required in the overall source selection process, i.e., SSEB, Selection Plan preparation, etc.

The maintenance concept action item stemmed from the observation that the maintenance concept, i.e., the way the Army wants maintenance to be done, is not defined early enough in the acquisition process to allow it to serve as the basis for developing detailed design requirements for entry into the system/development specification.

The subgroup recommended that the ILS manager be made responsible for ensuring the availability of a detailed, coordinated maintenance concept, and that a maintenance planning standard be developed to define the terms and processes used in developing the maintenance concept and maintenance plan.

The logistic acquisition strategy action item stemmed from the observation that the lack of a definitive, coordinated acquisition strategy for developing and acquiring the logistic elements, e.g., tech pubs, training, etc,, adversely impacts the preparation of logistic inputs to the solicitation document. Since the solicitation document is the means by which the Army's "needs" are made known to the contractor, it is imperative that those "needs" are clearly defined and coordinated before beginning preparation of the solicitation document.

The subgroup recommended that the ILS Plan (ILSP) be updated and available at least 30 days prior to initiating solicitation document development for the Demonstration and Validation (DVAL), Full-Scale Development (FSD), and Production phases. The subgroup also recommended that the development of the DA pamphlet on the ILSP be expedited. This pamphlet should emphasize the role the ILSP plays in establishing the acquisition strategy for the logistic elements and serving as a baseline for developing the solicitation document.

The contractor incentive for reliability and support action item stemmed from the observation that knowledge and experience in applying contractor incentives for reliability and support is not widespread within the DARCOM ILS community. This is in spite of Carlucci Initiative #16 which stressed the need for the services to develop greater expertise in support related contractor incentives through analysis of lessons learned.

The subgroup recommended that the DARCOM Directorate of Procurement and Production effort in response to the Carlucci Initiative #16 be monitored and that a 1 day briefing be developed based on the results and presented to the DARCOM MSC ILS offices. The subgroup also recommended that the DARCOM ILS community develop policy and procedure for implementing these incentives based on results of Procurement and Production evaluation.

The ILS standardization action item stemmed from the observation that although all DARCOM MSCs basically contract for the same logistic work effort and data, there is little standardization in either the work tasks imposed or the data required. The work tasks required to develop the logistic products, e.g., tech pubs, training, ILS program, etc., are essentially the same for all acquisitions of like strategy and life cycle phase. Other services utilize limited coordination military standards to standardize the work tasks for specific logistic efforts, e.g., MIL-STD-1369 (EC), ILS Program Requirements; MIL-STD-1349, Contractor Training Programs.

The subgroup recommended establishment of ILS as a standardization area within the DOD Standardization and Specification Program; development of a standardization program plan to identify the areas of standardization with the greatest potential payoff; and, in accordance with the ILS Standardization Plan, development of selected standards either by an inhouse work group or under contract.

The dedicated logistic prototype action item stemmed from the observation that developmental prototypes are not available in sufficient quantity to enable the accomplishment of required logistic work tasks.

Developmental prototypes are basically hand crafted and, therefore, expensive and competition for use of developmental prototypes is keen. Primarily, they are used to support the engineering effort. However, development of the logistic products, e.g., LSA/LSAR, tech pubs, provisioning technical documentation and

training, requires ready access to developmental prototypes.

The subgroup recommended that the DARCOM ILS regulation be revised to state that dedicated logistic prototypes are required for all major and designated acquisition programs, and for nonmajor systems where availability of such prototypes will significantly reduce the risk of conditional materiel release.

The ILS contracting training action item stemmed from the observation that the training available on ILS contracting is not sufficient to meet the needs of DARCOM ILS managers. Developing the logistic portion of a solicitation document is a complex process requiring a broad range of skills and knowledge in such areas as the Defense Acquisition Regulation requirements, data management, good writing practices, and the many specifications and standards that relate to acquisition logistics.

DARCOM ILS training, at that time, devoted approximately four hours to contracting for ILS. The training referred to here was in the Army Logistic Management Center (ALMC) 4 week ILS regular course and the 2 week ILS management course. However, ALMC was developing a 1 week ILS contracting course with the instructor cadre currently available. The ALMC FY 83 schedule for ILS contracting course presentations was 1-5 Nov 82, 31 Jan - 4 Feb 83, and 28 Mar - 1 Apr 83. Consequently, the subgroup recommended that the first ALMC ILS contracting course be used as a developmental test with DARCOM ILS personnel with contracting experience attending and assisting the ALMC instructor cadre in developing necessary corrections.

CONCLUSION/SUMMARY

It should be noted that none of the solicitation documents subgroups recommendations can be considered earthshaking. This is in accordance with the study charter to develop pragmatic, doable corrective actions. This in part contributes to the fact that with only minor modifications, the recommendations of the solicitation documents subgroup were accepted by the study chairman and are in the process of being implemented. The implementation of some recommendations will require extensive coordination between HQ DARCOM staff elements. Needless to say, this will take time. However, those actions that only required changes to the DARCOM ILS regulation have, in effect, been implemented. Although the DARCOM-R 700-15, ILS, is still being revised, interim guidance has been provided in a "six star letter" signed by both DARCOM Deputy Commanding Generals.

The DARCOM ILS Study provided an excellent vehicle for elevating ILS contracting problems to the general officer level. With this attention and the continuing overwatch by the DARCOM Director of Supply, Maintenance, and Transportation on efforts to implement the recommendations, significant progress is being made to improve the quality of the ILS contracting effort within DARCOM.

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THE NEW MIL-STDs 1388

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ADP002806

ABSTRACT

The concept for LSA was originally set forth in MIL-STD-1388-1 published in October 1973. Since that time each service has pursued an independent course in the applications of LSA. DOD policies and directives for ILS and LSA have changed to reflect refinements to and availability of analytical techniques developed to meet state-of-the-art hardware requirements. This paper describes the latest effort to provide a standard LSA with the broadest possible application. The recently published MIL-STD-1388-1A overcomes many shortcomings that were identified with the original military standard. It defines the LSA tasks in greater detail and provides the capability to tailor the level of effort for LSA to meet the specific requirements of any given acquisition program. Also discussed is a proposed version of MIL-STD-1388-2A, DOD Requirements for a Logistic Support Analysis Record (LSAR). This document describes the data elements, definitions, and input data records for the DOD standard LSAR which is currently under development.

INTRODUCTION

As the title indicates, the purpose of this paper is to introduce the A versions of MIL-STD-1388-1, Logistic Support Analysis (LSA), and MIL-STD-1388-2, LSA Data Element Definitions. To better represent the need for the new A versions of these MIL-STD's, it is necessary to review the original documents and highlight the deficiencies which brought about their revision. An examination of the new standards will show how they overcome the problems inherent to their predecessors.

The basic MIL-STD-1388-1 was published in October 1973 and provided both a definition of LSA and a description of the individual analysis tasks which comprised the LSA process. The definition of LSA as given was:

> "...a composite of systematic actions taken to identify, define, analyze, quantify, and process logistic support requirements."

Thirteen tasks were established as the basic analyses which made up the LSA process. The tasks were described in general terms making it incumbent upon the procuring activity to redefine each task into a specific work requirement, for a given contract, in a particular life cycle phase. As demonstrated in the following extract from MIL-STD-1388-1, tailoring guidance was equally vague:

> "The magnitude, scope and level of detail shall be consistent with the stage of development, namely, parametric in conceptual versus detailed in production."

In addition to the task descriptions, the standard also contained a sample data system. This data system, known as the Logistic Support Analysis Record (LSAR), was composed of nine (9) data sheets and was intended to serve as the standard medium for the systematic recording, processing, storing and reporting of data during LSA. No specific outputs were identified. MIL-STD-1388-2 provided the data element definitions to be used in conjunction with the sample data sheets contained in MIL-STD-1388-1. The MIL-STD-1388-1 LSAR was never established as the standard data system for use throughout DOD. Instead, it was left to each service to develop their own data systems for documenting the LSAR data. The Army's LSAR, as documented in DARCOM PAM 750-16, is a good example of one of these service-unique LSAR data systems.

MIL-STD-1388-1A

In November 1978, after 5 years of experience with the LSA process, representatives from each of the services met to exchange service experience and increase interservice cooperation in the implementation and standardization of LSA and LSAR. As this cooperative effort progressed, a Joint Service Working Group (JSWG) evolved. The JSWG was composed of representatives from the Army; Navy; Air Force; Marine Corps; Defense Industry Associations; and the Office of the Assistant Secretary of Defense for Manpower, Reserve Affairs and Logistics, OASD (MRA&L). Aware of the recurring problems during the implementation of LSA/LSAR and cognizant of the current DOD policies and initiatives, the JSWG identified significant shortcomings of the basic MIL-STD's. They concluded that:

1. Task descriptions were too general.
2. Tasks were difficult to tailor.
3. Tasks were not tied to specific deliverable products.
4. The standards no longer reflected DOD policies and initiatives.
5. The standards did not adequately address early analysis tasks requirements.

Based upon this assessment, it became obvious that a complete revision of the standards was necessary. To achieve the desired results, the JSWG concluded that two distinct efforts would be required. The first was a total rewrite of MIL-STD-1388-1. The second was development of a joint service standard LSAR. Work began on both efforts in mid 1979. In September 1980, an LSA Steering Group (LSA-SG), composed of senior service and industry representatives and chaired by OSD, was formed to oversee the revision of MIL-STD-1388-1 and the development of the DOD standard LSAR. It also sponsored two additional intiatives; the formation of a DOD LSA Support Activity, and a reduction in the number of redundant logistic-related Data Item Descriptions (DID's). During the same month, the Army was tasked with the responsibility for update of MIL-STD-1388-1. With the US Army DARCOM Materiel Readiness Support Activity (MRSA) serving as the primary author for the LSA-SG, a draft MIL-STD-1388A was prepared to supersede MIL-STD-1388-1. This draft publication was formally staffed throughout DOD and industry during May-August 1982. In April of 1983 the new standard, now redesignated MIL-STD-1388-1A, was released for publication and became effective with the issuance of DOD Index of Specifications and Standards (DODISS) Notice 30-83, dated 25 April 1983.

This new MIL-STD-1388-1A is characterized by the following:

1. A better definition of LSA making the link to ILS. LSA is; "the selective applications of scientific and engineering efforts undertaken during the acquisition process, as part of the system engineering and design process, to assist in complying with supportability and other ILS objectives."

2. More definitive analysis requirements. Fifteen (15) major tasks and seventy-seven (77) subtasks comprise the LSA process. These tasks and subtasks are categorized into five (5) general sections: Section 100, Program Planning and Control; Section 200, Mission and Support System Definition; Section 300, Preparation and Evaluation of Alternatives; Section 400, Determination of Logistic Support Resource Requirements; and Section 500, Supportability Assessment.

3. Front End Analysis more clearly defined. Many of the tasks and subtasks have been designed for early application (concept phase) to influence design and support concepts.

4. Tasks inputs are identified. Input requirements necessary to perform each analysis task are defined. Additionally, those inputs that the procuring activity must provide are identified.

MIL-STD-1388

OLD vs NEW

	MIL-STD-1388-1	MIL-STD-1388-1A
● Tasks	13	15
● Subtasks	0	77
● Inputs	No	Yes
● Outputs	No	Yes
● Life Cycle Phasing	Marginal	Yes
● Application Guidance	No	Yes
● DID's	No	Yes
● LSAR	Yes (Sample)	No*

* Standard LSAR contained in proposed MIL-STD-1388-2A.

Figure 1. Comparison of MIL-STD-1388-1 and MIL-STD-1388-1A

5. Tasks outputs are identified. The expected product from each analysis task is specified.

6. Data Item Description (DID's) are included. All required DID's for delivery of the outputs from each support analysis task have been developed, approved, and are published in the Acquisition Management Systems and Data Requirements Control List (AMSDL).

7. Applications guidance is provided. An appendix is included which identifies task and subtask applicability by life cycle phase and provides specific guidance for tailoring analysis requirements.

Figure 1 provides a general comparison of the contents of MIL-STD-1388-1 and MIL-STD-1388-1A.

To illustrate the definitive nature of the new analysis task descriptions, the steps from an actual task contained in the standard will be reviewed. For this purpose Task 203, Comparative Systems Analysis, will be used. A 200 level task, Comparative Systems Analysis falls into the general section of Mission and Support Systems Definition. The purpose of a Comparative Systems Analysis is to project the supportability parameters of a new system/equipment; assess the feasibility of those parameters; identify targets for improvement; and to determine the supportability, cost, and readiness drivers by selecting or developing a Baseline Comparison System (BCS) from existing systems/equipment which represent the characteristics of the new system/equipment. The task is composed of the following eight subtasks:

Subtask 1. Identify existing systems/equipment useful for comparison with the new system/equipment alternatives.

Subtask 2. Select or develop a BCS for each significantly different new system/equipment alternative.

Subtask 3. Determine the O&S costs, logistic support requirements, R&M values and readiness values for each BCS.

Subtask 4. Identify qualitative supportability problems in the BCS to be avoided on the new system/equipment.

Subtask 5. Identify and document the supportability, cost and readiness drivers for each BCS.

Subtask 6. Identify and document any supportability, cost and readiness drivers for the new system-equipment subsystems for which no BCS was developed.

Subtask 7. Update the BCS as the new system/equipment becomes better defined.

Subtask 8. Identify and document risks and assumptions associated with each BCS.

Similar to the Historical Data Review task in the basic MIL-STD-1388-1, the Comparative Systems Analysis task can provide a sound analytical foundation for projecting new system/equipment parameters and identifying areas to be improved. The task description provided outlines the individual steps to be accomplished and supplies the user with a specific plan and sequence of actions, thereby eliminating uncertainty as to the analysis required and what the expected results are to provide.

The new standard, as previously stated, contains a use guidance appendix which identifies the applicability of each analysis task during each phase of the system/equipment life cycle. Table III of this appendix is the Task versus Documentation Matrix. As is evident in Figure 2, this matrix is a valuable tool for use in the preparation of a statement of work (SOW). For each task and subtask the applicability and level of effort is identified. In addition, the specific DID which provides the format for the deliverable is given.

MIL-STD-1388-2A

A significant characteristic of MIL-STD-1388-1A is that, unlike the basic MIL-STD-1388-1, it contains no sample data sheets. The documentation of a standard set of data records and data element definitions has been reserved for the proposed MIL-STD-1388-2A, DOD Requirements for a Logistic Support Analysis Record (LSAR), which forms the second portion of the revision effort.

As with the rewrite of MIL-STD-1388-1, the process of developing a standard set of LSAR data records and data element definitions began in mid 1979. Early in the development process, the decision was made to remove all data system related aspects of the LSA process from MIL-STD-1388-1 and consolidate this information into a separate document. As a result, the proposed MIL-STD-1388-2A, assumes a greatly expanded role over the original MIL-STD-1388-2.

In August of 1981 the Army was chartered by OASD (MRA&L) to serve as the DOD LSA Support Activity. The responsibilities under this charter were subsequently assigned to MRSA. Since that time, MRSA has been working in close coordination with the joint service working group on development of the proposed MIL-STD-1388-2A

TASK	PRE-CON-CEPT	CON-CEPT	DVAL	FSD	PROD	APPLICABLE DATA ITEM DESCRIPTION
203 Comparative Analysis	G	G	G	G	NA	DI-S-7116 Comparative Analysis Report
Subtask 203.2.1	G	G	G	NA	NA	
Subtask 203.2.2	G(5)	G(5)	G(4)	G(4)	NA	
Subtask 203.2.3	G(5)	G(5)	G(4)	G(4)	NA	
Subtask 203.2.4	G(5)	G(5)	G(4)	G(4)	NA	
Subtask 203.2.5	G(5)	G(5)	G(4)	G(4)	NA	
Subtask 203.2.6	G	G	G	NA	NA	
Subtask 203.2.7	NA	G(5)	G(4)	G(4)	NA	
Subtask 203.2.8	G	G	G	G	NA	

Code Definitions

S	-	Selectively applicable.
G	-	Generally applicable.
C	-	Generally applicable to design changes only.
NA	-	Not applicable.
(1)	-	Requires considerable interpretation of intent to be cost effective.
(2)	-	MIL-STD-1388-1A is not the primary implementation document. Other MIL-STD's or statement of work requirements must be included to define the total requirements.
(3)	-	Done just prior to initiation of the phase.
(4)	-	Selectively applicable for equipment level acquisitions.
(5)	-	Not applicable for equipment level acquisitions.

Figure 2. Application of analysis subtasks to Life Cycle Phase

and standard LSAR ADP programs which will process the data.

The new standard contains the general requirements for LSAR in terms of a manual, automated or hybrid data storage and delivery effort. Detailed requirements address the data entry instructions and data element definitions to be used in conjunction with the fourteen (14) standard DOD LSAR input data records. The standard also covers the output reports and the DOD ADP system master file record layouts. These master record layouts have been included to establish a standard ADP format for delivery of LSAR data. The new LSAR input data records and associated ADP routines now provide the integrated logistic support (ILS) managers, throughout DOD and defense industry, a standardized means of handling the logistic data required during the acquisition process. LSAR data is generated in all phases of the life cycle and is used as input to follow-on analyses. Figure 3 gives an overview of the LSAR data process and its relationship to other logistic products.

Two use guidance appendices have been incorporated into the standard to assist in the application and tailoring of an LSAR effort and the assignment and usage of the major file control keys; the LSA Control Number (LCN), Alternate LCN Code (ALC), and Usable On Code (UOC). The first of the guidance appendices, covering application and tailoring of an LSAR effort, provides a series of five (5) tables to be used to determine specific LSAR requirements. Table I relates the applicability of the individual input data records to the analysis subtasks contained in MIL-STD-1388-1A. Table II identifies the interface of the LSAR records to the specific tasks and subtasks of related program elements, such as the Reliability or Maintainability Programs, to preclude the duplication of efforts. Table III outlines the relationship of the LSAR to the logistic related DID's and indicates the degree to which the LSAR can be used to satisfy the data requirements of the individual deliverable products. Table IV shows the applicability of each input data record to the various logistic products. And finally, Table V provides the LSAR output report to DID relationships. Using the combination of tables provided, it is now possible, based upon the analysis tasks imposed and the products to be generated, to tailor the LSAR effort down to the data element level. This capability permits the

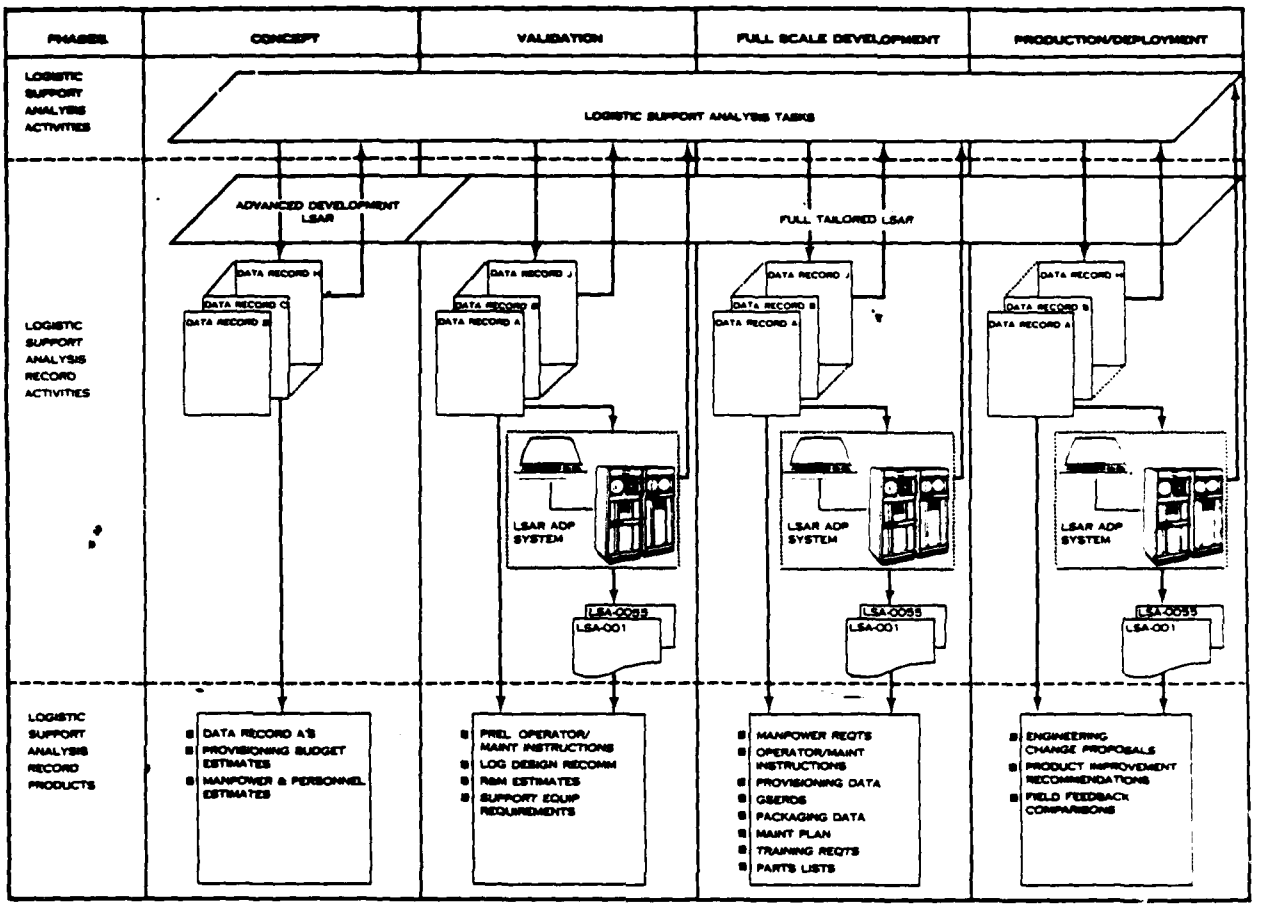

Figure 3. LSAR Data Process Overview.

orderly procurement of the minimum amounts of logistic data required to support an acquisition program.

The second guidance appendix provides the user with a description of the major file control keys, the assignment method options available, and the capabilities associated with each option. Three (3) data elements, LCN, ALC, UOC, constitute the primary file keys and, as such, dictate the structure of the master files. Knowledge of this information is essential for early planning of an effective LSAR effort. The addition of the Alternate LCN Code (ALC) and Usable On Code (UOC) as key elements for master file control has expanded the ability of the LSAR to document and store data related to multiple hardware configurations/models and alternate design/maintenance concepts within a single data base. The expanded capabilities of the LSAR, coupled with the detailed application and tailoring guidance, provides the LSA process with an extremely flexible data handling system.

To supplement the procedures and guidance contained in the new military standards, a number of instructional type publications are also under development. These documents include a Functional Operating Instructions (FOI) handbook, a Computer Operating Instructions (COI) handbook, a Testing Guide, and a periodic bulletin of ADP program updates. Figure 4 identifies the planned function of each of these publications.

In addition to the documents shown in Figure 4, MRSA is also responsible for the development and update of a Five Year Enhancement Plan (FYEP). The FYEP, originally published in 1978, has been upgraded to reflect those development tasks associated with the DOD standard LSAR. The plan is updated annually, staffed among the services, and approved by OASD (MRA&L). It has been designed to serve a twofold purpose. First, it identifies the established enhancement tasks and provides a means for prioritizing their accomplishment. Second, it serves as a

Supplemental Publications

Document	Purpose
Functional Operating Instructions (FOI)	Identify LSA output report options, selection procedures, update logic, and system edits.
Computer Operating Instructions (COI)	Provides ADP program descriptions, computer resource requirements, and ADP system installation procedures.
Testing Guide	Provides sample input data, output selection cards, and output reports for use in system installation verification.
LSAR Bulletin	Used to disseminate LSAR and LSAR-related information to all LSAR system users.

Figure 4. Companion documents to MIL-STD-1388-2A.

vehicle whereby users can identify new requirements for input into the system enhancement cycle. The current FYEP addresses the planned enhancements to the DOD standard LSAR during the fiscal years 84 through 88. There are twenty-seven (27) enhancements documented in the plan and cover actions ranging from initial development of the baseline DOD LSAR to the automation of additional data sheets and output summaries.

CONCLUSION

With the publication of MIL-STD-1388-1A and 2A one more step will be achieved in closing the gap between ILS regulatory policy and its proper implementation. These standards constitute the primary tool for achieving the goals of ILS. They have been structured to facilitate initiations of the analysis effort up front in the development process where the greatest influence on design and support concepts can be realized. The process they describe is intended to serve as the basis for, and audit trail of, design and support-related decisions made during the acquisition process. In order to be effective in this role, LSA/LSAR must be evolutionary in nature. It is essential that LSA/LSAR be responsive to the changing requirements of the logistic community. Users of MIL-STD-1388-1A and 2A are strongly encouraged to submit substantive comments and recommendations to:

Commander
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MANAGEMENT OF SUPPORT RESOURCES

Panel Moderator: Colonel John J. Tedesco
Commander
USA DARCOM Materiel Readiness Support
Activity

Papers:

Central Demand Data Base (CDDB) End Item Code (EIC)
by George Campbell

Improved Management of Support Resources
by David V. Glass and Donald W. Srull

Project: Acquisition Strategy
by William D. Majewski

ADP002807

CENTRAL DEMAND DATA BASE (CDDB) END ITEM CODE (EIC)

George Campbell, US Army DARCOM Materiel Readiness Support Activity

ABSTRACT

One of the most difficult tasks facing Army Logisticians is the accurate determination of the repair parts stockage levels to support the equipment in the hands of the soldier. Decisions on total repair parts consumption are based on demands, but repair parts for individual fielding of equipment in operational units are based upon estimates known as Failure Factors (FF's). These FF's established during the initial deployment of equipment are used throughout that equipment's life cycle. To update FF's, individual repair parts consumption must be identified to a specific end item application. The problem has been that there is no data source sufficiently reliable and valid to identify and collect data to update FF's. The EIC was designed to accomplish the identification and capture of individual repair parts consumption by specific end items, and provide the Army managers with an accurate record of repair parts consumption throughout the life cycle of an end item.

INTRODUCTION

a. The Army's logistical system is segregated into five distinct management and operational groups: Organizational, Direct Support Unit (DSU), General Support Unit (GSU), National Inventory Control Point (NICP), and depot. In many cases, data and management information may be available at one level but not at a higher level in the hierarchy, due to the large volume of data generated at each level. Furthermore, the Army does not have a systematic methodology to collect, analyze, and distribute this data from and to all the various management groups.

b. The US Army Materiel Development and Readiness Command (DARCOM) has the overall responsibility to procure, stock, store, and issue weapon systems and materiel to maintain the mission responsibilities of the US Army. To accomplish these responsibilities; HQ DARCOM operates five major subordinate commands (MSC's) which perform the basic logistical functions for various commodity groups. These MSC's react to the stated needs for materiel from various Army customers through a funded requisition. The Army's logistical system is structured upon a hierarchy of various levels of support designed to replenish materiel on a consolidated basis. The rationale for consolidation was designed to prevent the system from being saturated with individual requests and allow for a more economical and rapid satisfaction of needs. However, the consolidation of requests effectively precludes the DARCOM MSC's from identifying the individual demands and the application of that materiel to a specific weapons system.

c. Under the Army's Technical Services Concept, end item managers could obtain reliable data on materiel consumption by end item application. During the 1960's, the Army entered into a systems philosophy of management and moved away from maintaining individual vehicle consumption data. However, under the present Single Manager Concept, end item managers and secondary item managers do not always work at the same wholesale supply activity that manages the end item(s). While secondary item management is moving away from identifying repair parts consumption by end item, end item management is moving towards a system philosophy of management. System managers have complained about their inability to determine field repair parts consumption for a specific end item. In essence, weapon systems managers may know in aggregate numbers the materiel their systems are consuming, but they cannot stratify the consumption of multiapplication repair parts or other materiels by end item.

d. The DARCOM MSC's are the prime source for recommended repair parts support in the areas of initial fielding, Concurrent Spare parts listings (CSP's), Essential Repair Parts and Special Tools List (RPSTL's), International Logistics (IL)/Foreign Military Sales (FMS) and the Support List Allowance (SLA) for Prescribed Load Lists (PLL's) and Authorized Stockage Lists (ASL's). To produce these various products, the DARCOM MSC's use FF's to provide a methodology for system peculiar items that considers inherent and noninherent failures, incorporate the maintenance concept and establish an audit trail to support logistics decisions and budgetary requirements. The FF is an indication of the expected number of failures for a repair part in a specific application per 100 end items.

e. The reliability of the FF has been questioned on numerous occasions and history has demonstrated that FF's are seldom changed after initial provisioning is accomplished. The FF's are supplied by either the contractor or DARCOM MSC's engineers during the initial provisioning process. In concept, the FF and the wholesale stockage requirements should be updated in the follow-on provisioning or through subsequent logistics supply control studies. Initial provisioning estimates should be completely replaced/validated by consumption or demand history during the total life cycle of the equipment as demand data are accumulated. Unfortunately, these contractor/engineering estimates are seldom revised and the apparent reason appears to be the lack of a systematic method available to collect individual demands identified by end item

application from field users. The CDDB through the application and use of an EIC will establish a methodology to identify a demand to a specific end item.

OBJECTIVES

To derive the maximum benefits and accomplish the goals and objectives of the CDDB, the EIC must be implemented and be a primary data element and driver of the CDDB. The collection of individual demands without identifying those demands to a specific end item will serve no useful purpose nor satisfy the requirements of the principal CDDB benefactors and supporters: The Combat PLL/ASL Program and the Automation Wartime Planning Factors. The DARCOM MSC's have predicated their support and utilization of the CDDB on the implementation of the EIC and the capabilities to extract demand data by EIC. Furthermore, the CDDB capabilities to tailor logistical support packages and conduct meaningful analysis would not be feasible nor cost effective unless the CDDB demands can be identified to an end item.

a. The CDDB will provide the Department of Army with a single centralized repository of all individual demands initiated at/by the organizational level. As the centralized repository, the CDDB will access, retrieve, reformat, and communicate the demand data to various management levels/activities throughout the Army. Furthermore, the CDDB will establish a precedent to eliminate all data extract or data call requirements from the retail Automated Data Systems (ADS) and require all request for demand data extracts to be answered by/through the CDDB. Specifically, the CDDB will provide:

(1) A two-year historical data base of all individual demands initiated at/by the organizational level.

(2) Twenty-four months of summarized data for each NSN/part number stratified by EIC.

(3) A Customer Assistance Office (CAO) and Special Analysis Office (SAO) to perform data extracts against the data base.

(4) A communications capability to access the CDDB.

b. The CDDB will act as the basis for, and provide selected data to:

(1) Compute usage factors/FF's by means of a code (EIC) which relates repair parts to an end item.

(2) Update/revise or validate FF's and engineering estimates at the DARCOM MSC's.

(3) The Combat PLL/ASL Program.

(4) Wartime/Transition Planning Factors program.

(5) Identify part numbers and local purchase transactions for possible NSN assignment/central procure/issue.

(6) Compute and track operating and support costs to an end item based on EIC.

(7) Tailor a logistic support plan for task forces or special projects.

(8) Support requirements for statistical demand analysis that can be tailored to a specific requester or summarized to/at any level of the Army logistics system.

EXISTING METHODS AND PROCEDURES

a. At present, there is no existing system that collects all individual demands in/at a central repository, nor is there an existing system that collects requests/demands for repair parts identified to a specific end item. Many of the retail ADS collect individual demands, but do not transmit these demands up or down the Army's logistical heirarchy. The DARCOM MSC's normally receive requisitions for replenishment of ASL stockage which represents a consolidation of numerous individual demands and subsequent issues.

b. The lowest level of field maintenance and consumption of repair parts is the organizational level. To perform the authorized maintenance at the Organizational level, a PLL consisting of a Mandatory Parts List and demand supported materiel is maintained. The PLL is managed on a "one-used, one-replaced" basis and, when an issue is made to a mechanic, a request must be prepared to replenish the stock that was consumed. Likewise, when a mechanic requires a part that is not stocked in the PLL, a request must be made to obtain that materiel. The requests from the PLL are submitted to a DSU for supply action.

c. For the DSU to accomplish this replenishment of PLL stockage, the DSU maintains an ASL which in theory contains enough demand supported materiel for 45 days of operation. When the DSU receives a request from a PLL and can satisfy the requirement, an issue is made from the ASL to the PLL. The DSU continues to issue stock from the ASL until they reach a re-order point (ROP). When the ROP is reached, the DSU will prepare a replenishment requisition to replace the stock issued from the ASL. The DSU does not prepare a requisition each time a request is received from a PLL. This replenishment requisition is therefore not to support or maintain a specific piece of equipment, but to re-establish a stockage position for supporting PLL's. The mandatory data elements, policy, and guidance required to

process a requisition(s) through the Wholesale Supply System are defined in DOD 4140.17-M, Military Standard Requisitioning and Issue Procedures (MILSTRIP) and implemented by the Army in AR 725-50.

d. There are two specific cases where a request from the PLL will be passed on to the wholesale supply system as a requisition; if the PLL request is for a Not Mission Capable Supply (NMCS) situation, or if the PLL request is for a part not stocked by/on the ASL. The Army Supply System is designed to maximize the use of replenishment requisitions.

e. The Army's best effort thus far at obtaining end item application for the specific requests/requisitions of repair parts is the use of the Weapons/Equipment System Designator Code (W/ESDC). This code must be on all NMCS requests/requisitions and should be on all other requests/requisitions where end item application can be identified. However, the W/ESDC has several drawbacks. Since W/ESDC has only two positions, there are not enough possible combinations to accommodate all the different end items in the Army; W/ESDC has been used to identify families of end items; and W/ESDC's cannot be perpetuated on ASL replenishment requisitions from retail or intermediate level suppliers, because these are consolidations of many individual demands. Replenishment requisitions account for 80 to 85 percent of field requisitioned repair parts, therefore, most of the W/ESDC data are being lost. Furthermore, W/ESDC's are only assigned to readiness reportable items and therefore exclude many end items.

f. Requests/demands and replenishment requisitions input to the retail ADS that are not, or cannot be satisfied, are transceived to the wholesale supply systems, which includes the DARCOM MSC's, the Defense Logistics Agency (DLA), General Services Administration (GSA), or other DOD supply sources. These transceived documents are routed through the Defense Automatic Addressing System (DAAS). The DAAS has been programed to provide the Logistics Control Activity (LCA) with an image copy of every document with an Army Department of Defense Activity Address Code (DODAAC) in the document number. The LCA uses these documents to build the Logistics Intelligence File (LIF) as a repository and data base of all Army requisitions passed to the DOD wholesale supply system.

PROPOSED METHODS AND PROCEDURES

a. We propose that a new data element EIC be established as a mandatory three position entry in cc 68-70 of all requests for issue initiated at the organizational level. The basic regulatory guidance for EIC will be incorporated into AR 725-50 replacing the current guidance for W/ESDC. The EIC is a three position alphanumeric code, utilizing the full English alphabet and the numerals 2, 3, 4, 6, 8, and 9. Assignment of the EIC will be restricted to every NSN cataloged as an end item in the Army inventory and identified as a valid line item number (LIN). Only LIN's with NSN's will be assigned an EIC, developmental items with "Z" LIN's or LIN's without a valid NSN will not be assigned an EIC. A unique EIC will be assigned for the total life cycle of these items. The important thing to note here is that three characters will allow assignment of a unique EIC to every end item the Army has today and expects to have in the foreseeable future.

b. The intent of W/ESDC is to provide management a method to obtain data for review of weapons systems support to identify existing or potential deficiencies in a weapons system. The EIC will accomplish this goal with a greater accuracy and efficiency. We therefore propose to eliminate the W/ESDC in cc 55-56 on all requests/requisitions.

c. The lowest level of field maintenance is the consumption point. In effect, the mechanic in the organizational unit is the consumer of repair parts. Many repair parts are available in the PLL of the unit which owns the end item, but if the required part is not available in the PLL, then it must be obtained from the DSU. Whenever a part is issued from the PLL, the PLL clerk must submit a request to the DSU. Under the EIC concept, the request from the PLL clerk, whether for replenishment or because the desired part was not on hand, must include the EIC of the end item to which the repair part applies.

d. The first level of automation for the repair parts request occurs at the DSU. Each repair parts request will process through the DSU's data processing system for supply action. These systems currently use these requests to build a demand summary file to form an audit trail basis. We propose that each system prepare an image of each individual demand during this process and format this image to the output processing of the daily cycle. We have requested that a Document Identifier Code (DIC) of "BAH" be assigned and utilized for the image identification.

e. The daily DIC BAH output will become part of the daily cycle from these systems transceived through the DAAS. At this point, we propose that the DAAS route Army documents with a DIC BAH to the LCA.

f. At the LCA, the DIC BAH will be used as the basis to build the CDDB as a repository of all Army individual demands generated prior to any consolidation into a replenishment requisition.

g. Two points in the EIC collection procedure should be emphasized. First, the EIC data will be stratified by end item application. Second, the data collection is automated and does not impede request/requisition flow in any way. The requirement to put the EIC on the PLL request merely replaces the current W/ESDC requirement. EIC does not slow down the flow of repair parts to the mechanic, nor does it require additional research on the part of mechanic, PLL clerk, or SSA.

h. The CDDB will collect EIC data and prepare analyses and reports for use by MSC's, system/project/product managers, and field users. Among the new and improved management tools that EIC data can bring about, will be an improved SLAC product. The repair parts allowances in SLAC could finally be based on a current history of parts usage instead of the estimates which are often many years old. The MSC's compute repair parts packages to accompany international logistics sales. These are called concurrent spare parts lists and again are based on SLAC, and would be likewise improved through EIC data.

i. EIC would enable the Army to obtain by far the most accurate record of organizationally applied repair parts costs throughout the life of an end item. Because there has never been a system that successfully identified consumption of multiapplication repair parts to specific types of end items, all estimates of repair parts costs have only been gross approximations. By having a total history of parts usage and applying unit price information, we can actually obtain an accurate picture of repair parts support costs for particular types of end items. Such information would be especially valuable in identifying deficient end items. If a particular end item is becoming more expensive to maintain than to replace, then it should be replaced rather than repaired and reprocured indefinitely. A record of all the repair parts used and the associated costs would be a valuable tool in making such a decision. Likewise, we would be able to spot repair parts that are performing below par. We could see if a particular part is failing excessively in all applications, indicating a problem with the part itself. All the data would be collected retaining geographic identity and any geographic factors in parts consumption would become apparent. In addition, computed ASL's and PLL's could then accurately reflect geographic differences. Finally, because a history of parts usage can be a valuable tool in predicting certain parts usage of new equipment similar to existing equipment, the EIC data will help improve the accuracy of the provisioning process.

j. The ultimate goal of EIC is, of course, to make the repair parts provisioning process more effective. The history of consumption of a certain part in a certain application can enable more accurate estimates of consumption for a new part similar in design and application, thus, enhancing initial provisioning. Likewise, follow-on provisioning will be enhanced by having a total "birth-to-death" record of parts consumption by end item. By providing wholesale and MACOM materiel managers a clear picture of current field repair parts consumption, procurement and stockage decisions can be made which will improve overall materiel readiness.

ADP002808

IMPROVED MANAGEMENT OF SUPPORT RESOURCES

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ABSTRACT

Improving the management of support resources for major weapon systems is a crucial goal for the Department of Defense. The problem of weapon systems being inadequately supported in the field because of fragmented decision making in the allocation of support resources (e.g., spares, support and test equipment) was addressed in DoD Acquisition Improvement Initiative #30. New management procedures to help correct this problem were tested during the FY83 and FY84 budget reviews and the FY84-88 program review. In this paper we evaluate the test results in terms of the feasibility of identifying individual weapon system support resource needs, and the utility of collecting and reviewing this information during key points in the planning, programming and budgeting process. We then make several recommendations to improve the trial procedures and to move the initiative to final implementation.

BACKGROUND

Initiative #30 (Item "G") of the 30 April 1981 Deputy Secretary of Defense memorandum on acquisition (Reference 1) requires the Office of the Secretary of Defense (OSD) and the Military Departments to take actions to improve the management of support resources for major weapon systems and to increase the involvement of Program Managers in the process. Responsibility for following up this decision was assigned to the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics) (ASD(MRA&L)) with assistance from the Assistant Secretary of Defense (Comptroller) (ASD(C)). An OSD/Service Steering Group and a working group were established to oversee implementation. The Initiative called for the Services to develop internal procedures for increased Program Manager involvement and improved visibility of support resource requirements and readiness objectives for the 20 to 30 weapon systems entering or in early production at any given time. It also called for OSD to conduct a single, integrated review of support associated with individual weapon systems during key stages of the Planning, Programming and Budgeting System (PPBS) process. The Initiative required a two-year trial period for the implementing procedures.

One of the first actions of the OSD/Service working group was to define the categories of support resources to be considered in the trial period (Reference 2). The nine categories chosen are shown in Table 1.

TABLE 1. INITIATIVE #30 SUPPORT CATEGORIES

1. Spares and Repair Parts
2. Support and Test Equipment
3. Training and Training Devices
4. Publications and Technical Data
5. Depot Repair
6. Contractor Support
7. Facilities
8. Integrated Logistic Support Management and Analysis
9. Other Support-Related Requirements

Data were requested by OSD for the trial reviews in each of the support categories for both the "required resources" and the "funding" for these resources over time. The "required resources" by year are those resources necessary for the weapon system to meet its specified, scheduled readiness goals. The "funding" by year are those resources that are actually included in the official Service resource allocation document, i.e., either the Service Program Objective Memorandum (POM) or the Service budget.

TRIAL REVIEWS

Trial procedures were developed for an integrated OSD review of major weapon systems support resources during the overall OSD review of Service programs (POMs) and budget submissions. These reviews were "integrated" in the sense that the appropriate staff offices of the ASD(MRA&L), ASD(C), and the Director,

Program Analysis and Evaluation (DPA&E) would review the submitted weapon support data, and their comments would be consolidated and summarized for inclusion in an issue paper or Program Budget Decision (PBD) as appropriate. Formerly no organized or formal procedures existed to tie these various staff review efforts together. As a result, weapon system support received very spotty, disjointed and sometimes inconsistent coverage at key points in the PPBS.

The trial procedures were tested three times on nine selected weapon systems. The first trial was in the final stages of FY83 budget formulation (October-December 1981). The second trial was in parallel with the FY84-88 Program review (May-July 1982). The third trial was during the FY84 budget review (October-December 1982). The weapon systems included in the second and third trials were: Army -- M-1, Multiple Launch Rocket System, UH-60A; Navy -- F/A-18A, Aegis, Tomahawk; Air Force -- Ground Launched Cruise Missile, European Distribution System, Next Generation Trainer.

Procedures for the FY85-89 program review were finalized and included in the POM Preparation Instructions (PPI) for FY85-89 (Reference 3). The FY85-89 POM review concluded the Initiative #30 two-year trial period.

This paper synthesizes our previous evaluations, along with the trial results and the experience gained over the first year and a half of final implementation. Our evaluation focuses on three areas:

(1) the feasibility of identifying support resources by weapon system,

(2) the feasibility of involving the program manager more directly in support resource issues within the PPB System, and finally,

(3) the feasibility and utility of a consolidated OSD review of support requirements and resources by weapon system.

MANAGEMENT GOAL

Initiative #30 is concerned with improving the management of major weapon systems' support resources. To achieve this goal, two steps must be taken. First, the required and the funded resources in each of the support categories must be identified, and the impact of any resource shortfalls on system readiness quantified. Second, the resource allocation decision-making process, both within the Services and OSD, must be influenced by these data to ensure that a balanced level of funding across the support categories is provided. The bottom-line objective is to acquire the highest level of readiness possible for the total amount of resources available.

The first step, that of identifying and summarizing the support resource requirements and funding for individual weapon systems during the Planning, Programming and Budgeting (PPB) cycle, had not been done in a systematic way prior to Initiative #30. Much of the information had not been reported regularly by weapon system at all. Instead functional support categories, such as replenishment spares or training equipment, were reported as totals that included resources for all weapon systems. Whether or not allocation to specific weapons was adequate, consistent with current program schedules, or made at all, could not easily be determined.

Because support information by weapon system has not been previously reported to OSD during the program or budget reviews, there has been no systematic review at the OSD level of support for individual weapon systems. To varying degrees, the same has been true within the Military Departments. One result was that support resource decisions made during OSD reviews could not be easily related to their effects on individual weapon systems or forces.

An equally serious problem was that decisions affecting one category of support, such as spares, were often made in isolation from and inconsistent with other decisions affecting related support resources, for instance, test equipment and training devices. This could result in an unbalanced support program where, for example, funding for spares would be made available but the means to make proper use of the spares would not be funded. Improving and coordinating the review of support resources to assure that a weapon system's support is in balance over all categories of support is the second step in Initiative #30.

SERVICE RESPONSIBILITIES

One of the primary Military Department responsibilities in Initiative #30 was to first identify and then to collect the requirements and funding data in each of the support categories for selected weapon systems. A corollary to this responsibility is to assure that the requirements are based on the readiness goals established for the weapon systems. The other primary Military Department responsibility was to increase the involvement of Program Managers in the support resource decision process throughout the PPBS cycle. Experience gained in the three trial reviews, review of the Service implementation plans provided to OSD, and discussions with Service personnel are the basis for the following conclusions on Service progress in these two areas.

Identifying Requirements and Funding

The Military Departments demonstrated in the trial period that it was feasible to identify the requirements and funding in most of the

support categories for the selected weapon systems. The principal exception is common equipment. Resources for common Spare and Repair Parts and, in some cases, for common Support and Test Equipment could not usually be broken out by weapon system.

Although it was feasible for all three Military Departments to identify most of the support resources called for, it was difficult for the Army and Navy to do this routinely because they do not have formalized or fully automated systems that contain the data. This made it necessary to rely principally on ad hoc and manual methods for producing the data. One of the limitations of these methods became evident when the production rates for several weapon systems were changed late in the Service resource allocation process. Such changes occurred in the M-1 tank and the F-18 fighter programs during the final stages of POM 84-88 development. As a result, in the case of the M-1, no data were turned in. In the case of the F-18, only the FY84 data were available and these were delayed. More structured, automated systems will be necessary if future support resource determinations are to be responsive enough to effectively support internal Service resource allocation decisions as well as OSD reviews.

Two other factors affect how readily the Services can supply the weapon system support data called for by Initiative #30. One is the degree to which the data system for the support information is tied to the data systems used to develop Service programs and budgets. The other is the extent to which the responsibility and lines of communication for producing the support requirements and resource information are clearly defined.

In the Air Force the system from which the Initiative #30 data are extracted is the system that is used in the programming and budget process, the Program Decision Package (PDP) system. The PDP is a decision document that describes an independent portion of the total Air Force program (such as a weapon system) in terms of the resources needed for that program portion. It also describes proposed alternatives to the current program. Programming resource allocation deliberations and decisions are made in terms of PDPs.

The PDPs are updated often (daily, in some cases) during the POM development phase and on an as-needed basis throughout the remainder of the PPBS cycle. Each PDP is monitored and kept up to date by a designated PDP monitor on the Air Staff. The PDP monitor is therefore slated to play a major role in implementing the Initiative. Also the Assistant Program Manager for Logistics (APML) is slated to play an important role in determining and reporting the requirements for the system.

In the Army the main data source for the trial reviews was the Functional Program Decision Increment Package (FPDIP) system. This system is an expansion of the PDIP system used in Army programming. Weapon system PDIPs in general contain program-associated R&D, Procurement and O&S funding. Functional PDIPs include funding for Associated Support Items or Equipment (ASIOE) as well. The FPDIP could be a useful source of much of the Initiative #30 data, but it is not yet entirely automated nor does it cover all weapon systems of interest. For the FY85-89 POM, critical items of ASIOE were identified by the Army staff and included as nonadditive memorandum entries to the nine weapon system PDIPs required for Initiative #30.

For the development of the POM 85-89 support data, the Army has modified the Modernization Resource Information Submission (MRIS), a document that provides the OMA (Operations and Maintenance, Army) and MCA (Military Construction, Army) input to the PDIP. The modification requires the use of standard cost element definitions and identifiers by all of the Army Major Commands, and should make it easier to use the automated MRIS data base in implementing Initiative #30.

The Army also has a number of long-range initiatives under way to identify and establish Integrated Logistics Support (ILS) funding needs in terms that are directly relatable to the Army program and budget. An effort is being made to assure that these Army initiatives and Initiative #30 are consistent and mutually supportive. If successful, the Army implementation of Initiative #30 as well as the Army's internal management of ILS will be greatly strengthened.

Because the Army long-range initiatives are not yet precisely defined, the specific responsibilities for implementing Initiative #30 have not yet been formally assigned.

The source for the Navy's Initiative #30 data will be the Navy's new ILS assessment program (Reference 4). The ILS assessment program involves three steps. First, project offices are responsible for recording the support resource requirements for their system in the ILS Resource Requirements Format (ILSRRF). The Logistics Assessment Sponsor (OP401) then evaluates these requirements and determines what funding has been programmed by the Navy Resource Sponsors to meet the requirements. Finally OP401 acts as a proponent for the support funding during the resource allocation deliberations which eventually lead to the Navy POM. The Navy plans for the Initiative #30 requirements data to be extracted from the ILSRRF, and for OP401 to provide the Initiative #30 funding data on the basis of program decisions. The data systems, such as the

ILSRRF, which support the ILS assessment program are not now automated. It is also not clear how the procedure and data will be linked to the budgeting phase of the Navy PPBS.

Based on the above findings, we conclude that the Air Force has a workable system in place for identifying the necessary Initiative #30 support data. The system is tied into the Air Force's internal data systems used for the programming and budgeting process, and responsibilities for making the system work are well-defined and reasonable.

The Army FPDIP is a possible source for Initiative #30 data but the system is not yet fully mature. Further, while the FPDIP is linked to the programming system, a more direct link to the budgeting system needs to be established. A number of other longer-term improvement efforts are under way, which should eventually contribute to Initiative #30.

The Navy ILS assessment program is a good first step toward identifying Initiative #30 requirements and funding. The process is not automated and will require substantial manpower to make it work. In addition, the link to budget development needs further definition. Responsibilities in the programming phase have been assigned and are reasonable.

As a final observation, the initial Service difficulties in developing weapon support information, as noted during the Initiative #30 trial, were a cause for concern beyond the limitations they placed on the OSD review. The more serious concern is that an inability to identify and track support resources during internal Service PPBS deliberations reduces the chances of producing balanced program and budget proposals. Service progress in improving their internal ability to develop timely and accurate Initiative #30 data, therefore, can be viewed as progress toward improved POM and budget development.

Involving the Program Manager

A major goal of the original Initiative was to give the Program Manager better visibility of and a stronger role in the resource allocation decisions that affect support for his weapon system. It was felt that, in this way, Program Managers could act more effectively as advocates for full support of their systems.

Program office personnel, formerly not involved in overall support issues during the PPB process, have in some cases already benefited from involvement in the Initiative #30 trials. One of the benefits cited was simply that of periodically bringing together all support resource requirements and funding. This produced a clearer appreciation for the extent to which the ultimate success of a program depends on resources controlled by others. Increased communication with other offices controlling these resources was also cited as a major benefit. In two program offices for weapon systems that were at an early stage of acquisition, the personnel responsible for logistics felt that early formal identification of all support resources requirements would help to ensure that explicit consideration was given support needs during subsequent resource deliberations. It could also deter shifting of program funds from support to other portions of the program.

In terms of specific procedures to involve program managers more in support resource decisions, the Air Force plan specifically identifies the assistant program manager for logistics (APML) as the key person in the implementation. Headquarters, Department of the Army, plans to provide the Program Offices with a "final report" of support funding status when the submissions are made to OSD. In the Navy, Program Managers will be informed of what is happening to support resources by means of the ILS assessment program. The prime Navy focal point will be the Logistics Resource sponsor (OP-04), who is considered a major advocate for support in the Navy.

OSD RESPONSIBILITIES

As part of Initiative #30, OSD was required to conduct a single, integrated review of support associated with individual weapon systems during key stages of the PPB process. The actions taken as a result of the trial reviews at OSD did affect the resource allocation process. For example, an issue paper was written to correct a shortfall that had been identified in the support of the F-18 during the Initiative #30 FY84-88 program review. This issue was considered and acted upon by the Defense Resources Board (DRB) in its POM deliberations. In addition, as a result of the Initiative #30 review of the FY84 budget, a PBD was written to correct a shortfall in F-18 test equipment. That PBD was also acted upon by the DRB to correct the shortfall (References 5 and 6).

The trial reviews have demonstrated, therefore, that it is possible for OSD to evaluate support issues for individual weapon systems in a fashion timely enough to influence resource allocation decisions during POM and budget reviews. It was also shown that the procedures used made it possible to identify specific shortfalls in support resources for individual weapon systems. Previously the systematic identification of weapon-system-specific support issues had not been possible.

The support issues identified during the test period, however, were limited to those highlighted in the Service data submissions where requirements were shown to be greater than funding. The OSD staff did not identify any

issues based on its own independent evaluatic or verification of the support data provided by the Services. One reason was the limited participation of some of the key functional offices. Because of this the ability of OSD to independently identify issues or verify requirements across all nine categories was not demonstrated.

The focus and staff effort within OASD(MRA&L) during program and budget reviews is almost totally concerned with functional issues involving the Military Departments' supply system, transportation system, training base, maintenance system, etc. Therefore, during the trial review the effort applied to evaluating the adequacy of these support functions for individual weapon systems was extremely limited. While generic functional issues are of great importance and must continue to be treated, it is our belief that a more balanced review process, including increased attention to weapon systems, would be more productive and more effective. Initiative #30 requires OSD to conduct integrated reviews of individual weapon support data at key points in the PPB process; it also provides OSD an opportunity to rebalance its review and evaluation efforts and place more emphasis on weapon systems.

We believe more attention to specific weapon systems within all functional OASD(MRA&L) staff offices would be beneficial for three reasons. First, it would assure that the functional expertise within OSD is more effectively brought to bear on important, technical support issues. Second, there are few major support issues of concern to OSD that are limited to one functional area. The increasing interdependence of supply, maintenance, training and test equipment, and the opportunities for tradeoffs among these areas means that support issues are generally system issues. Finally, a stronger weapon system perspective would help provide a link between support resources and military readiness, the "bottom line" of DoD output. Generic support functions are of no value in and of themselves; their value can only be measured in terms of how well they support weapons and forces in carrying out their missions. Ultimately, a weapon system focus is necessary to evaluate and balance the sum total of support resources.

SUMMARY OF FINDINGS

The procedures tested in the trial reviews were successful and beneficial. They demonstrated that the two basic steps required to meet the management goal of Initiative #30 were feasible. Specifically, the necessary support resource data on requirements and funding for specific weapon systems can be identified, and these data can be used by OSD to influence the resource allocation decisions made during the PPBS cycle to help balance the support programs for selected weapon systems.

The success of the trial reviews was qualified, however, by the difficulty the Army and Navy experienced in developing the necessary data, and the limited ability of OSD to independently validate the support requirements. The following recommendations address these deficiencies and define how to move from trial procedures to final implementation.

RECOMMENDATIONS

To make it possible for DoD to carry through the management intent of Initiative #30, to identify the support resources required by specific weapons and to influence the resource allocation process so that balanced support resources are made available, we recommend that:

(1) the Initiative #30 process be continued and the procedures used in the trial reviews be formalized and implemented in future PPB cycles.

To take full advantage of this action, we also recommend that:

(2) OSD strengthen its weapon system perspective so that it can more effectively review and validate weapon-system-specific support requirements; and

(3) OSD monitor the progress of the Military Departments in completing and acting upon their plans to improve their internal management of weapon systems support.

Implementation should ultimately result in more effectively supported weapon systems and greater readiness in the field than is achieved by the present management system.

Procedures

The procedures that we recommend be formalized are those that were included in the FY85-89 POM Preparation Instructions (PPI) and those used during the FY84 budget review. The procedures specify the weapon system support requirements and funding data to be provided by the Services to OSD, the categories in which the data should be supplied, and when the data should be provided. Trial reviews have shown the procedures to be workable and to provide useful and timely information.

OSD Weapon System Perspective

OSD should strengthen its weapon system (vice functional or appropriation) perspective in order to use the information provided by Initiative #30 to the greatest benefit. To do so will require functional offices within OASD(MRA&L) to concentrate more time and effort on specific weapon system support issues than they have in the past. We recognize that

expending more effort on specific weapon systems requires either more staff or a reallocation of existing staff effort. However, we believe such an adjustment will ultimately benefit not only OSD's Initiative #30 effort, but also its overall review and evaluation responsibilities.

Service Implementation Plans

OSD should monitor the progress of the Military Departments in completing and acting upon their implementation plans. At the time of our evaluation, none of the Military Departments had a final, workable implementation plan. The Air Force did have a draft plan that was well structured and appeared workable; if its final plan contains the elements of the draft plan, it will satisfy the intent of Initiative #30.

OSD should require periodic updates of the Military Departments' implementation plans until final, workable versions are completed.

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ADP002809

PROJECT: ACQUISITION STRATEGY

William D. Majewski, Corpus Christi Army Depot

ABSTRACT

A point of view, acquisition support for the Army depots--The depots rely upon major systems, i.e., major commands (MAJCOMs) and Defense Logistics Agency (DLA) to support their mission by providing approximately 80 percent plus of their logistics needs. What this paper is concerned about is the apparent delay in response time that the major systems provide for the depots.

The lack of timely/responsive support for the depots may not totally be the fault of the major acquisition systems; however, the following are problems that thwart the acquisition strategy of acquisition planning.

- Cost to commercial firms
  - Manufacturing costs involved in anticipation of sales
  - Inventory costs involved in anticipation of sales
  - Money costs
    - Interest
    - Loss of capital for expansion, investment, and daily operations.

As a result of the above costs, industry firms no longer manufacture and stock items in anticipation of sales; they cannot afford to. NOTE: The practice of stocking in anticipation of sales was commonplace ten years ago, but not now.

How can the government be more responsive to Department of Defense industrial based activities (depots and arsenals)?

Is centralized procurement a way of the past?

Why has the dollar expenditure of the depot procurement offices increased 300+ percent in the past three-plus years, and is the growth rate going to continue at this dramatic rate?

Each of these questions are evaluated and answered.

INTRODUCTION

This paper describes a concept that is being observed with skepticism and an unwillingness to change that pervades throughout the management levels of the major procurement communities. This paper will discuss the trends of the outlying smaller procurement offices that directly support production facilities in the United States Army. The growth in central procurement that is evolving haphazardly is causing confusion throughout the procurement field.

The principal elements that play a major role in this concept include, but are not limited to, delivery time, lead time, and general responsiveness on the part of the government; and speculative stocking, delivery time, lead time, cash flow, and investments on the part of the contractors/sellers. All of these elements play a formidable role in the recommendation to decentralization. This paper will discuss each of these items and will provide an explanation where the elements have a staggering effect upon the readiness and hence responsiveness of the military.

The case studies to be covered in this paper will include Local Purchase Economy, Raritan Arsenal, Joint AMSAA/TARCOM Procurement Manpower Study, and an Audit of Procurement Related Functions. Although the elements used in all three cases are similar, there are particular differences in terms of the types of procurement method studied.

The technique to overcome the problem of haphazard growth in central procurement will heretofore be described as the Class "A" concept. The decisions leading up to this concept and firsthand observations will be discussed in detail.

DESCRIPTION OF COMMODITIES

At this point an explanation into the commodities that are evolving into decentralization will be discussed. The hardcore production/maintenance line items that support the production lines, which have proven to be nonforecastable or impractical to plan for are affected. The need for the items by the requisitioners is immediate and the response by MAJCOMs may be termed tentative. The role which can be played by a functional element in the procurement community that can hopefully provide an objective analyses will be outlined. Finally, recommendations for implementation of the Class "A" concept regarding the application to future programs and the outcome, if it is not applied, will be discussed.

OVERVIEW

A Need Exists to Effectively Support the Military Production/Maintenance Based Industrial

Facilities on a Timely Basis: During the last decade, DOD has become aware of the challenge to reduce unit acquisition costs, increase readiness, and achieve military performance. The trend has been to attempt to centralize procurement when all indicators point to a decentralized atmosphere of the aforementioned items.

Economics of Scale: Economics of scale come into play, however, and one would assume that there would be a point at which one would want to centralize procurement. But when the system becomes too slow, and is not responsive to the needs/requirements of a manufacturing or operable activity, and production is affected and operating units are shut down, a look at the bureaucratic system from an upward point of view is necessary, and a point of centralized inefficiency, therein, has been attained.

One may assume that the "Peter Principle" pervades throughout government procurement and centralization occurs to a point whereby procurement becomes inefficient. This is the foundation of the Class "A" concept. What are some of the indicators of the Class "A" concept?

- Extensive lead time from point of award far beyond the forecasted time frame.
- Unmotivated negotiators
- Delivery times and or lower unit prices excelled by a subordinate procurement activity after a major procurement activity had placed orders for the same material, and in some cases, from the same manufacturer/supplier
- Unwillingness, passiveness, or ineptness on the part of the buyers/administrators at the centralized activities to negotiate:
  - Quicker deliveries due to a change in priorities
  - Diversion of deliveries to alternate points due to a change in priorities.

Why is the Class "A" concept allowed to continue? The answer is quite simple. There is no incentive in government to decentralize. Quite the contrary the incentives are to centralize, because the more personnel under one command the higher the personnel grades, and greater numbers provide security. To decentralize would mean to destroy a base that took many years to create and hence a reduction in personnel grades and security. To further complicate the problem, the top levels of management would have to acknowledge that the Class "A" concept has been allowed to perpetuate and therein their management practices has been less than adequate. An environment must be created to decentralize a procurement operation to attain maximum efficiency.

Class "A" concept - There is/must be a point wherein optimum efficiency in procurement is attained. Beyond that point, additional personnel create a negative result.

Relationship of Optimum Efficiency Sizes in Private Industry to Government Procurement: This relationship must of course then take place and then postulates must be defined to achieve optimum efficiency.

- Local Purchase Economy - This study was concerned with determining the point that it would be more economical to procure an item centrally than continue to procure it locally. A computation of cost formula was presented and recommended as a standard guide for computation to determine when a local purchase item should be returned to central procurement. (This study was prepared by Raritan Arsenal, now inactive.) The problems occurring at MACOMs, however, are such that transfer from local procurement to central procurement is impractical. The following are problems that thwart the acquisition strategy:
  - Costs to commercial firms
    - Manufacturing costs involved in anticipation of sales
    - Inventory costs involved in anticipation of sales
    - Money costs
      - Interest
      - Loss of capital for expansion, investment and daily operations.

As a result of the above costs, industry firms no longer manufacture and stock items in anticipation of sales; they cannot afford to. Note: The practice of stocking in anticipation of sales was commonplace 10 years ago, but not now. How can the government be more responsive to Department of Defense industrial based activities (depots and arsenals)? Is centralized procurement a way of the past? Why has the dollar expenditure of the depot procurement offices increased 300+ percent in the past 3+ years, and is the growth rate going to continue at this dramatic rate? Each of these questions must be evaluated.

- Joint AMSAA/TARCOM Procurement Manpower Study - This report describes a quantitive methodology, developed jointly by personnel from the USA Material Systems Analysis Activity (AMSAA) and the US Army Tank Automotive Readiness Command (TARCOM) for estimating the manpower needed to perform a command's central procurement activity workload. Conclusions attained were that the current trend of an increasing backlog of procurement actions, impacts the material readiness of the Army by causing slippage in obligations against that planned. Furthermore, the study indicated that without significant amounts of overtime, adequate personnel are not available to perform the simplest procurement operations workload. The backlog that was attained in the aforementioned study highlighted the significance of the material readiness posture of the Army, and that is the major thrust of this paper. By continuing to centralize, the staff elements at many major commands become so methodical and reluctant to change, that initiative and reaction to the simplest reflex action becomes a cumbersome nonproductive movement. It is well known that the PALT (procurement administrative lead time) at many procurement activities varies greatly. But, what is the actual time in calendar days needed to effect an award from date of receipt of the requisition? The calendar days may range from 1-1½ years, but the PALT time may only be 120 days. How does the actual calendar days at one procuring activity compare to another procurement activity? PALT may then be not a true indicator. How well a procuring activity operates, on the average, could simply be plotted on a chart by showing the average calendar days to effectuate an award through a procuring activity. When that point is attained, growth in personnel should be immediately halted, and another procuring activity should be created.

- Audit of Procurement-Related Functions, Defense Industrial Supply Center - This audit presented the results of an audit of selected procurement-related functions at the Defense Industrial Supply Center (DISC). The objectives of the audit were to:

  - Determine the causes for the high volume of small purchase awards processed manually
  - Evaluate center controls over receipt data for fast payment awards
  - Analyze the procedures used to adjust procurement lead times (PLT) in the supply records.

  The principal concern of this audit was the second objective above. The adjustments made at most procurement activities are made to satisfactorily achieve PLT. Almost all goals can be attained through manipulation of the computer system. The only outcome, therefore, is to measure input and output from a procuring activity via calendar days. The only objection put forth would be the type of commodities obtained. This is a valid point. On the average, however, everything should even out, and the number of calendar days needed to effect an award should correlate to other procuring activities if one takes into account the various categories, i.e.:

  - Dollar thresholds
  - Priority
  - Sole source
  - Specifications/availability
  - Funding
  - Etc.

CONCLUSION

As long as a major procuring activity remains, and by organization it must remain, one, two, or three steps removed from the requisitioner, the response and hence urgency of need will not be passed on to the buyers. A buffer is effected by each level that a requisition passes through. To complicate matters, the major procuring activities grow, and continue to grow in personnel strength without recognizing the inefficiencies created. The Class "A" concept must be recognized. There must be a point wherein optimum efficiency in procurement is attained. Beyond that point, additional personnel create a negative result.

The current method of using PALT or PLT as an evaluative criteria for procuring activities is questionable. Recommend the usage of calendar days from date of receipt to determine the effectiveness of a procuring activity. When the average days, for example 200 days, are exceeded the commodities procured should be reduced and another procuring activity, from scratch should be created. There is, and must be a point at which centralization is inefficient, and therefore, must be recognized.

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NOTE:

MUCH OF THE INFORMATION IN THIS PAPER IS THE RESULT OF THE AUTHOR'S PERSONAL EXPERIENCE WHILE WORKING FOR THE CORPUS CHRISTI ARMY DEPOT AND ARRCOM AND SHOULD NOT BE CONSIDERED A STATEMENT OF US ARMY POLICY.

MARKET RESEARCH AND ANALYSIS

Panel Moderator: Mr. Leroy J. Haugh
Associate Administrator
Office of Federal Procurement Policy
Office of Management and Budget

Papers:

Large Firm Efficiency, Concentration, and Profitability in Defense Markets
by Robert F. Allen

Export Trade: Big Business for the Small Entrepreneur
by Jeanne M. Colachico

Tactical Buying Decisions for Strategic Petroleum Reserve Spot Procurements: The Tunnel Theory
by Lawrence C. Ervin

ADP002810

LARGE FIRM EFFICIENCY, CONCENTRATION, AND PROFITABILITY IN DEFENSE MARKETS

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ABSTRACT

This paper attempts to quantify the relative impacts of large firm efficiency and market power on profit margins in defense industries. The methodology employs a direct measure of firm efficiency together with a conventional measure of market power. Large firm efficiency and the effective use of market power appear to be generally present in industries characterized by decreasing costs. However, the basic defense industries - aircraft, missiles, ordnance, and shipbuilding - are notable for the absence of large firm efficiency and the absence of effective use of market power by leading firms.

INTRODUCTION

A significant, positive association between concentration and profitability is perhaps the most widely reported statistical relationship to be found in the literature of industrial organization [16]. According to conventional oligopoly theory, this reflects the ability of the leading firms in concentrated markets to collude tacitly or explicitly.

Some economists, most notably Harold Demsetz [6,7] have challenged the conventional view. Demsetz argues that it is the superior efficiency of large firms which results in both high concentration and high profits. He supports this argument with evidence, replicated by Round [12] and Carter [3], that concentration increases the profits of large firms but not small firms. If the firms in an industry are equally efficient, effective collusion should raise the profits of small and large firms alike. The fact that it doesn't strongly suggests that efficiency, concentration, and profits are interrelated in American manufacturing.

In a recent paper, Allen [1] quantified the relative impacts of efficiency and concentration on industry profit margins for a broad cross-section of American manufacturing industries. He found that concentration adds six to seven times more to industry profit margins than does large-firm efficiency. Allen concluded that the effective use of market power by leading firms is the dominant influence in the widely reported association of concentration and profitability.

This paper extends the analysis of the Allen paper to 29 defense-related industries. The purpose is to test the general presumption that ignorance and/or mismanagement on the part of the Defense Department has led to industrial structures in the defense sector of the economy which are particularly inefficient and subject to the abuse of market power by defense suppliers.

REGRESSION MODEL

The relative roles of efficiency and market power may be estimated in the context of the traditional structural performance model [16, 10, 8, 9]. In particular, we may take as the basic model:

$$PCM = f(C_4, NCO, KO, DISP, CDUM, GROW) \qquad (1)$$

where all variables are defined in the usual manner; namely:

- PCM = price-cost margin calculated as value added minus payroll, divided by value of shipments [13].
- C_4 = four-firm concentration ratio [13].
- NCO = number of companies in the industry [13].
- KO = capital-output ratio to account for interindustry differences in capital intensity. It is calculated as the gross book value of fixed assets divided by value of shipments [13].
- DISP = a geographical dispersion index to capture the effect of widening markets on price competition [13].
- CDUM = a dummy variable to account for systematic differences in advertising expenditures. It is equal to one for consumer goods industries and zero for producer goods industries.
- GROW = an industry growth measure defined as the percentage change in industry shipments between 1967 and 1972 [13].

This model is extended by introducing a direct measure of the relative efficiency of large firms into the model. To capture the relative efficiency of large firms, one needs an esti-

The views, opinions, and/or conclusions in this paper are those of the author and should not be construed as a Department of Defense, United States Air Force, or other Government agency official position.

mate of large and small firm average costs. The latter may be obtained from concentration ratio data on value added per employee in the manner suggested by the work of Caves et al [4], Miller [11], and Brush [2]. In particular, one can calculate

CAR = a measure of the cost advantage of the four largest firms relative to the next largest four firms. It is calculated by dividing the average value added per employee of the largest four firms by the average value added per employee of the fifth through the eighth largest firms [13].

As a measure of relative efficiency, this variable is subject to a number of potential limitations. The chief ones are that intraindustry productivity differences may be offset by intraindustry in wage payments and/or the value added measure of output for the largest firms may be inflated due to the presence of group specific market power. The following tests suggest that, though real, these limitations do not seriously undermine the usefulness of CAR as a measure of relative firm efficiency.

As discussed more fully below, the data base consists of 307 four-digit industries from the 1972 Census of Manufacturers. The relationship between the variable CAR and employee wage payments may be estimated directly from the 1972 census data. To do so, one calculates the ratio of wage payments per employee of the largest four firms to the fifth through eighth largest firms (PAY) and regresses the log of PAY onto the log of CAR. As expected, intraindustry differences in wage payments are significantly positively related to intraindustry productivity differences, as the following equation shows:

$$LPAY = .059 + .192LCAR \quad \bar{R}^2 = .112 \qquad (2)$$

$$(6.175)\ (\ ) = \text{t-value}$$

A ten percent increase in the relative productivity of large firms implies an increase in relative wages of less than two percent. This leaves much of the productivity improvement to lower costs.

The impact of market power on our measure of cost differences is a more complex matter. Greater value added may indicate lower costs due to economies of large plant size and/or vertical integration by larger firms. However, it may also reflect the ability of firms with market power to sell their output at higher prices. To check on the possible influence of market power on CAR one may regress the latter on measures of market power (C_4), average plant size (S), and vertical integration (VI). All variables are ratios. Average plant size is calculated as the ratio of value of shipments per plant for the four largest firms to that of the next four largest firms. Vertical integration is calculated as the ratio of each group's average value added per dollar of shipments. All data are from the 1972 Census of Manufacturers [13].

The simple correlations among the logs of the variables of interest are:

	LCAR	LVI	LS	LC_4
LCAR	1.00	.38	.33	.26
LVI		1.00	.07	.06
LS			1.00	.46
LC_4				1.00

Costs are correlated with market power, vertical integration, and average plant size. However, plant size and market power are highly correlated, which makes it difficult to assess their relative statistical significance.

Market power and average plant size explain about 12 percent of the variability in costs, as equation (3) shows:

$$LCAR = -.227 + .123LS + .076LC_4 \quad \bar{R}^2 = .118 \qquad (3)$$

$$(4.283)\ \ (2.319)\ (\ ) = \text{t-value}$$

Both variables are significant at the one percent level suggesting that market power is contaminating our measure of efficiency. Adding vertical integration, the results for the complete model are:

$$LCAR = -.214 + .488LVI + .113LS + .070LC_4 \quad \bar{R}^2 = .243 \qquad (4)$$

$$(7.040)\ \ (4.268)\ \ (2.307)\ (\ ) = \text{t-value}$$

Vertical integration is highly statistically significant and its addition to the model more than doubles the explanatory power of the model. Both average plant size and market power remain statistically significant. Market power is apparently influencing our measure of costs. However, it is hardly the dominant influence and CAR appears to be a serviceable measure of the relative efficiency of large firms.

Industry price-cost margins should be positively related to the measures of large firm efficiency (CAR) and market power (C_4). The number of firms (NCO) should be negatively related to profit margins unless market power gives rise to a significant umbrella effect. Capital intensity (KO) and the geographical index (DISP) are defined in such a manner that their expected signs are positive and negative, respectively. The sign of the growth variable is ambiguous. Growth is likely to be associated with larger price-cost margins. However,

extreme growth may reduce profitability or firms may sacrifice profits to achieve growth.

REGRESSION RESULTS

The model is applied to data from the 1972 Census of Manufacturers. Of the 451 industries comprising the census, 60 denoted "miscellaneous" or "not elsewhere classified" were deleted as not conforming to reasonably well defined economic markets. Eighty-four additional industries were deleted due to the lack of data on capital intensity, margins or concentration. The basic sample therefore consists of 307 four-digit census industries.

In addition to this broad cross-section of American manufacturing for which data are relatively reliable, the analysis focuses on a subset of 29 defense-related manufacturing industries. These industries are identified from Commerce Department records on Defense Department final demand for goods and services for 1979 as recently published by Degasse [5].

Table I lists the top 11 manufacturing groups serving the Defense Department in 1979. These 11 manufacturing groups account for almost two-thirds of total DoD demand for goods and services, with the top five groups--aircraft, communications, missiles, ordnance, and shipbuilding--accounting for 83.5 percent of this. These five groups are heavily dependent on sales to the Defense Department, with from 40 to 65 percent of their group sales going to DoD. Four-digit census industries from these five groups are denoted primary defense industries. Industries from the 11-group total are referred to as defense-related industries. There are nine of the former and 29 of the latter for which complete census data are available.

Table I. Top Eleven Manufacturing Groups Serving the Defense Department - 1979

Industry Group	1st Demand (Millions of Dollars)	% of DoD Total	% of Industry Total
Aircraft	11754.2	19.0%	39.6%
Radio & Comm Equip	10795.9	17.4	51.8
Missiles	4277.0	6.9	58.2
Ordnance	3747.6	6.0	65.0
Shipbuilding & Rep	3424.5	5.5	50.4
Motor Vehicles	1744.5	2.8	1.5
Industrial Organic & Inorganic Chems	1269.5	2.0	16.2
Petroleum Refill & Related Products	1106.3	1.8	3.4
Computers & Per Equip	1046.7	1.7	4.6
Optical & Photo Equip	802.7	1.3	5.0
Scientific & Controlling Instruments	736.9	1.2	9.8
11 Group Total	40705.8	65.7	NA
DoD Total	61970.7	104.0	NA

Source: Adapted from Robert W. Degrass, Jr., "Military Spending and Jobs," Challenge, July/August 1983, p 10.

The regression results for the 29 defense-related manufacturing industries are compared with those for the large cross-section of American manufacturing industries in Table II. Equation 1a fits the conventional structure-performance model to the data for all manufacturing. The statistical results compare favorably with those reported by others [8,9]. The estimated value of the concentration coefficient indicates that a 10 percentage point increase in concentration will raise profit margins by less than one percentage point. This modest role for concentration is typical of the results obtained with conventional structural models. As shown in equation 2a, concentration plays no role in the profit margin behavior of the 29 defense-related industries.

Equations 1b and 2b add the measure of large-firm efficiency to the model. It is highly statistically significant in both the defense-related and all manufacturing populations. The efficiency coefficient is almost two-thirds greater in the panel of defense-related industries than it is for all manufacturing industries. However, the estimated coefficients for large-firm efficiency do not suggest an economically strong role in either population. An increase in large-firm efficiency of 10 percentage points will raise profit margins by 1 percentage point in defense-related industries and perhaps one-half that in manufacturing in general.

Quite a different picture emerges when one looks closer at the set of industries characterized by significant large-firm efficiency. To identify these decreasing cost industries, the efficiency variable (CAR) was specified as a dummy variable for firm cost differences of various magnitudes. For example, the efficiency variable is set equal to one for industries wherein it departs from unity by five percent or more; otherwise it is set equal to zero. If five percent is a significant difference in costs between the large and small firms, the dummy variable should be significantly positively related to industry profits; otherwise it is not. Tests were performed on cost differences of 5, 10, 15, and 20 percent and the critical value of the efficiency variable found to be 15 percent. All industries wherein the efficiency variable equals or exceeds 115 are thus identified as decreasing cost industries.

As is shown in equations 1d and 2d of Table II, large-firm efficiency and market power apparently coalesce in manufacturing markets. Both variables are statistically significant. However, increased concentration of sales in the hands of the top four firms adds 3 to 5 times more to profit margins than does a similar

Table II. Regression Analysis of the Effect of Efficiency and Concentration on Profit Margins in Defense and Nondefense Industries

	C_4	CAR	NCO	KO	DISP	GROW	CDUM	R^2	$\bar{R}^2$	N
				All Manufacturing Industries						
1a	.093 (3.546)[a]		.001 (1.816)[c]	.080 (3.981)[a]	-.031 (1.916)[c]	-.088 (-.569)	2.369 (2.022)[b]	.114	.096	307
1b	.057 (2.167)[b]	.063 (4.953)[a]	.001 (1.856)[c]	.089 (4.561)[a]	-.037 (-2.326)[b]	-.010 (-.787)	2.118 (1.874)[c]	.181	.162	307
1c	.164 (4.716)[a]		.003 (2.665)[a]	.075 (2.659)[a]	-.048 (2.199)[b]	-.020 (-1.119)	4.746 (3.139)[a]	.253	.217	132
1d	.142 (3.996)[a]	.041 (2.202)[b]	.002 (2.558)[b]	.080 (2.857)[b]	-.050 (2.362)[b]	-.015 (-.843)	4.425 (2.957)[a]	.281	.240	132
				Defense-related Industries						
2a	.134 (1.080)		-.000 (-.007)	.098 (2.050)[c]	.023 (.317)	.094 (2.038)[c]	NA	.320	.170	29
2b	.140 (1.301)	.102 (2.931)[a]	.000 (.085)	.092 (2.218)[b]	.877 (.141)	.060 (1.441)	NA	.510	.370	29
2c	.435 (2.723)[b]		.008 (1.098)	.102 (1.673)	-.099 (-1.247)	.041 (.266)	NA	.632	.467	15
2d	.382 (2.743)[b]	.083 (2.061)[c]	.007 (1.224)	.095 (1.808)	-.088 (-1.288)	.008 (.165)	NA	.760	.580	15

NA = not applicble. Figures in parentheses are t-values. Significance levels of the coefficients are: [a]1% level; [b]5% level; [c]10% level.

increase in the relative efficiency of the largest firms. In the case of the defense-related industries, a 10 percentage point increase in concentration implies an increase of 3.8 percentage points in profit margins. A similar increase in large-firm efficiency would raise profit margins by less than 1.0 percentage points.

These results suggest that large-firm efficiency, which rests in part on large-size plants and extensive vertical integration of production facilities, supports significant barriers to market entry by smaller firms. This allows the leading firms in decreasing cost industries to elevate prices well above the levels implied by their relative efficiency.

Five industry groups--aircraft, communications, missiles, ordnance, and shipbuilding--are heavily dependent on defense sales and collectively account for 83.5 percent of total DoD demand for manufactured goods. Mean values of profit measures and structural variables for the nine four-digit defense industries from these groups are compared with those for broader manufacturing groupings in Table III.

The primary defense industries differ significantly from all manufacturing industries in ways that are generally well known. In particular, the defense industries are considerably more concentrated than is all manufacturing with an average concentration ratio of 54.1 percent compared to 42.1 percent for all manufacturing. During the period 1967-1972, primary defense industries have generally experienced negative sales growth while all manufacturing sales rose an average of 32.4 percent. And profitability in the primary defense industries is either higher or lower than that of all manufacturing, depending on whether one focuses on the return on assets (ROA) or the profit margin (PCM).

What is new in the data of Table III, and perhaps surprising, is the general absence of large-firm efficiency in the primary defense industries. The highest efficiency index for the group is the 118.7 for the communications industry. Five of the nine industries have efficiency indexes below 100, indicating that the top four firms in those markets are less efficient than the second largest four firms.

If significant cost savings generally require an efficiency index of 115 or more, the poor price performance of basic defense industries in recent years may reflect the relatively low productivity of the largest firms in these industries. Further, though large-firm efficiency is generally absent within the basic defense industries, profit margins vary considerably among these industries. The statistical analysis which follows suggests that the relative efficiency (inefficiency) of the

Table III. Mean Values of Selected Variables for Defense and Nondefense Manufacturing Industries

Industry Group	ROA*	PCM	CAR	C_4	KO	GROW
Primary Defense						
Aircraft (3)	67.3	24.9	107.6	33.0	.37	-18.7
Communications (1)	83.4	24.2	118.7	19.0	.29	6.8
Missiles (3)	88.2	30.2	101.4	70.0	.34	-23.3
Ordnance (1)	57.0	18.8	75.0	54.0	.33	-30.5
Shipbuilding (1)	37.5	14.0	87.9	47.0	.37	30.3
9 Primary Defense Industries	70.3	24.6 [6.0]	100.9 [16.0]	54.1 [18.5]	.35 [.08]	-13.3 [21.4]
29 Defense-related Industries	63.8	30.6 [9.7]	119.9 [43.6]	51.7 [16.2]	.48 [.38]	23.9 [7.1]
307 Manufacturing Industries	68.5	27.4 [9.2]	117.5 [40.0]	42.1 [21.3]	.40 [.27]	32.4 [37.3]

( ) indicates number of 4-digit census industries in group

[ ] indicates standard deviation

* indicates gross return on depreciable assets. This measure is the product of the gross profit margin (PCM) and sales per dollar of depreciable assets (1/KO).

largest firms in these markets has much to do with this result.

The statistical results for the primary defense industries are reported in Table IV. The measure of geographical dispersion (DISP) is omitted from these regressions due to the dominance of a single buyer in the primary defense markets. Such a measure is included in the conventional structure-performance models to capture the effects of widening markets on price competition. With a single buyer, namely DoD, there is a single market and it is national in scope. Thus DISP lacks a theoretical basis in this setting.

Simple correlations between the structural variables and profit margins are shown in rows 1a and 1b and the regression results in equations 2a-c and 3a-c of Table IV. The number of observations is small, collinearity among the variables fairly high, and statistical significance difficult to establish. For example, the simple correlations between the efficiency variable (CAR) and other structural variables are of the order of .40 to .50 while the correlation between C_4 and NCO is .88. The estimated coefficients are, however, quite stable and the results do suggest that large-firm efficiency (inefficiency) is an important factor in the profit margin behavior of basic defense industries.

Large-firm efficiency and sales growth explain about two-thirds of the variation in profit margins among the nine primary defense industries. The negative sign on the growth variable is consistent with the results reported for all manufacturing in panel one of Table II. Seven of the nine defense industries had negative growth. The exceptions were shipbuilding and communications, whose sales increased 30 and 7 percent, respectively. Apparently sales growth depresses profit margins. This conclusion needs to be qualified in view of the strong influence that shipbuilding has on these results. This industry reports the highest sales growth and lowest profit margin of the nine industries in the sample. As shown in equations 3a through 3c of Table IV, removing shipbuilding from the data base reduces both the role of growth and the explanatory power of the model considerably.

The efficiency variable shows a simple correlation of .43 to .51 with industry profit margins and is statistically significant in three of the five regressions shown in Table IV. It is the only variable that retains statistical significance when shipbuilding is removed from the data base. The estimated coefficient indicates that a ten percentage point increase in the relative efficiency of large firms adds from 2 to 2-1/2 percentage points to industry profit margins. This is well beyond the impact of large-firm efficiency in all manufacturing. It suggests that significant improvement in the economic health of the defense base may be possible by identifying and eliminating the source(s) of large-firm inefficiency in these markets.

Table IV. Regression Analysis of the Effect of Efficiency and Concentration on Industry Profit Margins in Nine Primary Defense Industries

	C_4	CAR	NCO	KO	GROW	R^2	$\bar{R}^2$	N
				Sample Correlations of Variables with PCM				
1a.	.04	.51	-.11	-.05	-.69*			9
1b.	-.08	.43	-.10	.05	-.36			8
				Regression Ccefficients				
2a.					-.191 (-2.498)[b]	.471	.396	9
2b.		.193 (2.470)[b]			-.193 (-3.319)[b]	.738	.650	9
2c.	-.038 (-.204)	.273 (2.022)	-.004 (-.439)	.191 (.807)	-.165 (-1.906)	.794	.451	9
2d.	.033 (.384)	.246 (2.295)[c]		.165 (.806)	-.184 (-2.727)[c]	.781	.562	9
				Regression Coefficients Excluding Shipbuilding				
3a.					.117 (-.958)	-.133	.000	8
3b.		.200 (2.040)[c]			-.206 (-1.909)	.527	.337	8
3c	.036 (.258)	.257 (1.848)		.164 (.696)	-.201 (-1.579)	.607	.082	8

Figures in parentheses are t-values. Significance levels of the coefficients are: [a]1% level; [b]5% level; [c]10% level.

CONCLUSIONS/SUMMARY

Large-firm efficiency, high levels of concentration, and the exercise of market power are intermingled in much of American manufacturing. Industries characterized by decreasing costs are especially subject to the influence of market power by leading firms. About one-half of the 27 defense-related industries studied are characterized by decreasing costs. Most of these are from the chemical, computer, and photographic equipment groups. For these industries, a 10 percentage point increase in concentration implies an increase of 3.8 points in industry profit margins. A similar increase in large-firm efficiency would raise profit margins by less than 1 percentage point. Apparently, the cost advantage of the four largest firms in these industries does not extend much beyond 15 percent of the costs of the second largest four firms.

The primary defense industries--aircraft, communications, missiles, ordnance, and shipbuilding--are notable for the absence of large-firm efficiency and the apparent inability of the leading firms to use their positions to elevate profit margins. There is considerable variation in profit margins among these industries and it appears to be related to differences in the relative efficiency of the leading firms. The results suggest that inefficiency on the part of the leading firms in basic defense markets is an important factor in their poor profit performance.

One must be properly cautious concerning these results inasmuch as they are limited to data for a single year and, for the primary defense industries, a small number of observations. Nevertheless, the data presented do suggest that quite different policies may be appropriate for controlling the cost of defense systems, depending on whether one is addressing suppliers of aircraft or suppliers of communications equipment. In particular it may be useful for DoD to examine more closely the efficiency/market power trade-off in various defense markets as well as the sources of large-firm inefficiency in basic defense markets.

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EXPORT TRADE: BIG BUSINESS FOR THE SMALL ENTREPRENEUR

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ABSTRACT

American corporations have, in many ways, been spoiled by their own lucrative and previously expanding domestic markets. The result has been that exporting, to the extent that it occurred, was largely conducted by corporate conglomerates. Although government regulation and trade laws such as the Webb Pomerene Act discouraged many from entering the international marketplace, small businesses themselves similarly limited their own horizons. Today, economic insecurity and the lack of developing domestic markets place an unprecedented demand for small businesses to overcome the fear and unfamiliarity of foreign markets, regulations and customs, the expense, lack of resources and inadequate capitalization which have made exporting previously prohibitive.

Faced with a record trade deficit, President Reagan sought to take an initial step toward encouraging American business participation in the global marketplace by the enactment of the Export-Trading Company Act of 1982. The thrust of the legislation is to remove some barriers which have inhibited US world trade such as the fear of anti-trust violations and lack of investment capital from banks and bank holding companies.

The advantages of including exporting in corporate philosphies can be many for all businesses, but particularly so for the small and mid-sized business. In addition to increased sales, overcoming market saturation and dependence on a single market, exporting can give a competitive edge, increase employment growth and reduce production costs while giving access to new customers and revitalizing the local economy.

The federal government, primarily through the Department of Commerce and the Small Business Administration, has allocated resources and personnel to help the new entrepreneur through the maze of the international arena. However, for the small and medium size business an educational reorientation must also take place to overcome the reluctance of these sectors to become involved in international trade.

The Export Trading Company Act of 1982 can be the first in a series of governmental initiatives which can effectuate a dramatic turn in the American economy and the presence of American business throughout the world. However, a number of other steps need to follow—and follow quickly in order for America to catch up in the international marketplace. With several legislative opportunities for government support of this initial step on the horizon, it will soon be evident whether there is a sincere desire to do what must be done to secure that place. But, catch up we must, for export is good business.

INTRODUCTION

From the days of the Phoenicians and Carthaginians to Marco Polo to the advent of the Yankee Clipper, the world has traded and traded widely. However, lucrative and previously expanding domestic markets have lead many American corporations to forsake the possibilities presented by world commerce for those closer to home. The result has been that exporting was largely conducted by corporate conglomerates.

Although previous legislation, such as the Webb Pomerene Act, did not particularly enhance exporting opportunities for small businesses, there were a number of other factors which similarly discouraged this move. First, and perhaps foremost, American business did not have to look to exporting in order to become successful, unlike its foreign counterparts. Developing domestic markets made it possible to become successful at home. These possibilities coupled with the fear and expense of foreign markets, unfamiliar regulations and customs, and other problems have made exporting prohibitive.

For more than a century, the U.S. federal Government has generally assumed a laissez faire posture toward exporting and discouraged joint venture, feeling trade was the domain of the free enterprise system. During the same years, foreign governments including Japan and West Germany, have actively encouraged exporting.

The situation which has resulted for the American economy is a landmark trade deficit, the spectre of protectionism, and threatened trade wars. The difference in dollar value of products imported from those exported continues to widen with a landmark $180 billion trade deficit forecasted for 1983. There is growing concern that the United States will fall hopelessly behind the trading curve and become completely non-competitive in the international arena. There is also the assurance that drastic measures will be required to reverse this situation.

In an effort to improve this situation and give new opportunities to small and medium-sized businesses, President Reagan signed the Export Trading Company Act of

1982 into law on October 8, 1982. This legislation allowed banks and bank-holding companies to invest in and own export trading companies. Further, it allowed for certification by the Department of Justice against anti-trust prosecution when corporations joined to export.

The import of this legislation is to bring U.S. exports and the American Export Trading Companies in competition with our highly successful Asian and European counterparts. The Japanese sogo shosha and the West German trading companies have been particularly successful and provide models for comparison with the American export trading companies.

The balance of this research will be devoted to an analysis of the ways in which small, medium-sized, and minority-owned businesses can take advantage of the unprecedented opportunities presented by the Export Trade Acts. The benefits which can result from fuller utilization of exporting and proper marketing of the concept are being explored by many. In addition to increased sales, overcoming market saturation and dependence on a single market, exporting can give a competitive edge, increase employment, reduce production costs while giving access to new customers and revitalizing the local economy. Some have theorized exporting can substantially diminish unemployment since each million dollar increase in exports results in the creation of 100,000 new jobs.

The Department of Commerce and the Small Business Administration have developed a variety of programs designed to implement this new legislation and open export opportunities to large segments of the previously excluded American business community. Well-intentioned as these efforts may be, there is some evidence that they are not being fully utilized by their constituents due to less than satisfactory past encounters with those agencies. This presents important responsibilities for the newly-created export trading company.

Finally, this research will explore the variety of services an export trading company can provide for American corporations of all sizes, with particular emphasis on the new life and horizons which can be opened for the small business entrepreneur. Whether by an outside consortium or by formation of an internal export trading company (similar to the to the GE and Sears models), the American business utilizing an export company can expect foreign market research, assistance in carrying out negotiation of trade agreements, arrangements for transportation, insurance, freight forwarding, financing, market analyses and establishment of cultural liaison.

The Export Trading Company Act of 1982 if properly marketed and utilized, can be the first in a series of governmental initiatives which can effectuate a dramatic turn in U.S. product and commodity acquisition since proper acquisition management is crucial to full utilization of imports, their conversion into exportable commodities and adaptation of U.S. goods for foreign consumption. But, many more initiatives are required to secure a meaningful American presence in international trade, and, it may prove significant to analyze the actions which Congress has chosen not to take in resolving these problems as well as the challenges presently on the horizon.

In any event, full utilization of export potential by small and medium sized businesses can result in tangible corporate gains while accomplishing important Government objectives. While the Export Trading Company Act of 1982 is an initial step, many more must follow in order for America to catch up in its trade balance. But, catch up we must, for export is good business for all involved.

PAST PRACTICES AND PRESENT EFFECTS

It is undisputed that the United States is firmly linked with other nations in the global economy by mutually beneficial international trade and indeed it has been so at least since the Industrial Revolution of the 1880's. Indeed, some would trace the awareness of the importance and benefits of multi-national trading to colonial days with the Three-Cornered Trade of slaves, rum and tobacco to the West Indies and Africa.

American export policy has been further fostered by the major role of the United States in rebuilding the economies of both allies and enemies after World War II. Believing that a coherent system for governing trade between nations was essential for world peace, the U.S. initiated the General Agreement of Tarriffs and Trade (GATT), which became the major international forum for trade liberalization and tariff reduction. (1)

It is true that exports now account for more than 16% of the total value of all goods produced in this country. Two of every five acres of farmland produce commodities destined for export, and one of every eight jobs in manufacturing depends on overseas trade for its existence. Indeed, four of every five new manufacturing jobs created in the corporate world today are export-related. (2)

However, the United States may have succeeded in its post-war objectives too well. For, by the mid-1970's, the very countries which the U.S. had rebuilt became our domestic and international competitors.

Despite the involvement of the United States with international trade, its level of involvement falls far from matching the international sales efforts of its leading competitors. Since 1977, the United States has accumulated a trade deficit of more than $154 billion, and 1983 figures are expected to widen that number to more than $180 billion. This has occurred at a time when, in Japan, exports exceed imports by $76 billion. The share of the world export trade held by the United States has steadily decreased since the mid-70s, while Japan, West Germany, the Republic of Korea, and France have substantially increased their share of the world trade market. According to a recent National Governors Association Report, the American decline in world trade stems primarily from institutional problems, rather than from prices or qualitative deficiencies. (3)

Many feel the United States has been basically "out-organized, out-financed, and out-maneuvered" (3) by its world competitors, largely through the successful use of the Sogo sosha and the European trading company. Additionally, American corporations have, in many ways, been spoiled by their own lucrative and previously expanding domestic markets. The result has been that, until recently, 95% of all exporting done from the United States was conducted by 5% of the registered corporations, which are primarily large multinational companies with sufficient overseas networks and expertise for effective and profitable foreign trade endeavors. With 25,000 corporations presently involved in exporting activities, another 30,000 small and medium-sized businesses manufacture products with exporting potential. With only 7% of the U.S. gross national product finding its way into foreign markets (less than half the percentage of our major trading partners), it is clear that the opportunities of small and medium-sized businesses for advancement into the billion dollar a day market of export trade have been limited to domestic opportunities alone. (4)

The status of legislation up to the enactment of the Export Trading Company Act of 1982 did not particularly enhance exporting opportunities for small businesses. One piece of governing legislation was the Webb Pomerene Act. (5) In essense it said, businesses could associate for the purpose of exporting so long as that association did not have the effect of a restraint on the export trade of any domestic competitor. Additionally, the Act imposed extensive reporting requirements to the Federal Trade Commission. Under these circumstances, only the large corporations had the resources to export by themselves. Small, less capitalized companies, did not join with other companies, as would have been necessary to make exporting feasible for them, for fear of anti-trust violation prosecution.

These concerns left some question as to whether the Sherman Anti-Trust Act, which vaguely refers to the illegality of restraints on foreign commerce, would prohibit such associations. Since Webb Pomerene created an exemption from domestic anti-trust laws for U.S. associations exporting goods, it is generally believed that no Sherman Anti-Trust violation exists. However, to avoid costly discovery and litigations, many U.S. businesses chose not to enter into the foreign joint venture arena. (6)

In 1930 the Smoot-Hawley Act enacted the highest protective rates ever and the Reciprocal Trade Agreements Act of 1934 opened the way to lower U.S. import duties. (7)

There were a number of other factors which similarly discouraged the move of small business into exporting. First, and perhaps foremost, American Business did not have to look to exporting in order to become successful, unlike its foreign counterparts. The plethora of developing domestic markets made it possible to become successful and even wealthy without looking beyond American shores. Japan, as an island nation, had to look outside its shores to acquire almost every item needed by its people. The continual history of european land wars, changing borders, and slowly developing economies had the same effects in Europe. On the contrary, the United States, with the Industrial Revolution had developed all the technology needed which, when coupled with rich natural resources, were the fundamental raw materials for a prosperous domestic economy.

These differences were coupled with the fear and unfamiliarity of foreign markets, regulations and customs, the expense, lack of resources and inadequate capitalization which characterizes many small businesses. These factors, when totalled, have served to make exporting prohibitive for the small and medium size business. (8)

The corporate attitude and legislative enactments, were embodied in a federal government policy, which, for more than a century, assumed a laissez-faire posture toward exporting and discouraged joint venture which could result in anti-trust violations, feeling trade was the domain of the free enterprise system. During the same years, foreign governments including Japan and West Germany, have actively encouraged exporting by incentives, public outlays for infra-structure, preferential rates for industrial energy, tax rebates for exports, financial support and protection against imports.

EXPORT TRADING COMPANY ACT OF 1982

In an effort to improve this situation and give new opportunities to small and medium-sized businesses, President Reagan signed the Export Trading Company Act of 1982 into law on October 8, 1982. This legislation authorized the creation of export trading companies which combine previous trading companies and export management companies in one entity. It is the hope of its sponsors that this legislation will attract producers of goods and services, manufacturers, banks, export management companies, freight forwarders and other export service businesses into an effective joint effort to develop foreign markets.

The Export Trading Company Act accomplishes these goals through implementation of a four Title Act which provides for: (9)

1. Establishment of an Office of Export Trade within the Department of Commerce for the purpose of promoting and encouraging the formation of export trading co panies while facilitating contact between producers of exportable goods and services and firms offering export trade services.

2. Title II of the Act sets forth the governing definition of an export trading company as "a company doing business in the United States principally to export goods or services produced in the United States or to facilitate such exports by unaffiliated person(s)". While the definition is intentionally broad, a stricter interpretation of the amount of other activities which may be mixed with the exporting activity in order to still quality as an export trading company, is applied when bank ownership is involved.

3. The Act also, in Title II, gives permission for bank holding companies and banks to invest directly in and extend credit to export trading companies, a practice which had been entirely prohibited under current law. Now, such companies can own up to 100% of an export trading company. Bank of Boston, for example, has done precisely this with the establishment of its own export trading company, World Trade Group.

Further, with Federal Reserve Bank approval, bank holding companies and bankers' banks may invest up to 5% and loan up to 10% of their capital and surplus in an export trading company. Under this process, a bank need only notify the Federal Reserve Board of the intended investment. If no objection is made within 60 days thereafter, the bank may proceed with the intended investment. A bank is exempted from the collateral requirements contained in the Federal Reserve Act for loans to its export trading companies.

Ownership by bank holding companies and other banking entities is important because it gives exporters new avenues for obtaining capital and financing. These banking institutions will also have valuable contacts, communications networks, and expertise that will aid in processing export and foreign exchange transactions, finding markets, and determining the credit worthiness of potential customers. However, with many of the largest banking institutions forming their own export trading companies, many independent export trading companies fear this step may limit the amount of support they can expect from banks for their activities.

4. Title III provides for a Department of Commerce and Department of Justice certification process which certifies that applicants, who wish to engage in export activities, have satisfied the requirements of the bill. This certification procedure grants immunity from prosecution under U.S. Anti-Trust laws provided the export activity does not: 1) substantially lessen competition or restrain trade in the United States or restrain the export trade of a U.S. competitor; 2) unreasonably enhance, stabilize, or depress prices in the U.S.; 3) result in an unfair method of competition or 4) cannot reasonably be expected to result in the sale or resale in the U.S. of the exported goods and services.

As stated, a certificate holder has complete immunity from U.S. anti-trust laws, except for private party lawsuits for actual damages. Such lawsuits would be subject to the following limitations:

a. The trading entity must have violated the specific anti-trust standards enumerated in the bill

b. A two year statue of limitations is applicable

c. A certificate creates a presumption of lawfulness

d. Certificate holder can be awarded costs, including attorney fees, if he prevails in any action brought against him.

Title III did not affect the Webb-Pomerene Act and companies may still register as associations under that act with the Federal Trade Commission. Unlike Title III, the Webb-Pomerene Act does not protect against the filing of private treble damage suits and does not cover the export of services or technology.

5. Title IV is referred to as the Foreign Trade Anti-Trust Improvements Act and it amends the Sherman Act and Section 5 of the Federal Trade Commission Act to clarify that these acts do not apply to export trade unless there is an adverse anticompetitive effect on commerce in the United States or on the export commerce of a U.S. resident. As such, there must be a "direct, substantial and reasonably foreseeable effect on domestic or import commerce, or on the export opportunities of the United States person," as a jurisdictional threshold for enforcement actions. (10)

RISKS AND LEGAL QUESTIONS

The certification procedure and the banking provisions provide some business risks and raise some legal questions for the businesses which may also seek to take advantage of their benefits.

The business concerns focus on the need for disclosure of company proprietary information in the application procedure. Many corporations will be reluctant to release detailed financial information to the government and will be concerned that the requirement to publish a notice of their application in the Federal Register may signal their business plans to competitors. Bureaucratic delays and the length of time required for application completion can also be a problem. The Department of Commerce is seeking to allay these fears by utilization of a simple and confidential application.

Also, Title III of the Act provides some possible legal questions in that the exemption provided by the certificate applies only to an activity that does not violate the four standards enumerated om the Act (see above). As such, although an exporter may not be sued by the federal government, it may still be possible for a private party to sue an exporter for actions that restrain trade or lessen competition in the United States. Also, certification aside, an exporter is still liable for damages if he/she violates the prohibition on reimportation of exports into the United States.

While Title IV allows exporters to rely on the express statutory restrictions relative to United States anti-trust laws rather than certification application, such companies may still face the spectre of treble damages or government enforcement.

In analyzing the legal questions presented by the Act, it should be noted that the Export Trading Company Act and the Webb-Pomerene Act are distinguishable in that their purposes are essentially different. The Webb-Pomerene Act allows for the formation of U.S. cartels, in order to minimize competition by combating the effects of foreign cartels. The Export Trading Company Act is not pro-cartel. In fact, it seeks to foster competition in order to increase foreign marketing opportunities for firms not presently exporting by giving them greater access to those markets. As appropriate, companies may continue to register as Webb-Pomerene Associations. While there is the procedural advantage of no certificate of review involved, the Webb-Pomerene Act does not protect against treble damage suits and excludes export of services or licensing.

It is also noteworthy that barter and third party trading are encouraged by Title II. However, the certification process only applies to exporting activities which leaves joint ventures for the purpose of importing subject to anti-trust laws. Similarly the anti-trust exemptions only apply to United States anti-trust laws and have no effect in foreign countries. Therefore, an export trading company should be sure its transactions will not violate the anti-trust laws of the particular foreign country to which it plans to export.

A major stumbling block to full utilization of the advantages presented by the banking provisions will be the inherent nature of bankers. There appears to be an innate reluctance to mix banking and commerce, with the two frequently seen as totally incompatible. Therefore, it has already

been demonstrated that bankers and bankers' banks will be reluctant to invest in a purely commercial venture such as an export trading company. Such movement will require a re-orientation and re-assessment of the basic purpose of banks and the scope of activities which are deemed appropriate.

Similarly, small export trading companies may be slow to associate themselves with banking institutions since this affiliation brings certain limitations on the kinds and amounts of other business that company can pursue (Title II). However, they are encouraged to explore these possiblities nonetheless, because bank affilation will bring additional credibility, contacts and financial resources which have been absent from United States export businesses in past years. (12)

BENEFITS OF EXPORT TRADING COMPANY UTILIZATION

The forecasted benefits of increased international business activity and specific utilization of the export trading company to the overall national economy are impressive. According to a Chase Econometrics study, export trading companies could create 320,000 to 640,000 new U.S. jobs, reduce the federal budget deficit by $11 billion and increase the gross national product by at least $27 billion by 1985. (13) Some have theorized that increased exporting activity can substantially diminish unemployment since each million dollar increase in exports results in the creation of 100,000 new jobs.

However, utilization of the provisions of the Export Trading Company Act and of the services of an export trading companies can accrue many features, advantages, and benefits for the small and medium sized business, the large corporation already involved in some international business transactions, and for the small, medium and large banking institution. These benefits extend beyond the anti-trust and financing provisions outlined in the legislation itself. It has been demonstrated throughout the world that by combining the expertise, financial resources, and increased bargaining power which results from numbers, an export trading company can reduce the costs and risks of international trade and open new markets for foreign competition. No where has this proven more successful than with the Japanese Sogo Sosha.

Trading companies in America have traditionally handled one line of products which were traded to one country or one area of the world. Japan, by its huge general trading companies, has operated with unparalleled success under a different philosophy. They have created, with the Sogo Sosha, conglomerates of services, resources, strategies, operations, and organizational structure around a core business. Unlike American trading companies, the Sogo Sosha may handle an almost infinite number of commodities at one time. Each handles between 10,000 and 20,000 commodities. Fundamentally devoted to trading, they are also the creators of supply and demand which ensures stability and generates new business opportunities. They buy and sell as principals and agents with global dispersion, concentrating heavily on developing and communist bloc countries. They may be involved in single product sales, one-way and two-way seller-buyer transactions, and also third-country trade (trade between two foreign countries handled by Japanese firms without direct involvement of Japan as a source of supply or market). Unlike American firms who perfer to assume their own direct supply and marketing techniques and purchase their own manufacturing resource needs, the Sogo Sosha are huge traders and supply and sales intermediaries, not manufacturers or financial institutions per se. Of the top ten Sogo Sosha in Japan, Mitsui and Mitsubishi register annual sales in excess of $30 billion. (14)

Advantages for Small and Medium Size Businesses

It was intended with the passage of the Export Trading Company Act that small and medium sized businesses would be the primary beneficiaries. Since cooperative efforts would now be greatly facilitated, it was felt that they would have an opportunity to now compete with their larger conglomerate counterparts. The benefits which would come to the small business by utilization of exporting are tied to the factors which have previously inhibited their entrance into those markets, namely, lack of resources, fear of entering into business transactions in strange countries, with strange regulations and the possibilities of many unexpected contingencies, lack of knowledge about procedures and paperwork documentation required.

In addition to increased sales, overcoming market saturation and dependence on a single market, exporting can give a competitive edge, increase employment growth, reduce production costs while giving access to new customers and revitalizing the local economy. A small corporation may choose to utilize the services of a single export trading company to have its own external export arm. Or, a consortium of businesses, perhaps from a particular industry, could

band together to engage in exporting through an export trading company. Others may want to join with manufacturers of similar or complementary products to invest in and form their own export trading company.

In whatever form it may chose, the American small business utilizing an export trading companies can avail itself of a variety of services:

1. Foreign market research. An export trading company can seek out foreign markets where US products are in demand and identify those changes which may need to be made to the American-made product to make it marketable in the foreign market.

2. Overseas Communications. An export trading company generally has an established network of overseas offices and contacts which can provide direct communication between the buyer and seller. These facilities routinely include computers and telex which may be too expensive for operation by small businesses.

3. Promotion of American Product Overseas. Since proper marketing of the American product will be the key to its entrance into foreign markets, an export trading compa y can insure that the marketing approach is attuned to the sensibilities of its target population. This will generally include promotion in foreign languages coupled with knowledge and understanding of cultural mores and differences.

4. Transportation. This will include both domestic and overseas shipping arrangements. Acting largely as a freight forwarder, an export trading company can provide advice on freight costs, port charges, consular fees, licensing requirements, cost of special documentation, handling fees, insurance costs, packing requirements, and letters of credit. In preparing the necessary documentation, the export trading company will handle export declarations, commerical collection documents, such as, commercial invoices, consular invoices, certificates of origin, inspection certificates, bills of lading, dock and warehouse receipts, certificates of manufacture, and insurance certificates.

5. Distribution. Many export trading companies will distribute merchandise to buyers through qualified distributors in foreign countries. Since many countries, e.g., Middle East, require distribution through an agent who is a national, the ability to identify such agents and distributors is crucial to successful trading in many parts of the world.

6. Negotiations. An export trading company can lend assistance in carrying out negotiations of trade agreements, agency agreements, and contracts.

7. Title. In some instances, an export trading company will take title to the goods produced from the American business, thereby making the sale essentially another domestic transaction. This type of transaction is most attrative to American businesses since, with the passage of title, all risks for the American business concern are terminated. However, since a considerable amount of capital is required for this type of activity, many new export trading companies act as brokers between a foreign buyer and American seller.

8. Technical assistance. An established export trading company can offer technical assistance to a corporation which desires to establish its own in-house export trading company.

9. Build customer base. An export trading company can increase selling to customers by providing them with additional products or services which may be complementary to the investor's primary business, while gaining access to new classes of customers.

10. Identify unique investment opportunities abroad for the developing corporation which may not otherwise come to its attention. (15)

Benefits to larger Corporations

Several large corporations, in anticipation of the 1982 Act, have established and are operating in-house export trading companies. The principal models in this area are operated by General Electric, Sears, General Motors, Rockwell International, and Control Data. These corporations, as well as others in the international arena, have discovered the advantages presented by broadening their sales to acquire and promote the product lines of other manufacturers in addition to their own commodities. This can benefit small businesses who cannot afford an inhouse export arm nor engage an outside firm. Organizationally, large corporations have frequently discovered that international trading is best accomplished when treated as a separate and independent operation of the corporation. Also, in order to take advantage of the fast growth rate of certain developing countries, e.g., Third World countries, many have found it is necessary to engage in countertrade, i.e., the necessity to establish good will by purchasing some goods in certain countries in order to sell there.

While the in-house export trading company will certainly expand the sales of its parent company by utilization of an extensive sales network, hundreds of distributors and sales representatives, a teleprocessing network, and product service

facilities around the world, such extensive expertise may also benefit the small business too. The new GE Trading Company, which offers comprehensive export services ranging from market identification, sales, and distribution through financing gleaned through over a century of export trading, will offer its expertise to both GE businesses and external clients. Internally, GE affiliated businesses with shorter-cycle, medium technology products will be the focal points. With companies outside the GE nexus, GE export efforts will center on acquisition of complementary products, which will likely be the majority of sales. (16)

Sears, another company which has operated throughout the world for many years, will offer assistance to other American firms as they seek to enter world trade as well as improve its own sales and growth picture through its newly formed export trading company. This company will conduct exporting, primarily in technology and management services; importing of components and parts, third country trade (a new area for Sears); and counter-trade. With offices in Japan, Hong Kong, Singapore, Brazil, Mexico, and Europe, Sears will be in a good position to identify export and import opportunities for other small businesses and provide a communications network, as well as develop targeted marketing strategies.

Control Data Commerce International is the only large in-house export trading company which was formed expressly for the purpose of providing services for small businesses (rather than as an ancillary function to profit to the parent corporation). For a number of years, Control Data had operated a network of business centers throughout the U.S. and last year those operations were expanded to include export services and international market access. The services Control Data offer vary depending on the desires of the individual small business. If the small business wishes to export itself, Control Data offers them the international support services needed to complete export transactions by selling essential individual services to the manufacturers such as market research, distributor service, and export assessment. If the company desires export through Control Data, it offers a cooperative program in which it joins with the manufacturer by taking title to goods or by way of a joint venture to develop and implement a marketing plan ranging from product modification to promotion, marketing management, distribution, credit, and transportation of collections and transports the product from factory to foreign customer. (17)

Benefits to Banking Institutions

Bank-owned export trading companies and export trading companies with the financial backing of a banking institution can provide great financial strength to its clients. In view of a skepticism within the banking community toward involvement with entrepreneurial activities, the large banks such as Bank of Boston, Bank of America, and City Bank will be the most likely leaders in this effort.

The capability of providing exporting services could provide the large banking institutions with inroads into the medium size business cummunity. Oftentimes, these businesses lack essential export expertise. Large banks, with extensive overseas contacts and international experience, would be very attractive to this middle-market, and could result in more customers and a new market for the banking institution. Similarly, the banks would again benefit by providing additional business and profits for their already established network of branch offices throughout the world.

A bank-owned export trading company can be very helpful to a large commercial bank who has clients in need of assistance with customers from the over-leveraged developing countries, whose credit has been over-leveraged. In such instances, the greater reliance on bartering and countertrade which would be necessary mandates the assistance of export trading company skills. In fact, some large banks, which have not formed their own export trading company, now find themselves relying on independent export trading companies for more accurate and timely investment and risk analysis. (18) Charles F. Mansfield of Marine Midland Bank said, "As projects become more global in scope, increasing pressures will be placed on banks to serve as umbrella organizations drawing together a range of unrelated disciplines whose final product depends on initial credit decisions". (19)

Additionally, banks affiliated with or owning an export trading company can provide a broader line of customer services. Further fees can also be accrued from these associations by performance of associated operations such as letters of credit and documentation. Collection handling and transfers would also result in large balances by foreign correspondent banks.

The utilization of an outside export trading company can also be the tool for the small and medium size unaffiliated bank. The availability of export servicing may prove a useful feature for these banks which wish to

remain in competition with large international banks. Regional banks will then be able to compete with the larger international banks for the international business of regional bank customers. Due to the reluctance and conservatism which prevades banking institutions, particularly small ones, it may be feasible for several regional banks to form a consortium and establish their own export trading company. With possibilities for cooperative efforts with bank investment numerous, a final option which may prove particularly useful is bank sponsorship of a community-based consortium of local businesses in their efforts to export.

There is, however, fear and speculation among independently-owned export trading companies that bank-owned export trading companies will, in effect, monopolize the export market. By cornering the finance market, independent export trading companies and those established since the enactment of the Export Trading Company Act fear larger banks will be reluctant to loan money and resistent to investment in their competitors.

Public Involvement and Foreign Trade Zones

Public participation in export development through an export trading company, although a new concept, has been used in some areas. Most noteworthy are Massport in Boston, Mitco in Minneapolis, and the Port Authority of New York and New Jersey.

Foreign Trade Zones, which are generally seen as beneficial to American companies seeking to import, can also show substantial profits for exports as well. There are now 78 approved general purpose Federal Trade Zones and 14 sub zones throughout the United States. A general purpose zone provides economic advantages to a number of tenants located in a specific facility. Whereas, a sub-zone, which can only exist in a State which also has a general purpose zone, benefits only the company in which it is located.

Full utilization of a foreign trade zone can manifest substantial reductions in production and labor costs in addition to other marketing, financial, and transportation capabilities which encourage commercial and industrial operations in the United States that would otherwise have been conducted abroad for Customs reasons. Companies can first lower production costs by reducing tariffs on items transported to the Foreign Trade Zone, since those goods are not taxed until they leave the zone. Other advantages such as deferred tariff duties, improved general cash flow, through-zone importing and exporting, waste and defective merchandise exemption from duty, and secutiry must be considered as primary benefits of a Foreign Trade Zone (20).

Under these circumstances, utilization of Foreign Trade Zone privileges can benefit companies who currently import for domestic distribution and who may now want to consider exporting. Goods could be brought into the Zone with the benefit of cheaper costs, remain in the Zone untariffed while processed or modified into a suitable export commodity, and taxed only upon departure. This could result in substantial savings for the Foreign Trade Zone tenant, since a non-zone tenant would have to pay import duties to bring the commodity to its facilities, as well as export costs upon departure.

About 1,200 business firms used Foreign Trade Zones in Fiscal Year 1982, including some 300 that occupied zone facilities on a permanent basis. The value of merchandise moved to and from the zones during 1982 exceeded $6 billion. However, in many zones, the space allocated has not been fully utilized since many companies are hesitant to relocate established operations to Zone facilities. Awareness of the import as well as export possibilities may make the move more attractive, particularly for small and medium sized businesses and for the start-up business.

FEDERAL GOVERNMENT PROGRAMS

The Department of Commerce, primarily through the direction of its International Trade Administration Section, has been designated as the focal point in the federal government for information and assistance pertinent to the establishment of export trading companies and increasing international trade opportunities for all American businesses. The International Trade Administration, which was created by Presidential directive to consolidate non-agricultural international trade functions in one agency, seeks to strengthen and promote trade development, international economic policy and trade administration.

Since the passage of the Export Trading Company Act, the International Trade Administration has been particularly involved with counseling perspective exporters on the benefits of that legislation and on the ways to create and develop an export trading company. To this end, it sponsored 40 informational seminars, which were widely attended, in major cities throughout the country. They also counsel members of the business community who may be potential clients for these services on the

advantages of exporting, sponsor overseas exhibitions and trade missions, develop and maintain current commercial and marketing information on each country, and maintain a corps of Foreign Commercial Service officers around the world. (22)

The Department of Commerce is perhaps best known for its extensive series of resource and informational publications. In this connection, the Department of Commerce publishes several useful tools for those seeking to enter the global marketplace. These include:

a) Trade Opportunities Program (TOP) which matches US business firms who desire to export products with foreign buyers. A TOP Bulletin indicates items which are needed by foreign buyers on which American suppliers can submit bids.

b) New Product Information Service (NPIS) which provides worldwide publicity for new US products available for immediate export.

c) International Market Search (IMS) which promotes the products or technology of a single industry and researches the global market for those products. Each year the Department of Commerce selects several industries (eg. graphics, computers) for this type of promotion.

d) Export Contact List Services. The Department of Commerce maintains a Foreign Traders Index which contains information on more than 140,000 importing firms, agents, representatives, distributors, manufacturers, service organizations, retailers, and potential end-users in foreign countries.

e) The Export Mailing List Service (EMLS) provides lists of foreign firms in selected countries by commodity classification on gummed labels and in printout form.

f) Agent/Distributor Service (ADS) serves the exporter by locating foreign import agents and distributors. This is particularly useful in countries which require representation by a resident agent.

Additionally, Department of Commerce researches the marketing possibilities for a number of different countries and also compiles information on trade opportunities in a Global Market Survey according to particular industries.

In addition to these in place and developing programs by the Department of Commerce, there are several supporting programs sponsored by the Small Business Administration. The Small Business Administration offers aid to current and potential small or minority exporters through its management assistance and financial assistance programs, in accordance with the provisions of Public Law 96-481. The management assistance programs focus on counseling from retired persons with international business experience, professional international trade management consulting firms or Small Business Development Center programs. They also provide referral to other public or private sector organizations with in-depth knowledge and experience as well as provide a number of international trade and export marketing publications.

The Financial assistance programs may be in the form of a Small Business Administration loan which can be repaid from future earnings or the Revolving Line of Credit Loan. The Export Revolving Line of Credit Loans (13 CFR Part 122) authorizes extensions and revolving lines of credit for export purposes, to develop foreign markets, and for pre-export financing at the same rate as guaranteed loans. The activities covered could include professional export marketing advice or services, foreign business travel or participation in trade shows. (23)

The Department of Commerce and Small Business Administration have assisted many businesses--newly created and well established--in the years they have operated. However, with that reputation, too, have come much criticism and concern. Small Business Administration has been singled out for the long lead time required to acquire a loan, stringent eligibility requirements, and more cumbersome reporting requirements. Department of Commerce has, with several reorganizations, been critized for a loss of some efficiency and a difficulty in locating the vast resources at its disposal on request, particularly in District offices.

It is perhaps these concerns, coupled with a desire to place emphasis on the international trade initiative which prompted President Reagan to suggest consolidation of all trade-related functions from the Department of Commerce and the U.S. Trade Representative Office into a new cabinet level office, Department of Trade. One of the reasons for this consolidation is the inherent inefficiency of having the planning function for international trade in the U.S. Trade Representative's Office, while responsibility for implementing policy remains largely with the Department of Commerce. (24)

FUTURE ACTIONS

The 98th Congress will have several opportunities to expand upon or limit the initial steps taken by the Export Trading Company Act of 1982 since specific trade proposals and the need to renew several trade statutes will cause it to provide a broad review of U.S. trade laws and the economic policies (both import and export) they effect during the coming year.

Import regulation review will continue to focus on protection provisions for American business. Congress will undoubtedly have an opportunity to re-argue the "domestic content" bill which, in essence, would force Japanese automakers to shift their manufacturing operations to the United States. Also, there will be another review of Sen. Danforth's proposal for a "reciprocity bill" which will require an annual accounting of foreign trade barriers for the purpose of determining whether US trading counterparts are reciprocating the benefits extended to them under trade agreements. Further, there is likely to be Administration backing of a Caribbean Basin Initiative which will provide trade, tax and aid to Caribbbean and Central American countries. Another area for import controversy will be the General Systems of Preference renewal for newly industrialized countries. Many believe these countries should begin to assume more of the responsibilities of mature economies, as they are demonstrably competitive in many sectors. Import related activity will also focus on affording easier and cheaper access to unfair trade remedies, resurrecting the predatory dumping law, and clarifying how the statutes deal with non market economy dumping. (25)

Of equal importance will be the opportunities to improve export competitiveness which will be introduced. In the 97th Congress, the Export Trading Company Act, in its amended form, was the only piece of export related legislation to pass. In the coming session, Congress will be faced with decision on renewal of the Export Administration Act, which expires on September 30, 1983; revision of the Domestic International Sales Corporation (DISC) tax laws; enhancement of agricultural export subsidies; and renewal of the charter and enlarging the budget of the Export-Import Bank.

The Export Administration Act of 1979 is aimed at licensing exports and the imposition of export controls where national security, foreign policy, or short supply are at issue. While it is probable that it will be renewed, the form and changes from the present regulation are uncertain. With proposals to limit the effects of commercial considerations on license issuance and reduction of the President's authority to deny licenses, its future is unclear. (26)

In 1971 DISCs were created to counter the comparative tax advantage of European suppliers who were assisted by those and poorly implemented rules for capturing foreign-source income. After complaints from the European community that DISC taxing amounted to an illegal export subsidy which violated the General Agreements on Tariffs and Taxes, the Administration has agreed to revise those provisions. Although the form the revisions will take and the disposition of Congress are uncertain, any successful proposals have to avoid double taxation of foreign income. (27)

The President has publically stated that he would defend the US agricultural export market. The purpose of this support is to keep American farmers competitive with European counterparts. Past programs have permitted a "credit buy down" program which was used to subsidize the prices charged by American farmers to make them competitive. This costly program, along with Payment-in-kind programs, which allow growers an opportunity to sell commodities they didn't produce in foreign countries, will be reviewed carefully. (28)

Another opportunity for export-related Congressional action will concern the Export-Import Bank. This action will likely focus on funding levels for the Bank and on Export-Import rules determining the distribution of its funds. The rules which govern lending procedures are perceived by some as cumbersome to the point of making loans untimely, if awarded. As for funding, with some proposing a large infusion of funds in order to provide a "war chest" to allow competition against nations not observing the rules of economic co-operation, it is not likely that the Administration proposed funding levels will be sufficient. (29)

CONCLUSION

Under the impetus of a widening trade deficit and recessionary economic conditions for United States businesses, Congress and President Reagan have sought to place emphasis on increased growth of international trade by removal of some of the barriers which have inhibited the entrance of businesses, particularly small and medium size corporations, into the global marketplace. This initial step, in the form of the Export Trading Company Act of 1982, has been met with caution and →

optimism in the business and banking community.

If maximum advantage is taken of the provisions of that legislation and a number of export trading companies are developed—independent, in-house large corporation models, and bank-owned,—the benefits to American business can be substantial.

However, this initial step is not likely, of itself, to provide the necessary thrust to bring American business on an equal footing with its European and Asian counterparts. With several opportunities for support of this initial forray into international business coming in the next year, it will be essential for the Congress and Administration to work closely to insure that these efforts do not remain in a vaccuum. Some fear recent improvements on the domestic economic scene may lessen the pressure which initially fostered drastic changes in the international trading system. The directions which follow in the coming months, particularly if they foster industrial protectionism and government export assistance, will have farreaching consequences both in economic terms and politically, with the advent of the 1984 elections.

Temporary domestic improvements will no longer be sufficient to maintain stability in the world market and American businesses of all sizes will have to overcome their provincialism to balance import and export relations for survival. The country which has been largely responsible for the economic development of Europe and Japan since World War II now finds itself in a game of catch up - in resources and international business expertise. But, America must catch up, and do so quickly. For, international trade - both import and export - is good business for all and the foundation of the future.

FOOTNOTES

(1) Robert E. Herzstein, "Trade Policy in the Years Ahead", Business America, October 20, 1980, 3.

(2) "World Trade Week 1983", Presidential Proclamation, signed by Ronald Reagan, April 7, 1983.

(3) "Export Trading Company Act of 1982", Fact Sheet by Chamber of Commerce USA, January 1983. Also reprinted in International Business Review, January 83.

(4) Ibid.

(5) 15 C.F.R. 58-62.

(6) Chamber of Commerce

(7) "Events & Highlights in U.S. Trade, 1880-1980", Business America, October 20, 1980, 4.

(8) "Special Report: Why and How to Establish an Export Trading Company", Department of Commerce, Fact Sheet publication.

(9) Export Trading Company Act of 1982, Public Law 97-290, 96 Stat. 1233.

(10) Ibid.

(11) U.S. Chamber of Commerce, 6.

(12) Ibid, 9, 11. Also see "U.S. Exports Means Jobs" in Business America, October 18, 1982, 10.

(13) Kevin Farrell, "Exports", Venture, March 1983, 62.

(14) Alexander K. Young, "The Sogo Sosha: Japan's Multi-National Trading Companies", (Colorado: Westview Press) 1979, 3-19.

(15) Special Report, 1-2

(16) See Farrell, 66, Business America, October 18, 1982, 8-9, International Business Review, 2.

(17) Presentation by B. J. Newbeck, Vice President of Control Data at Export Trading Company Conference sponsored by Department of Commerce in Boston on February 8, 1983.

(18) Business America, October 18, 1982, 9-10, International Business Review, 2-3, Farrell, 66.

(19) Business America, October 18, 1982, 9.

(20) Massport Export: A Basic Guide for Small Business Exporters, 22-4.

(21) "Foreign Trade Zones", Business International, January 4, 1974, and Memorandum on Foreign Trade Zone submitted to Massport from Lawrence Strategy Inc., dated February 2, 1982.

(22) "Commerce Export Assistance Program", Department of Commerce publication, February 1983, 1-7. Also see International Trade Administration, Department of Commerce publication.

(23) "International Trade Assistance", Small Business Administration Fact Sheet No. 42 and 13 C.F.R. Part 122 on Business Loans: Export Revolving Lines of Credit Loans 122.400-122.406.

(24) Thomas Oliphant, "U.S. Trade Proposed", Boston Globe, April 26, 1983, 11.

(25) See, e.g. S. 50 ("Small Business and Agricultural Trade Remedies Act") 129 Cong. Rec. S 250 (daily edition January 26, 1983); S. 127 and S. 418 (predatory dumping), 129 Cong. Rec. S 607, S987 (daily editions January 26 and February 3, 1983); S958 (97th Cong. 1st Session), 127, Cong. Rec. S 3782 (daily edition, April 9, 1981).

(26) Theodore W. Kassinger, "The Trade Agenda of the 98th Congress" Federal Bar News and Journal, Vol. 30 No. 4, April 1983, 223-5. Also see "Commerce Establishes Business Information Center to Promote Administration's Caribbean Initiative", Business America, May 3, 1982, 9.

(27) I.R.C., Sec. 991-997. See Cohen & Hankin, "A Decade of DISC: Genesis and Analyses", 2 Va. Tax Rev. 7 (1982). Also referenced in Kassinger, 225.

(28) Kassinger, 224-5.

(29) Ibid.

The Information presented here is the result of research gleaned from the above-referenced publications and the personal observations of the author. Any opinions or conclusions drawn are solely those of the author and do not necessarily reflect official Defense Logistics Agency policy.

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Tactical Buying Decisions for Strategic Petroleum Reserve Spot Procurements: The Tunnel Theory

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ABSTRACT

Procurement of crude oil on the spot market at minimum prices requires economic analysis which focuses on the discovery of market price levels and the determination of short-run market direction.

This paper presents the results of statistical research concerning the formation of spot prices in the crude oil market. Variables suggested by the economic theory of raw material and commodity markets are investigated. The demand for incremental (spot) volumes of crude oil is found to be derived from the demand for incremental volumes of petroleum products. Insights gained from this analysis are used to establish tactical decision rules to be followed when making purchases under the provisions of the Defense Fuel Supply Center's open and continuous solicitations on behalf of the Department of Energy's Strategic Petroleum Reserve. The results of this research are also shown to be important input for strategic decisions concerning the mix and timing of spot and long-term contract procurements.

INTRODUCTION

This paper describes a nontraditional tool of fundamental market analysis developed at the Office of Market Research and Analysis, Defense Fuel Supply Center (DFSC). The technique, known as the "Tunnel Theory" is used in the preparation of market analyses in support of DFSC procurement activities on behalf of the Department of Energy's (DOE) Strategic Petroleum Reserve (SPR). The Tunnel Theory is an application of ideas from microeconomics and the theory of commodity markets to the continuing study of the "spot", or short-term, crude oil market.

Through the use of this analytical technique, it is possible to estimate a range of values in which the spot price of a given crude oil should be found given the prices of refined products. Comparison of actual spot prices to the range, the "tunnel", is used to postulate the short-term behavior of spot prices. Historical evidence from the 1981-83 period supports the use of the Tunnel Theory to explain and to predict spot crude prices. The theory and the supporting empirical evidence suggests several decision rules to be applied when making tactical purchasing decisions. Understanding the market relationships which produce the "tunnel" is useful when planning the timing of spot and term crude oil procurements. Use of the Tunnel Theory in market analysis along with the traditional tools of price discovery has improved DFSC's timing in market operations and improved the U.S. Government's understanding of oil market trends. Finally, the theory suggests a new direction of research into the dynamics of price formation in the oil market which is more promising than current modeling efforts.

OVERVIEW

DFSC acts as DOE's procurement agency for SPR crude oils. Some 75 percent of the 364 million barrels in the reserve at the end of FY 1983 were purchased by DFSC; the balance was bought directly by DOE from Petroloes Mexicanos, the Mexican government-owned company. DFSC's purchases in FY 1983 totaled some $900 million. Since 1981, 88 percent of DFSC's purchases have been on the spot, or *short-term, market as the Center* has taken advantage of the discounts which have been available on that market for most of this period.

Spot market operations present some nontraditional problems to oil procurement and market research at DFSC. The Center's main acquisition function, the purchase of refined petroleum products for the armed services and other federal agencies, is conducted on a term contract basis with most business done on contracts of one year in duration. Price reasonableness determinations are based on adequate competition and/or established catalogue or market prices. Traditional market research at DFSC focuses on price discovery (to determine market prices) and the evaluation of escalators (economic price adjustment indices) which are characteristic of term contracts in the oil market. Cost minimization is accomplished through the negotiation of minimum prices which escalate/de-escalate through the contract period on indices which have been found to reflect market prices over time. For the SPR spot procurements, the price discovery function remains important, but there is no

need to evaluate escalators as contracts are for near-term delivery and prices are fixed and firm. Rather, cost minimization depends largely on the timing of purchases. Flexibility in timing is afforded by an open and continuous solicitation with bi-weekly closings, and a crude oil requirement which is sometimes deferrable. Optimal timing of purchases depends on the prediction of short-term market price movements.

Spot market prices are determined by technical and fundamental factors. Technical factors have to do with short-term market structure - the relative presence or absence of buyers and sellers. Generally, when selling interest exceeds buying interest, prices will tend to be bid down, while the opposite situation would obtain the opposite result. Technical analysts believe that short-term price behavior can be predicted through the analysis of recent price changes and express the state of the market in terms of indicators such as "momentum", moving averages, and chart patterns. Given that the spot oil market is a commodity market (though, as yet, without sufficient liquidity on its futures exchanges), spot market analysis seeks to identify indicators of technical market strength or weakness.

Analysis of the fundamental factors which determine spot prices involves economic analysis of aggregate supply and demand. Obviously, output levels in the various oil producing countries are important data. Also important is the demand for crude petroleum, which is derived from the demands for the various refined petroleum products. Inventory levels and expectations impact market prices as well. Spot market analysis seeks to quantify and interpret the relationships among these aggregates, market price levels, and the direction prices are moving.

The spot market has grown in importance as a source of crude oil supply. While hard data on spot market volumes is nonexistent, it is believed that less than 10 percent of all internationally traded oil moved on a short-term basis prior to 1973. Most oil was contracted for under long-term arrangements, with about three-quarters of it passing through the integrated channels of the seven largest companies (Exxon, Shell, Mobil, BP, Gulf, Chevron, Texaco). The emergence of the Organization of Petroleum Exporting Countries (OPEC) and the nationalization of producing interests changed institutional arrangements and opened up the channels of trade for more direct dealing between producing countries and refiner-buyers. Trading firms, both independent houses and affiliates of oil companies, became important middlemen in the oil business as they traded oil to balance supply/demand positions within and among regions and firms, and also took speculative positions in anticipation of price movements. The supply panic which accompanied the Iranian Revolution in 1978-79 resulted in a near-tripling of contract price levels and a rapid build-up in oil inventory levels. High prices and a weak world economy turned a shortage into a "glut" by mid-1980 as oil consumption began to fall below expected levels. Since early 1981, spot crude oil has been available at sizable discounts below OPEC "official" price levels, as companies have liquidated inventories and countries have made special deals to maintain high export levels. In this environment, long term contracts became relatively unattractive so refiners adopted a shorter-term perspective on their supply situations. Estimates of the volumes of internationally traded crude oils being sold on a spot or short-term basis now range from 25 percent to 40 percent of the total international trade.[2, 4, 12, 13, 15]

Most of the volumes purchased by DFSC on the spot market have been from independent trading firms. Much of the oil purchased from refiners have been from their trading subsidiaries. Trading firms have been successful offerors due to the flexibility inherent in their operations. The existence of these firms as businesses is based on their ability to purchase, sell, store, and transport oil profitably. Their sources of supply are term contracts and volumes temporarily surplus in the systems of producing and refining companies, and their ultimate customers are refiners though they often sell to other traders.[12] The ability of refiners to offer oil to DFSC is limited by the supply requirements of their own systems, to which any trading activities are usually subordinate. The largest spot suppliers to DFSC during the 1981-83 period were as follows (volumes in thousands of barrels):

Trading Firms

Company	Volume
Derby	42,510
Marc Rich	9,025
Trans World	6,630
Gatoil	6,204
Houston Oil	5,850
Coral	3,300
Others	11,985
	85,504

Refiners

Company	Volume
Exxon	22,620

BP	4,825
Texaco	4,287
Amoco	3,450
Coastal States	3,400
Hess	2,000
Others	3,488
	44,070

The ultimate purchasers of crude oil are refiners for whom it is a raw material input into manufacturing processes. The outputs from these processes are refined products for which the demand patterns vary among the major consuming regions of the world. Shown below is a table comparing the petroleum consumption patterns of the three largest Free World markets:

Refined Product Consumption 1982
(as percentage of total oil use)

	U.S.A.	Western Europe	Japan
Naphtha	1.7	5.8	8.7
Motor Gasolines	43.7	19.5	13.3
Kerosenes	8.3	4.3	10.9
Diesel/Heating Oil	18.4	33.5	17.8
Residual Fuels	11.7	27.0	28.2
Others	16.2	9.9	21.1

SOURCE: International Energy Agency[9]

The table above is ranked in declining order of the specific gravity of the major product groups. Gasolines, naphthas, kerosenes, and heating oil are said to be "light products," while residual fuel is also known as heavy fuel oil. Relative to Western Europe and Japan, U.S. refineries must have additional upgrading capacity, such as cracking units, to produce the lighter product slate demanded in this country. In practice, some of the heavier (low value or low priced) residual and heating oil molecules are "cracked" to produce the lighter hydrocarbons used in the manufacture of (high value or high priced) gasoline. The greater relative complexity of U.S. refineries is illustrated in the following table which compares the cracking capacity of the refining industries in the various regions (in millions of barrels per day):

Region	Total Capacity	Cracking Capacity	Cracking as % of Total
U.S.A.	16.7	8.7	54
Western Europe	19.8	2.8	14
Japan	5.6	.5	9

Sources: Department of Energy[7]
Oil and Gas Journal[14]

The effect of the greater upgrading capacity is further illustrated by a comparison of the product yield of Forties, a British North Sea crude oil stream, in a "simple" European refinery (containing no cracking and some gasoline production capacity) and a representative "complex" U.S. Gulf Coast refinery:

Forties Product Yield as % of Total Volume

	Simple Refinery	Complex Refinery
Naphtha	6.1	-
Premium Gasoline	13.4	-
Regular Gasoline	4.9	29.1
Unleaded Gasoline	-	26.2
Heating Oil	34.0	27.2
Residual Fuel	37.5	14.5

Source: Petroleum Intelligence Weekly[10, 16]

An understanding of refinery yields is important for the discussion of crude valuation and price formation which follows, because the prices that refiners are willing to pay for crude oil are determined by the value of the productswhich can be manufactured from it.

The Tunnel Theory

As a raw material, crude oil has little or no intrinsic value. Its worth is derived from the value of the products which can be manufactured from it, because it is of little use (and thus, value) to consumers when in its raw form. Crude oil is valuable only to a refiner who can process it into salable final products. The demand for crude oil is said, then, to be derived from the demand for refined petroleum products.[1, 3, 17]

Spot markets in crude oil and refined products exist when buyers and sellers engage in one-time or short-term transactions in order to exchange incremental volumes. Quantities of crude or product which are temporarily surplus to one company may be offered to buyers on the open market. Likewise, a firm whose commitments are greater than its current supplies may try to cover its deficit through spot purchasing. Other companies will speculate on price movements and attempt to hold and trade spot oil for a profit. Spot prices of refined products represent the marginal, or incremental, values of these goods in the market place at any given time.[12]

Because the demand for (and value of) crude is derived from the demand for (and value of)

refined products, the marginal willingness-to-pay of a refiner for incremental volumes of crude should be determinable from spot product prices as these represent the value that the market places on additional volumes of the products which would be refined from the crude oil. The marginal value of crude oil is estimated by multiplying the spot price of each product by its percentage yield in the refinery, summing over all products, and deducting applicable operating and transportation costs. This estimate - the "spot product netback" - is the marginal value of crude oil to the refiner. If the spot price of a crude oil is greater than its netback value, it will not be profitable for the refiner to purchase and process additional volumes of that crude. If the spot price, of a crude oil is less than its netback, the refiner can profitably purchase the crude, refine it, and sell the products. The range of possible netback values given a range of possible refining configurations (from "simple" to "complex") should define the possible range of spot prices for a given crude oil at a given time.

Spot netbacks can be calculated form current price information reported daily or weekly in a number of trade journals. This presents a possible problem in the calculation of crude oil values as spot product prices are usually quoted for near term deliveries, while crude which is sold on the spot market today is usually lifted several days to two months later, spends several days to several weeks in transit, and a period of time in storage and in processing before being sold as products. However, current spot product prices are related to forward prices through the cost of carrying inventory. Current prices should be no less than expected forward prices minus the cost of interest and storage over the intervening period. Current prices may exceed expected forward prices because, while there is no incentive to store product, current demands may be consistent with prices which are higher than expected future prices. Thus, netbacks calculated form current product prices may overstate, but not understate, crude oil values.[18]

The "tunnel" is formed by the "simple" netback value constituting the "floor" (high output of low value residual fuel) and the "complex" netback value constituting for the "ceiling" (high output of high value gasolines). In general, spot crude prices should track the "tunnel" over time. When spot prices exceed the "ceiling" for any reason, such as a short-term excess of buying interest over selling interest in the market, they should quickly fall back into the "tunnel", as refiners will not purchase them at higher prices (due to negative marginal returns from product sales). Should spot prices drop below the "floor," they should be bid back up as refiners with even the simplest equipment will be able to profitably process the crude. These hypotheses will be tested in the next section.

Historical Evidence

The Tunnel Theory was tested against actual market conditions for Forties crude from February 1981 through July 1983. The period was chosen because of data constraints (weekly spot crude price assessments were first published in August 1980) and because U.S. oil price decontrol took place in late January 1981. The period also coincides with DFSC's SPR procurements following the resumption of oil fill after the Iranian Revolution.

Forties is a high quality low sulfur crude oil which is well known refiners in the Atlantic Basin (North ica and Western Europe). The weekly a sment in Platt's Oilgram Price Report i d to indicate the spot price of Forties. ekly netbacks are calculated from spot ct prices in Platt's.[8] The "fl a simple netback calculated fro erdam spot barge prices which reflects the low complexity of European refineries,[16] and the ceiling is a complex netback calculated from U.S. Gulf Coast waterborne prices.[10] Complex forward netbacks are calculated from U.S. Gulf Coast forward prices (spot prices for future delivery periods) as assessed by Oil Buyer's Guide and Oil Price Information Service.[5, 6]

A simple forward netback has not been estimated because comparable data on forward prices are not available for European markets. The following events are of note:

1. Early 1981 - With high levels of oil inventories and a high rate of Saudi crude production, the market weakens. Netbacks decline and the spot price of Forties closely parallels the floor of the tunnel.

2. June 1981 - Rising product prices raise the floor above the spot price. Forties prices follow within two weeks.

3. August 1981 - An expected OPEC agreement on price and production policy firms spot crude prices. Product markets don't react. Spot Forties prices fall back to prior levels.

4. September 1981 - Nigeria grants deep discounts off of term contract levels. Spot Forties prices fall below the floor as buyers withdraw from the market but then recover as product price levels are unaffected.

5. October 1981 - Nigeria grants further discounts. Spot Forties prices fall below a rising floor, then recover rapidly.

6. November 1981-January 1982 - The tunnel "inverts" as a soft U.S. products market results in falling U.S. spot product prices and drives the ceiling below the floor. European markets begin to collapse in January. The spot Forties price continue to parallel the floor.

7. February-March 1982 - In rapidly collapsing product markets, spot Forties prices fall below the floor, but parallels the forward ceiling, which is lower still.

8. April-June 1982 - Spot Forties prices move upward rapidly with sharply rising netbacks as the markets firm following an apparently successful OPEC agreement to restrict output. On two occasions when spot prices exceeded the forward ceiling, they quickly fell back within the tunnel.

9. July 1982 - Crude market firms as Iran invades Iraq. Product markets are unmoved. Spot prices fall back and rapidly plunge toward the floor.

10. August-November 1982 - The spot price parallels a rising floor as concern builds about the adequacy of heating oil stocks. After mid-October, the spot prices parallel falling floor and ceiling values as warm winter weather weakens the heating oil market.

11. December 1982-January 1983 - The tunnel "inverts" as the glut of heating oil drives U.S. values below the floor. Hectic covering of oversold positions by trading firms keeps the spot Forties price above the ceiling, though they parallel its trend.

12. January-March 1983 - Spot prices drop rapidly, following the tunnel ceiling closely, as OPEC once again fails to agree on a policy to stabilize the market and inventories are liquidated in anticipation of a price collapse. The spot prices re-enter the tunnel in March.

13. April-August 1983 - Spot prices rise generally with netbacks and remain within the tunnel as product markets recover from low inventory levels. When netbacks dropped sharply for two weeks in May, spot prices did also.

The following observations can be made regarding the relationship between spot crude prices and the tunnel:

1. Spot price trends parallel spot netback trends very closely over time. Very short-term spot fluctuations tend to "correct" quickly if netback values are relatively unchanged. An emerging trend in netback values leads spot prices slightly.

2. Spot prices tend to remain in the tunnel over time, as expected.

3. The forward netback is a better indicator of trends and ceiling values than the current netback. This was most apparent in the February-March 1982 period when spot prices fell to levels well below the floor, but below and closely parallel to the forward ceiling value. This is consistent with the notion that current spot crude prices should be based on expected future market conditions (as indicated by the forward netback values).

4. The U.S. ceiling remained generally above the European floor. On two occasions when the tunnel "inverted," the European values subsequently dropped sharply due to product shipments from the U.S. This is due to the higher consumption (and consequent refinery output) of relatively low value residual fuels and heating oils in Europe, and the emergence of the U.S. as an export center in the last two years.

5. The high percentage of heating oil and residual output (two fuels with a strong winter demand pattern) in the simple netback formula suggests that the floor of the tunnel will be high and thus support a relatively high level of spot prices during the Fall and Winter quarters.

Market analyses based on price discovery and the study of the tunnel were key inputs into decisions to defer purchases of spot crude in January and Febraury 1983. Spot crude prices were slightly lagging a pronounced downward trend in netback values as high product inventories were liquidated during a warm winter. Bearish psychology developed about price trends. DFSC's eventual purchase occurred in March after the market had dropped by $2.80 per barrel, resulting in a savings of $5.6 million on acquisition of two million barrels of North Sea oil. Observation of the seasonal trend in the floor has resulted in advice to limit spot buying in the Fall and Winter calendar quarters and to make term contracts prior to Fall when general market conditions are weaker. This advice has been successfully followed during the last two years with term contracts being awarded prior to seasonal spot price run-ups.

CONCLUSIONS

From the analysis of the historical evidence regarding spot price behavior, the following

conclusions and recommendations are made:

1. The Tunnel Theory explains spot crude price formation and defines its limits very well. It is particularly good for determining whether rapid changes in market price levels are likely to be sustained.

2. Due to the seasonality of the major components of the floor values, Fall and Winter are not good periods to be in the spot crude market due to relatively strong heating oil and residual fuel markets during those periods. DFSC should seek to minimize its spot crude oil requirements during the Fall and Winter quarters by lining up term supplies prior to those periods.

3. The following decision rules are proposed, subject to price reasonableness and the size and urgency of the purchase requirement:

a. When the spot price is below the floor, buy, as prices will rise rapidly.

b. When the spot price is above the ceiling, withdraw from the market because prices should fall due to being overpriced in terms of their value.

c. When the tunnel is inverted and prices are above the ceiling, withdraw from the market as crude is overpriced in terms of the U.S. market.

d. When short term crude price movement is not accompanied by similar changes in its product value, purchase decisions should be based on the relative direction of the movement. Sharp increases in spot prices relative to product values are a "don't buy" signal, even if prices are within the tunnel.

The Tunnel Theory is a valuable analytical tool for market research in the spot crude market. In a procurement where requirements are deferrable and the solicitation is open and continuous with frequent purchase opportunities, timing is a key to cost minimization. Analysis of tunnel behavior and spot prices over time has resulted in determination of the best times of the calendar to be in the spot and term contract markets - Spring and Summer. The technique has also been useful in determining the likely duration of extremely short-term crude market price behavior. These have been important inputs to the SPR acquisition decision process at DFSC, and have resulted in cost savings to the government.

The Tunnel Theory has been used in short-run decision problems where the key unknown is the likely short-term market price level. The durations of the market anomalies which it identifies are measured in days and weeks. The technique is helpful in answering the question, "Given product market conditions, what should be the level of spot crude prices?"

The weakness of the Tunnel Theory is that it does not predict "turning points" in crude price trends, as these are found to be determined by changing conditions in the refined product markets. However, given product market conditions, it explains spot crude price behavior very well.

The Tunnel Theory is based on the idea that the key to understanding crude price movement is the movement of product prices. This is due to the derived nature of demand for raw materials. This direction of causality is the opposite of some oil price forcasting models which seek to project product prices based on crude price movements.[11] DFSC's analysis demonstrates that that chain of causation (crude price to product price) is not characteristic of short-term price behavior in the oil market.

The Tunnel Theory framework has promoted greater understanding of the dynamics of spot crude market and has resulted in both improved acquisition decisions and identification of further avenues of fruitful research. Future research into spot crude price prediction should focus on supply/demand/inventory relationships in the product markets with an effort to predict turning points in refined product price trends. The formation of expectations is another research topic of importance, as spot crude values today must be based on expected future returns. Finally, some technical analytical tools, such as moving averages or chart interpretation merit attention as possible trend indicators. Successful identification of major trend changes would represent an advance over the Tunnel Theory as it would enable longer term price movements to be predicted with greater potential cost savings to the U.S. government.

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MULTINATIONAL APPLICATIONS AND INNOVATIONS

Panel Moderator: Colonel Michael M. McMillan
Director for International Acquisition
Office of the Deputy Under Secretary of
Defense for Acquisition Management

Papers:

New Initiatives in International Programs
by John S. W. Fargher, Jr.

Rationalization, Standardization, and Interoperability: Protecting U.S. Interests in the Process
by James H. Gill

FMS (Foreign Military Sales) Support Opportunities of the 1980/90s in SE Asia
by Harold L. Segerson

AD-P002813

NEW INITIATIVES IN INTERNATIONAL PROGRAMS

John S. W. Fargher, Jr., Naval Air Rework Facility

ABSTRACT

The paper entitled "Management of Multinational Programs" based upon the research results contained in the Joint Logistics Commanders' Guide for the Management of Multinational Programs developed by the author, was presented in the 1982 Federal Acquisition Research Symposium Proceedings. This paper is intended to provide an update of new initiatives developed and implemented since the paper and guide were published. Examples of two new international programs, the U.S. Army/U.S. Marine Corps Light Armored Vehicle (LAV) and the U.S. Army Advanced Attack Helicopter (AAH), are presented. The author had the privilege to serve as the Deputy Project Manager on the LAV and consultant to the AAH Program Manager to establish an international consortium for coproduction of the Advanced Attack Helicopter.

INTRODUCTION

The Department of Defense and our NATO allies have made great strides to standardize, or at least interoperable, equipment (including weapons systems, ammunition and fuel) of the allied forces committed to NATO. In a report[2] issued to Congress by the Secretary of Defense, it is documented that progress has been made in strengthening the alliance conventional forces and adapting the alliance defense posture to the changing threats of the 1980's. The NATO Periodic Armaments Planning System (PAPS) is now contributing to the process of improving standardization within the alliance. Conventional defenses are to be improved by taking advantage of emerging technologies with an urgent priority.

Much still needs to be done, however, to improve NATO defense cooperation and collaboration. The family of weapons concept needs to be expanded to allocate development of new weapons types beyond air-to-air missiles and antitank guided weapons. General and reciprocal memoranda of understanding have been and will continue to be used to remove artificial trade barriers. Coproducttion is another tool that is to be selectively employed to provide standardized systems. Direct industry-to-industry agreements providing greater defense industry cooperation and collaboration is the keystone to the two-way street, increasing trade of defense equipment in both directions across the Atlantic. Greater defense cooperation within NATO serves the dual purpose of enhancing our NATO military capabilities and serving to deter Soviet agression by a strong, vital Alliance.

OVERVIEW

The cooperation required for codevelopment, coproduction and armaments collaboration for achieving weapons standardization and interoperability is fundamentally a political and economic issue beyond that of a military problem. Recognizing this, the real burden of achieving standardization rests with the civilian side of NATO, especially the Conference of National Armaments Directors (CNAD) and the various groups under the CNAD. The DoD has strongly supported various initiatives for cooperative armaments programs within the NATO Alliance.

Before 1979, common technical requirements for weapons systems were achieved on an ad hoc basis as a result of information exchanges in the Main Armaments Groups of the CNAD. The Periodic Armaments Planning System (PAPS) has taken the place of these information exchanges, resulting in a documented decision process at various milestones in the development process. PAPS is comparable to the DoD Major Systems Acquisition Process.[3] There are currently over 46 projects within the PAPS process. A full report on those projects is contained in reference 2.

DOD MULTINATIONAL INITIATIVES

Four major efforts have constituted the DoD multinational initiatives in 1982 and 1983. The Under Secretary of Defense for Research and Engineering, Dr. DeLauer, announced a "source selection" test program to our Allies on 1 March 1983.[4] The program is designed to test the concept of providing credit in source selection for cooperative industrial arrangements between U.S. and other NATO industry. It is designed to provide an incentive for more effective use of industrial resources in the Alliance. Technical excellence and cost are still to be the primary factors to be considered in the source selection, however. It is felt that even with this caveat, greater industry-to-industry cooperation will be encouraged. Request for Proposal (RFP) language for incentivizing multinational collaboration and conditions for the test program were passed to the Military Departments also on 1 March 1983. Three research and development programs for each of the Military Departments were designated for the test program. These are:

USAF

- NATO Identification Friend or Foe (IFF) Mark XV
- Low Cost Powered Dispenser (LOC POD)
- Pyrophoric Flare

USN

- Mine Neutralization System for Mine Sweeper Hunter (MSH)
- Surface Ship Magnetic Silencing
- Single Ship Deep Sweep

USA

- Improved Conventional Mine System (ICOMS)
- NATO IFF Mark XV (Joint with USAF)
- To be determined at a later date

Within Section D, evaluation and award factors, of the RFP within general considerations, the following language was provided to the Military Departments:

SECTION D - EVALUATION AND AWARD FACTORS
EVALUATION CRITERIA

A. GENERAL CONSIDERATIONS.

"2. A detailed evaluation will be made of the offeror's proposals. The Government's initiative to promote NATO Standardization and Interoperability make it desirable to attract participation by contractors from other NATO nations. Offerors are expressly encouraged to seek out and involve foreign concerns from other NATO countries as prospective industrial partners or sub-contractors as early as practical. NATO Industrial Collaboration is an item of consideration in the management area and the Government will give consideration to those offerors who best demonstrate actual accomplishment or the potential for meaningful and active participation of NATO concerns.

3. The Government may award more than one contract on the basis of this solicitation. This is to increase the competitive environment and to avoid the possibility of a failure in the event the first technical approach is not successful. As this acquisition is primarily a technical competition, the Government reserves the right to award to other than the low offerors. Alternate proposals will be evaluated using the same procedures and criteria. In making this integrated assessment, the descending order of importance of the evaluation areas listed below will be observed:

a. Technical

b. Cost (including Life Cycle Cost, Instant Contract Price and Option Price)

c. Management

(1) NATO Industrial Collaboration"[4]

The second initiative is a task force convened by the Defense Science Board (DSB) to examine the obstacles to and initiatives for greater industry-to-industry collaboration within the Alliance.[5] Two efforts are being undertaken; one, U.S. and Europe (mostly NATO) and another with other areas (e.g., Japan). Only the U.S. and Europe study has been released, thus the other area's study cannot be reported on at this time (September 1983). The DSB Task Force on Industry-to-Industry International Armaments Cooperation is composed of the following membership:

TASK FORCE MEMBERSHIP

Dr. Malcolm R. Currie, Chairman
SR VP and GP PRESIDENT--HUGHES

Mr. Gerald Sullivan
INTERNATIONAL PROGRAMS--USDRE

Major General Richard C. Bowman (Retired)
VP--RBI

Mr. Dale W. Church
SURREY AND MORSE

Mr. H. K. Hebeler
PRESIDENT--BOEING AEROSPACE

Dr. Donald A. Hicks
SR VP--NORTHROP

Mr. William H. Hulse
VP--WESTINGHOUSE

Dr. Walter LaBerge
VP--LOCKHEED MISSILES AND SPACE

Mr. Robert N. Parker
SR VP--VOUGHT

Mr. Herbert F. Rogers
VP--GENERAL DYNAMICS

Dr. Joseph F. Shea
SR VP--RAYTHEON

Mr. Arthur Stanziano
VP--HAZELTINE

Dr. Michael I. Yarymovych
VP--ROCKWELL INT'L

The task force held five meetings in the United States from June 1982 through January 1983; four special meetings in Brussels on 18-21 Oct 1982, involving NATO industrialists (2 days), NATO Parliamentarians, NATO Armaments Directors and the U.S. Delegation to NATO; and Congressional interviews by Dr. Donald Hicks. Ten Congressional interviews were conducted with the following committees represented: Senate Foreign Relations, Senate Armed Services, House Foreign Affairs and House Armed Services. A technology transfer sub-group headed by Dr. Michael Yarymovych was also formed. The membership and responsibilities of the subgroup is as follows:

TECHNOLOGY TRANSFER SUBGROUP

DR. MICHAEL I. YARYMOVYCH, CHAIRMAN

BOARD OF "TECHNOLOGIST-STATESMEN" FOR EXAMINATION OF MCTL

Mr. J. P. Munson.....Computers
Dr. A. M. Lovelace.....Materials; Chemistry
Dr. D. N. Tanimoto.....Directed Energy
Dr. A. N. Chester.....Electronic Components; Semiconductors
Dr. L. R. Weisberg.....Sensors; Instrumentation
Mr. R. L. Cattoi.....Communications
Mr. G. S. Schairer.....Vehicles

The task force accepted the approach that the DOD policy for increased industry-to-industry cooperation with Allies requires trading off advanced U.S. technology for increased Alliance effectiveness. It was recognized that this policy may lead, in time, to increasing foreign competition. The purpose of the task force is to "identify U.S. and allied government procedures and policies to incentivize U.S. industry to work more effectively with industries of allies in armaments cooperation programs."[5] The scope includes:

- o IDENTIFY IMPEDIMENTS - RECOMMEND RESOLUTIONS
- o DETERMINE OPTIMUM USE OF COOPERATIVE MECHANISMS
- o PROGRAM INITIATIVES FOR GREATER INTEROPERABILITY AND STANDARDIZATION
- o IDENTIFY INDUSTRY-TO-INDUSTRY COOPERATION INCENTIVES
- o HOW MAINTAIN VIABLE U.S. INDUSTRIAL BASE WHILE MOVING TO AN ALLIANCE-WIDE INDUSTRIAL BASE
- o ADDRESS ISSUE OF TECHNOLOGY TRANSFER
- o DETERMINE MORE EFFECTIVE ORGANIZATIONAL APPROACHES WITHIN OSD

The task force concluded that there has been significant progress on industrial cooperation in the last decade and that a broad infrastructure for cooperation exists, but many trends and impediments are occurring which will inhibit future industry-to-industry cooperation. Strong specific government policy decisions and actions and involvement of industry can reverse these trends. Motivations for industrial cooperation vary based upon the side of the Atlantic the participant comes from. The U.S. DOD desires a more cohesive Alliance with partners bearing a greater share of the costs, positive psychological climate to help Alliance relations and "will to defend," more efficient Alliance-wide industrial base and lower total investment, and increased military capability through standardization and interoperability and superior equipment. The task force concluded, however, that there are many disparate views from the Services, OSD, Congress and the State Department. The foreign governments motivations are characterized by the following: a more efficient military alliance, jobs are a prime consideration, monetary balance of trade, national technology base, and desire to protect defense industry as a national asset which requires exports to be viable. Foreign industry desires access to the large U.S. defense market, the ability to build a technology base, and a product base for third-country sales in order to survive. U.S. industry is more pragmatic and business oriented, desiring possible expansion of markets or license fees, possible exploitation of existing R&D investments, and help on increasingly tough offset requirements for business abroad. The long term benefits are viewed as mixed, however.

The task force also concluded that the current environment is leading to increasing protectionism on both sides; Congress overriding DOD commitments; actions that are contradictory to announced policies such as program cancellations and reluctance of the Services for multinational programs; and unclear, fragmented and often unimplemented U.S. policies on technology transfer, third country sales, waivers, and intellectual property rights. There will continue to be a large disparity in military R&D investment between the U.S. and Europe. Controversial factors in the current climate for industrial arms cooperation include increased offset demands by NATO countries, a rise in technical competence of European industry, European desire for "partnership as equal," view by Europeans that coproduction is sometimes of questionable value, and the criticality of third country sales to European and some U.S. industries. The major positive factors are the European government need for major development partners (e.g. Tornado); increasing U.S.-European cooperation at small system/subsystem/subcontract levels; and willingness of U.S. industry to support industrial cooperation if it clearly is supported by U.S. national policy, appropriate laws and regulations, and makes business sense. The major impediments are a lack of early agreement by governments on requirements; security procedures; a mismatch between competition in U.S. procurements and European chosen instrument contracts; and the

DOD organization without a senior advocate, little OSD control over the Services, difficult approval process, and an unwieldly organization.

The findings and recommendations of the DSB task force are divided into sixteen areas. These are contained at Appendix A. In summary the task force stated that "industry-to-industry initiatives can be enhanced significantly by reducing specific impediments and creating positive incentives" but it "requires unambiguous policy and a number of doable actions by DOD...and a steadfast commitment."[5]

The third initiative is a DOS task group on International Coproduction/Industrial Participation Agreements chartered by the Under Secretary of Defense for Policy USD(P) and Under Secretary of Defense for Research and Engineering. The group, with OSD and Service representation, addressed the issues confronting international arms collaboration and the objectives, programs, and policies of DOD to meet the increasing complexity of international programs. The deliberations of the task group began in September 1981, integrating the views of industry and DOD managers with its own corporate experience. In its report, the following are the major recommendations:

"•The DOD should continue to participate in arms collaboration efforts as they can contribute to national security objectives; however, it must be selective in its participation and ensure that US interests are actually served.

•US industry should be involved at each stage of project development.

•The DOD should continue refusing to guarantee offsets; and industry's offset offers should be reviewed as they impact on the DOD and national security.

•Decisions affecting pricing of programs (such as waiver of USG charges and "Buy America") should be more consistent and should reflect overall national security interests.

•DOD procedures, such as procurement practices, should be modified to take cognizance of international industrial bidding.

•Technology transfer considerations should be integrated into the collaborative program process.

•DOD needs a new procedure to evaluate key programs and give special attention to those proposed collaborative deals which have major ramifications.

•The OSD/Service organizational review, coordination, and negotiation of programs needs to be clarified and streamlined."[6]

Specific, detailed recommendations, issue and problem statement, discussion and actions required as approved by USDR&E and USD(P) are contained in the report. Plans have been formulated to update DOD Directive 2000.9 to include coproduction/codevelopment following the conclusion of the task group's study. The Secretaries approved the establishment of an International Program Policy Formulation Council at the Deputy Assistant Secretary level from USDRE, ASD(ISA), ASD(ISP), OSD(GC), ASD(C), Dir (PA&E), ASD(MRA&L), DSAA, the Military Departments and a representative of the Department of State. The US Trade Representative, Treasury, and Commerce will also participate as observers. This council is to systematically review proposed programs and cordinate at three stages in a program's evolution: (a) before a formal commitment is made with another country to enter into program discussions, (b) before the draft program is submitted to the country, and (c) during final OSD staffing of the program for approval.

In an effort to improve dialogue with leaders of American industry on defense trade and industrial base issues, the DOD and U.S. Trade Representatives have chartered a new Defense Policy Advisory Committee on Trade (DPACT). As the fourth DOD initiative, the DPACT will, among other things, help focus the attention of American defense industry on the importance of our standardization and interoperability objectives within NATO and elicit ideas on how best to achieve them.

The major irritation to NATO programs has been the restrictions prohibiting DOD purchase from NATO allies of items containing foreign specialty metals. Waiver authority was granted to the Secretary of Defense in 1977. The waiver authority was not renewed in the FY-82 DOD Appropriations Act. The FY-83 continuing resolution exempted weapons systems made outside the U.S., if their procurement is necessary to comply with agreements with foreign governments. This language thus prohibits purchasing of foreign-built components and subsystems to U.S. systems on general defense items. Our allies are disquieted and continue to voice strong opposition to these restrictions. The current restrictions could seriously undermine the NATO effort to exploit emerging technologies through codevelopment and coproduction arrangements.

LIGHT ARMORED VEHICLE

The U.S. Army and Marine Corps have selected a Light Armored Vehicle produced by General Motors of Canada for procurement. It is of interest that over 60% of the items included in the vehicle are of U.S. manufacture. The Marine Corps LAV Battalion will provide enhanced firepower and maneuverability. The LAV family will include helicopter transportable configurations which will utilize light armor for protection from small arms and artillery fragmentation. The initial procurement will be the 25mm Gun Vehicle (LAV-25) with other mission-role vehicles such as Command and Control (LAV-C^2), Motor Carrier (LAV-M) and Antitank (LAV-AT) being considered for follow-on procurement. The GM of Canada LAV was selected following a competitive test and evaluation of four candidate vehicles. The Marine Corps FY-82 funding is $41.3 million for the procurement of 60 LAV-25s. FY-83 funding is $94.7 million for 134 LAVs. The LAV is an "off the shelf competitive procurement.

The LAV program was conceived at the start as an international competition. Using a "missionized request for proposal (RFP)" the USMC initiated the competition by stating only the minimum requirements, planning for pre-planned product improvements (P3I) if the contractors could not meet all "desired" capabilities. The missionized RFP was issued to industry for comment prior to the formal prototype RFP. This helped shorten the process by allowing the government to gain additional knowledge of what industry could provide, allowed for industry comments to improve the formal RFP so that changes to the formal RFP are minimized, and allows industry to prepare for the formal RFP. Seven contractors responded to the prototype RFP: Giat (France) teamed with A.M. General (US), Enjezsa (Brazil) teamed with Bell Aerospace (US), FMC (US) with their improved Belgian Armored Personnel Carrier, Arrowpoint (US), Alvis (UK) teamed with Martin-Marrieta (US), Cadillac Gage (US) with two proposals, and GM of Canada with an improved Swiss MOWAG vehicle. Because this was an "off the shelf" procurement, offerors had to deliver three vehicles in two months after date of award of the prototype contract and a fourth vehicle three months later. The first three vehicles consisted of one vehicle with a 75mm to 105mm antitank gun (all contractors picked the Belgian 90mm Cockerill MK3) and two vehicles with the 25mm Bushmaster in a two-man turret, a squad leader (crew commander) and six infantryman in the back (nine men total). Four contracts were awarded: Alvis for the tracked Stormer and Scorpian vehicles, GM of Canada with an improved 8x8 MOWAG, and Cadillac Gage with the V-150 4x4 vehicle and the V-300 6x6 vehicle.

In a Secretary of Defense Decision Memorandum, dated 5 May 81, approving the USMC Light Armored Vehicle Mission Element Needs Statement (MENS), the Deputy Secretary of Defense directed that LAV become a joint USA/USMC program with the Army as the Executive Service, the USMC provide the Program Manager and the USMC Initial Operational Capability (IOC) date of 1983 be met. The program management responsibility transitioned from the Marine Corps Development and Education Command (MCDEC) to the U.S. Army Tank Automotive Command (TACOM) in October 1981.

Testing of the prototypes began 1 Nov 83 with the delivery of the first three vehicles. Automotive testing was accomplished at Yuma Proving Ground, AZ. Operational testing was conducted at 29 Palms, CA. Seven months of testing on extremely difficult varieties of terrain was a severe test of reliability, maintainability and durability. While testing was ongoing, the production RFP was issued to the Contractors. Test results were fed to each contractor to provide feedback for the fourth vehicle and response to the production RFP. Based upon testing results, response to the production RFP and production costs, a multiyear contract for vehicle deliveries and other prototype LAV family vehicles (LAV-C^2, LAV-M, and LAV-AT) was awarded in September 82. Other mission roles considered are the air defense, engineer, electronic counter measures, and logistics. The assault gun (Belgian 90mm Cockerill MK3) was the subject of a DOD Foreign Weapons Evaluation, but did not meet U.S. weapons safety criteria (double fuse safety).

The LAV is an example of what industry can provide when asked and what competition and concurrency can accomplish to shorten the acquisition process even with international implications. A comparison of a current vehicle and the LAV proves the point that none of this affects performance. The M-113 Armored Personnel Carrier with over twenty years of improvements as a reliablity of 443 mean miles between failure (MMBF). The M-113 carries only a pintel-mounted .50 caliber machine gun. The GM of Canada test vehicles with a hydraulically stabilized two-man turret and the 25mm Bushmaster had over 1700 MMBF in the severe testing environment.

ADVANCED ATTACK HELICOPTER

The APACHE will be the US Army quick-reacting, airborne antitank weapon. Terrain limitations and the unfavorable NATO/Warsaw Pact balance in armor dictate the need for a system that can fly quickly to the heaviest enemy penetration and destroy, disrupt or delay the attack long enough for friendly armor and ground units to reach the scene. A decision to begin production was made in March 1982. The AAH System consists of the basic AH-64 helicopter and a mission equipment package (MEP) which includes the HELLFIRE Modular Missile System, the 30mm area weapon subsystem, a 2.75-inch aerial rocket system, and a Target Acquisition Designation Sight (TADS) and Pilot Night Vision Sensor (PNVS). The MEP should offer signifi-

cant standardization and interoperability potential and was designed so that it could be coproduced and integrated into a variety of helicopter airframes. Areas of critical technology transfer associated with any essential coproduction efforts have been identified.

The M230E1 30mm Chain Gun and its ammunition are designed to be fully interoperable with the British ADEN and the French DEFA ammunition. The primary and alternate fuels, fuel receptacles and lubricants are also interoperable. The AAH Program Manager (PM) has actively pursued a commitment to improve NATO's conventional force capability through increased standardisation and interoperability. The coproduction of the AH-64 and/or its mission equipment would provide a significant contribution to the NATO effort to close a serious gap in West European defense. French, German, Italian and United Kingdom delegations have visited Hughes Helicopter and Martin Marietta to look at and be briefed on the AAH and its MEP. To increase the NATO countries' understanding and appreciation of the AAH weapon system, pilots from the UK, Italy and Germany have received flight training with the AAH PNVS. During Summer 1982, an AH-64 was demonstrated to both US and German army units in Germany, and the aircraft participated in the UK air show at Farnborough.

The AAH represents a definite challenge for coproduction. The AAH is a program with four prime contractors - Hughes Helicopter for the airframe and as the weapon system integrator, General Electric for the T-700 engines, Rockwell for the HELLFIRE and Martin-Marietta for the TADS/PNVS - and thirty nine major subcontractors. To integrate the consortium, the prime contractor for the air vehicle, Hughes Helicopter, was chosen as the integrating contractor for the overseas efforts, even though the air vehicle may not even be part of the international program. Technology is transferred via licensing agreements and licensed production from each individual U.S. contractor to European companies.

In order to determine which subsystems and components of the subsystems are to be produced in the U.S. rather than coproduced, an affordability analysis was conducted. The affordability analysis utilizes the work breakdown structure (WBS) as the framework for analysis, each subsystem being priced out for European coproduction. This is accomplished by providing a technical data package (minus some critical functions) to European vendors to be priced out for production and then comparing this price to the U.S. price. If the price is competitive that subsystem is considered for coproduction.

A NATO Rationalization, Standardization and Interoperability (RSI) Plan was developed as a joint contractor and AAH Program Management Office effort with consulting services provided by the Defense Systems Management College (myself). The plan identified milestones for coproduction for the four alternatives: 1) AAH with U.S. Mission equipment package (MEP), 2) AAH with a Europeanized MEP to include the HOT missile system, 3) a European airframe (A-129, BO-105, PAH-2, or Lynx) with the U.S. MEP, and 4) a European airframe with a Europeanized MEP. Full plans were developed for these alternatives to include research and development of the Europeanized MEP. Phased transfer of critical technologies was also included based upon U.S. release dates for these technologies. The AAH NATO RSI Plan also identified modes of technology transfer (licensing agreement and licensed production), areas of interoperability already achieved by the AAH to include standardized subsystems and compliance with ABCA Air Standards and NATO Standardization Agreements (STANAGs), and efforts to achieve further standardization and interoperability.

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APPENDIX A

DEFENSE SCIENCE BOARD TASK FORCE ON INDUSTRY-TO-INDUSTRY INTERNATIONAL ARMAMENTS COOPERATION
FINDINGS AND RECOMMENDATIONS

#1 NEED FOR CLEAR DOD POLICY AND COMMITMENT

FINDINGS

1.1 Administration and Congressional policies on arms cooperation unclear to U.S. industry and to NATO governments and industry

1.2 DOD's commitment and ability to achieve program stability are in question. Feeling that we will break commitments at convenience of U.S. Government and industry

1.3 SECDEF proposal to NATO on "Exploitation of Emerging Technologies" provides powerful opportunity to reaffirm policy and stimulate cooperative programs

RECOMMENDATIONS

1-1 Reaffirm policy and broad objectives for increased industry-to-industry cooperation in NATO Alliance - must be clear and unambiguous to services, industry, Congress and Europe, and policies of services must conform
(SECDEF)

1-2 Reinforce policy with specific invitation to North Atlantic Alliance for cooperative efforts on "Emerging Technologies Thrust." Consider offering several of our weapons and C^2 programs for joint development and dual production
(SECDEF)

1-3 Support agreements already made - e.g., family of weapons AMRAAM/ASRAAM and ANTI-TANK; MLRS/TGW; GPS. (Let Europeans be first to break agreements)
(SECDEF)

1-4 Discuss these actions with U.S. industry as means of introducing them as new policy
(USDRE)

1-5 Implement policy in procurement and other regulations and seek any necessary legislation
(USDRE)

#2 PROPER ROLES OF U.S. GOVERNMENT AND INDUSTRY

FINDINGS

2.1 In international defense arena, industry cannot "do it by itself"...government must play an essential role

2.2 Problem has been to define the appropriate roles for each - large differences between services and OSD views

2.3 U.S. Government should play an enabling role versus detailed execution

2.4 Greater participation by industry in formulating government agreements in collaborative programs

2.5 Rights and needs of industry must be recognized as an incentive

- Reasonable license fees without government dictation
- Recognition of ownership of intellectual property rights

RECOMMENDATIONS

2-1 Policy directive within DOD

- Clarify the purpose and scope of Gov't-to-Gov't MOUs in establishing cooperative programs
- Gov't set only broad guidelines within which industry can operate
- Participation by affected companies in formulating and reviewing Gov't MOUs
- Proper role of industry in negotiating the implementing industry-to-industry agreements
- Protection of intellectual property rights/licensing rights of industry

ACTION: DEPSECDE

#3 TECHNOLOGY TRANSFER

FINDINGS

3.1 Technology transfer is an essential part of industry-to-industry collaboration. "Involvement" necessary for success (DSB 1978)

3.2 Some concerns about technology transfers building commercial competitors for U.S. industry

3.3 Leakage to Soviet Block is a valid concern - A large concerted effort to attain Western technology

3.4 But...issues of technology transfer/ sharing with NATO and leakage to Soviet

Bloc are sometimes confused. Major Soviet acquisition has been public domain and dual-use technology, not military-technology per se

3.5 Most NATO defense industry respects security as much as our industry does and industry proprietary protections also help

3.6 Not all transfer one way - some valuable European contributions to U.S.

3.7 COCOM clearly needs to be made more effective

3.8 Divided views within administration of some parts of technology transfer policy

3.9 Industry needs technology transfer guidelines for initiatives

3.10 Military Critical Technologies List(MCTL):
- Well written document
- Reference document only, not a "control list" and not per se basis for denials to the West. Control through ITAR, CCL, and COCOM
- Prioritization of entire MCTL impossible, but a start has been made to identify extremely critical technologies
- Can be simplified (per DSB tech transfer subgroup suggestions)
- Would be useful as a guide to industry for planning and self-policing

3.11 New "Interim DOD Policy on Technology Transfer"

- Divided views on new policy
- Appears biased for denial rather than support of collaboration by industrial initiatives
- Omits mention of export policy considerations

- Creates large new bureaucracy which could defeat industry-to-industry cooperation

RECOMMENDATIONS

3-1 Strengthen COCOM by giving it resources and pushing governments to support it

3-2 Update MCTL annually with focus on emerging technologies; concentrate on protecting know-how rather than products per se

3-3 Develop simplified, readable, and unclassified version of MCTL and disseminate to industry for self-policing and planning

3-4 SECDEF should review and approve exports containing extremely critical technologies

3-5 For "final" DOD policy statement on technology transfer...simplify and streamline approval process rather than choking it...include export policy as a consideration. (SECDEF/DEPSEC)

#4 CONGRESSIONAL CONSIDERATIONS

FINDINGS

4.1 Congress is an essential player in cooperative programs

- Congressional concerns must be considered and accommodated where appropriate as policy options evolve

4.2 Many conflicting views

- Strong protectionist tide; general concern over creation of foreign competition

- Much support for cooperation in principle
- But systemic bias will continue to work against cooperative efforts whose visible impact adversely affects constituent economic interests

4.3 Annual congressional budgetary review places cooperative programs in question every year

4.4 "DOD must do better job of communicating and selling long-term benefits"

- National economic and security interests must clearly be served for congressional support

4.5 Nunn-Roth-Glenn Amendment should help

4.6 Congress has supported many cooperative programs when brought into program formulation process (e.g., AWACS, F-16, ROLAND...)

4.7 Large high-visibility programs must be handled on case-by-case basis

4.8 Industry-to-industry cooperation should help to

- Lower political visibility

- Show economic benefits for both/all participants

- Reduce government intrusion

4.9 Industry will have to develop and maintain congressional support. Trade associations can help

4.10 "DOD has no high-level full-time advocate and focus for these important alliance cooperation activities"

RECOMMENDATIONS

4-1 Designate high-level official (a second principal deputy USDRE) to act as key focus for cooperative programs and to spearhead interaction with Congress in establishing, articulating and defending programs

...This is also important for U.S. industry and European perceptions

4-2 Seek congressional approval for major cooperative activities early in the process

4-3 Urge Congress to re-establish oversight subcommittees to review NATO military readiness and broad armament programs and policies

(SECDEF/DEPSEC)

#5 DOD ORGANIZATION FOR ARMAMENTS COOPERATION

FINDINGS

5.1 No senior official to direct and implement cooperative armament activities - apparatus is dispersed through DOD

5.2 Services have autonomy which permits effective veto over cooperative programs

5.3 Most decision authority is separate from the procurement/acquisition chain

5.4 Need adequate staffing to:
- Expedite clearances, approvals
- Provide on-going expertise for int'l management, negotiations, contracting, regs, data rights, waivers
- Mesh with U.S. production base and technology transfer
- Act as experienced contact point for industry

5.5 Two previous SECDEF studies and decisions to move DSAA to the acquisition executive

RECOMMENDATIONS

5-1 Transfer DSAA management and acquisition functions to the acquisition executive and consolicate under the new principal undersecretary for arms cooperation and interoperability

5-2 Leave any policy components of DSAA with ASD(ISP)

5-3 Rename DSAA the "International Arms Cooperation Agency" (IACA)

5-4 Provide adequate staffing including experienced international program negotiators and managers for working with other nations

5-5 Policy remains in US(P); acquisition implementation in USDRE

(SECDEF)

#6 SUPPORT BY U.S. MILITARY SERVICES

FINDINGS

6.1 A widespread perception that services do not want industrial collaboration with NATO

6.2 Services must support or concept will fail

6.3 Splits between OSD and services also allow congress to kill programs

6.4 Some legitimate service concerns
- Pressure from Congress - "Programs Held Hostage"
- Want "best" military capability
- Vice Chiefs - "Need coherent U.S. strategy for technology sharing"

6.5 Services (not OSD) are the customers of U.S. industry so their support for cooperative programs must be convincing

RECOMMENDATIONS

6-1 Place responsibility for cooperative programs under acquisition executive so control over these programs can be exercised through PPBS process

6-2 Service chiefs explicitly announce support for allied arms cooperation and insure that source selection procedures encourage rather than discourage foreign participation when it is competitive and appropriate

6-3 Create high level military positions under the service secretaries, on service staffs, and within acquisition commands to coordinate/establish cooperative programs and insure interoperability

6-4 Semi-annual SECDEF/Service Council meetings to review cooperative efforts

(JT CHIEFS/SECDEF)

#7 TYPES OF COOPERATIVE PROGRAMS

FINDINGS

7.1 Collaboration can take many forms:

- o Two-way street on major systems
  - Regarded as failure by NATO
  - May not be realistic for major systems
- o Co-development
  - Toughest to implement
  - Preferred by Europe
  - Requires balanced partnerships and reciprocal technology sharing
  - Disparity in R&D funding (U.S.-Europe) makes difficult

o Co-production
  - Attractive - provides jobs, standardized equipment
    BUT
  - Some in Europe increasingly view co-production per se as "worst kind of cooperation"; has often created capacity with no follow-on business

7.2 Licensed Production
- Teaching of "know-why as well as know-how" part of license and basis for generating follow-on business

7.3 Subsystems versus major systems
- Major system cooperaation involves unique political situations. Deal with on case-by-case basis
- Subsystems and subcontracting - much potential for expanding industrial collaboration infrastructure
  - - Competition easier; easier to invest in and be technically advanced
  - - Of less concern to Congress

7.4 Only more investment in military R&D by Europe can create technologically balanced partnership and a true alliance-wide industrial base

RECOMMENDATIONS

7-1 SECDEF advocates greater European investment in advanced military R&D in North Atlantic Alliance as basis for a balanced technological partnership, without which extensive codevelopment is unrealistic
(SECDEF)

7-2 Encourage greater cooperation at small system/subsystem/subcontract levels. Initiate actions in services to insure that source selection, procurement and security procedures support rathern than impede this goal
(USDRE)

7-3 Where appropriate, emphasize "licensed production" with less restrictions on other uses of the technology and on third-country sales
(USDRE)

#8 OFFSETS WITHIN NATO

FINDINGS

8.1 Increasing use of direct offsets on a particular program often a problem (U.S.-Europe and within Europe). Used as tool to establish national industrial capabilities and to balance monetary flow (jobs)

8.2 Creating overcapacity in defense industry in NATO - pressure is then to export more to use capacity

8.3 General feeling both in U.S. and Europe that it may be getting out of hand

8.4 "Specialty Metals" restriction severely limits both ability to comply with offset commitments and cooperative efforts

RECOMMENDATIONS

8-1 Install a mechanism for DOD to attain after-the-fact visibility on all direct program offsets involving defense products, including component and subsystem procurements

8-2 DOD should initiate a detailed study on the long-range burdens and benefits

8-3 Provide strong support for congressional restoration of the "Foreign Government Agreement" exemption to specialty metals amendment (USDRE AND USP)

#9 THIRD COUNTRY SALES

FINDINGS

9.1 Agreements on third-country sales critically important to arms collaboration initiatives

9.2 Reasonable access to third-country sales must be assured to enhance viability of cooperative programs

9.3 State Department's restrictions on advance approval of third-country sales are based on policy, not statute

RECOMMENDATIONS

9-1 DOD and State Department meet partners half way at time of program MOU by -
- Offering sales within NATO (when pertinent)
- If necessary, offering also advance agreement on additional acceptable countries, subject to USG review and approval before sale is consumated
- DSB endorses use of time-phased release of products involving sensitive technologies for sale to specified third-countries
(USDRE/USP)

#10 PROCUREMENT REGULATIONS AND PRACTICES

FINDINGS

10.1 DOD policies/directives/instructions/regulations on collaborative programs are complex, ambiguous, and burdensome

10.2 Some of the simplifications and waivers on the F-16 program worked successfully but more needs to be done for future such programs

10.3 On FMS coproduction programs, DOD tends to sell the technical data package and manufacturing rights in competition with the U.S. contractors

RECOMMENDATIONS

10-1 Make simpler and more coherent DOD's policies/directives/instructions/regulations on collaborative programs, as recommended in the DENOON report

10-2 Complete negotiation of upgraded, common quality control document AQAP-1

10-3 Promulgate and enforce DOD instructions that, in collaborative projects, the government-to-government MOU establishes the framework for the industry-to-industry arrangements but leaves the transfer of the data package and rights to the industrial partners (USDRE)

#11 SECURITY IMPEDIMENTS

FINDINGS

11.1 Cumbersome and lengthy security procedures are a significant impediment to technical exchange and cooperation

11.2 Lack of close working relationship and incompatibility of policies and procedures between USDRE and National Disclosure Policy Committee (NDPC).

11.3 Special problem - foreign-owned subsidiaries in U.S.

11.4 USD(P) taking steps to simplify and improve security procedures involving industrial cooperation and foreign ownership

RECOMMENDATIONS

11-1 Complete work on simplification/improvement of procedures and implement them

11-2 Analyze current policies, practices, and responsibilities of NDPC and USDRE with goal of improving coordination and exchange of ideas between them

11-3 Investigate and alleviate to the extent possible the problems of foreign-owned subsidiaries. Consider using the reciprocal security agreements as basis for clearing foreign-owned companies and their personnel.

#12 RECOMMENDED ACTIONS IN NATO

AGREEMENT ON REQUIREMENTS

FINDINGS

12.1 Shared common requirement for a clearly defined product is a key basis for cooperation

12.2 Early agreements on military requirements significantly stimulate industrial initiatives

12.3 The "Periodic Armaments Planning System" (PAPS) is right-on and should be supported

NIAG

FINDINGS

12.4 NIAG is the only official NATO industrial forum

- Provides mechanism for early industrial dialog and advice to NATO authorities

12.5 But NIAG is not influential in NATO Program ActionsNATO INVESTMENT IN TECHNOLOGY

NATO INVESTMENT IN TECHNOLOGY

FINDINGS

12.6 Collaboration works best with balanced partners and starting with collaborative efforts in research

12.7 Imbalance in military R&B investment between U.S. and rest of NATO will continue the status quo

12.8 Mutual technology is a powerful catalyst for cooperation

12.9 Europe is investing significantly in civil technology

AGREEMENT ON REQUIREMENTS

RECOMMENDATIONS

12-1 Put steam behind PAPS. Make PAPS an explicit and active part of the DOD/Service Planning and DSARC Review Process

NIAG

RECOMMENDATION

12-2 Strengthen NIAG; make it attractive for particiaption by senior executives by giving it a stronger advisory role in program decisions

"Industrial cooperation starts at the top" (USDRE)

NATO INVESTMENT IN TECHNOLOGY

RECOMMENDATION

12-3 SECDEF propose goals of technological leadership across the alliance along with a policy of technology exchange. Propose greater NATO investment in exploratory R&D as the catalyst (SECDEF)

#13 SECOND SOURCE AND P^3/I IN EUROPE

FINDINGS

13.1 The opportunity to participate as possible second sources and in evolutionary product improvements would significantly increase NATO's adoption of U.S. systems and enhance standardization and interoperability

13.2 Would be a positive move towards alliance-wide industrial base (NUNN-ROTH-GLENN Amendment)

RECOMMENDATIONS

13-1 Explore second-sourcing in NATO Europe in situations with following conditions:

- Co-production for European market
- Second-source could supply limited percentage of U.S. requirements. Together with European market, could be competitive

13-2 Requires Legislative action

13-3 As an inducement for co-production, offer significant participation in product improvement programs

#14 SOME CURRENT OPPORTUNITIES FOR INDUSTRY-TO-INDUSTRY COOPERATION

FINDINGS AND RECOMMENDATIONS

14.1 Secretary Weinberger initiatives on "Emerging Technologies"

14.2 Delauer industry-industry source selection incentive programs ("nine small programs")

14.3 AWACS evolution including ground environment

14.4 GPS NAVSTAR user equipment and missile guidance

14.5 NATO FRIGATE

14.6 AMRAAM and applications of AMRAAM

14.7 ASRAAM

14.8 Next generation anti-tank

14.9 Minesweeper Hunter (MSH)

14.10 Air Commands and Control System (ACCS)

#15 IMPORTANCE OF INTEROPERABILITY

FINDINGS

15.1 The primary purpose of NATO-wide program collaboration is increased military effectiveness for the Alliance

15.2 Interoperability of systems and equipment is of paramount importance

- There has been over-emphasis on standardization per se
- Some progress but not enough. More success in competitive commercial world than in defense equipment
- Will be even more important in the future

15.3 Stronger demand for interoperability would enhance a supportive climate and infrastructure for industry-to-industry initiatives.

RECOMMENDATIONS

15-1 Demand interoperability wherever it is militarily important

- Address iln every service and DOD system development and review processes and in NATO
- Emphasize interoperability over standardization
- Establish appropriate interoperability criteria for various classes of systems in NATO

15-2 Sponsor on-going development of analytical models and specific operational analyses for scenarios with and without interoperability of systems to drive home the point to all NATO governments and industries (USDRE)

#16 U.S. INVESTMENT IN R&D

MOST IMPORTANT OF ALL!

FINDINGS

16.1 U.S. fears that it is losing technological lead are well founded. Will affect defense and national economy in the long run

16.2 Technology diffusion is an inherent part of a free and competitive society

16.3 We cannot maintain our technological posture by conservation and protection alone - we must run faster than the other guys

16.4 IR&D is a key to U.S. industry technological strength

16.5 An aggressive national policy on technological goals and commensurate investment will encourage industrial initiatives involving technology transfer and creation of competition

16.6 Our industrial base in a national asset and should be recognized and supported as such

RECOMMENDATIONS

16-1 Presidential statement that a national goal is to achiee and maintain clear superiority in civil and military technology

16-2 SECDEF statement that a cornerstone of our national security strategy is, explicitly, technological superiority

16-3 Investments in IR&D, research, exploratory and advanced developments should match this policy. In DOD substantial increase in "6.1, 6.2, 6.3A" funding

16-4 IR&D funding for industry must be maintained free from detailed controls. Total IR&D ceilings should be increased

THE PRESIDENT
SECDEF
USDRE

ADP002814

RATIONALIZATION, STANDARDIZATION AND INTEROPERABILITY: PROTECTING U.S. INTERESTS IN THE PROCESS

James H. Gill, University of Southern California

ABSTRACT

The military necessity for RSI increases as the possibility of a non-nuclear European war increases. The No-First-Use of nuclear weapons policy that has received considerable attention in the recent past must inevitably dictate that conventional force capabilities be significantly improved.

One of the most dramatic force multipliers as it were, is the capability of all nations to utilize weapon systems that are either the same (Standardization) or at least compatible in fuel, ammunition and communication.

National Security may be viewed in the context of capability and credibility. If a nation (or alliance) has no capability, the credibility of its actions is not significant. NATO has been viewed by its members a vehicle whereby the synergistic sum is greater than the sum of its parts. The viability of NATO will ultimately depend upon the willingness of the individual states to sacrifice their national interests for the advantage of projecting a combined conventional capability sufficiently credible to deter Soviet aggression. For this reason alone, a rational RSI Program must be an integral part of U.S./NATO strategic planning.

INTRODUCTION

Rationalization, Standardization and Interoperability (RSI) is an attempt to maximize efficiency and effectiveness, minimize duplication and avoid waste. If this concept appears almost too good to be true, this is indeed the case. As with the road to hell, the path to ineffective logistics is often paved with good intentions.

Before we can understand exactly how RSI is meant to function, we must first understand the integration of logistics into strategy and tactics. These three elements are fundamental to the capability of a nation to fight, and win, a war.

Strategy may be seen to be the methodical planning for attainment of a goal. It has come to represent the grand design for succesful resolution of conflict. Tactics are the application of power in accordance with the dictates of strategy; for example: the utilization of specific forces, weapon systems and operational techniques. Logistics are the source of power, resources which allow the tactics to accomplish its goals. "Logistics is the creation and sustaining of military capability to effectively serve our National objectives."[1]

The probability of conducting a successful military campaign diminishes in direct proportion to the inability of decision-makers to coordinate these interrelated elements. The integration of each element with the other is a prerequisite for successful conduct of hostilities. "Prior planning prevents poor performance" is more than a slogan, it is a reality.

It is therefore evident that logistic planning should be conducted concurrently, coordinated and integrated with operational planning which involves strategy and tactics. There is little value to a grand strategic plan or brilliant tactical development if the means to success are not provided as well. Without access to the fuel necessary to power his tanks, the forces of Rommel could not successfully implement the tactics required to carry out his grand strategy for the North African theatre.

Now, if we may assume that the principle applies to individual states, is it not fair to extend that theory to an organization of states such as NATO? The need for an effective logistical capability should therefore transcend the traditional desire for sovereign control by individual states. While strategy and tactics are the glamour elements of national security, logistics are often the true difference in determining the outcome of a conflict. Unfortunately, little attention is often given to this fact when funding is to be allocated for force planning and procurement.

What then is to be meant by the expression logistical planning? Logistics have been defined as "the whole of a system which involves four principal processes. They are requirements determination, acquisition, distribution and conservation. These processes of logistics must function to provide utility value to resources. That is, they must provide the right thing in the right configuration at the right time."[2]

The aforementioned processes of logistics may be defined as follows:

1. Requirements determination - the process of establishing that which is to be needed, when it will be needed, the quantity, quality and place of performance.

2. Acquisition - the procurement of goods, services and resources to provide for the predetermined requirements.

3. *Distribution* - provides for the movement of the necessary goods, services and resources to the place where they are required.

4. Conservation - the process used to maintain, improve or replace those resources that we currently have. In a world of limited resources conservation ensures that we make the best of that which we are provided.

RSI is an attempt on the part of the Allies to develop and implement a logistical system that will take best advantage to provide those resources that are necessary to successfully implement strategy and tactics. The problems that could develop for instance, due to the inability of a German tank to fire American ammunition or use British Petrol, Oil and Lubricants (POL) may prove catastrophic.

What is meant by the terms Rationaliation, Standardization and Interoperability? These terms are similar yet independent in concept. For this reason a brief description of each would prove useful.

The term Rationalization is perhaps the most difficult to define. Simply put, it is the attempt at making the most out of that which you already have. It is similar to the wise shopper, purchasing those items which will yield the maximum return on investment. Rationalization may take the form of any of a number of guises. It applies to both weapons and nonweapons (personnel, resource management, commmunications etc.). It may be said that the derivation of the meaning lies within the word itself, that is, the rational application of resource management to maximize the effectiveness and minimize the expense. It is a broad term which encompasses both Standardization and Interoperability.

Standardization is the attempt to ensure that weapon systems that are utilized by a variety of countries will be the same. This concept infringes upon much of the territory of sovereignty. A nation will inevitably be non-receptive to suggestions of dependency for weapons procurement, manufacturing or supply. In light of the historical relationship between many of the members of the NATO Alliance (two World Wars) it is not reasonable to expect standardization to prove successful on a large scale.

Interoperability represents the most logical alternative to standardization. It merely presumes that weapons of one country will operate in conjunction with those systems of other countries. Thus, a German tank would continue to operate while utilizing British fuel, ammunition or communications equipment. Interoperability, while falling somewhat short of the optimum, standardization, offers the flexibility needed to ensure logistical continuity, i.e., the tanks will continue to function.

A certain amount of confusion is understandable in light of the somewhat ambiguous use of these terms in military writing. With regard to Rationalization in particular, some confusion appears to be almost inevitable due to the somewhat ambiguous nature of the term. As Bernard Udis explains: "Among Europeans, both in industry and government, there is no standard definition of the term - rationalization. To most, it seems to imply a reduction of 'excess' production capacity or of possible redundant weapon systems."[3]

The implication that may be derived from the concept of RSI is that collaboration and consolidation reduces waste, duplicative procedures and inefficiency. There has been a concerted effort on the part of the individual members of the NATO community toward consolidation within the individual borders. Thus, it appears, as in the view of Mr. Udis that, "Given the extensive record of consolidation and merger ..., it would appear that the limits to merger of aerospace companies at the national level have been approached, if not reached. Significant further efforts at consolidation would appear to be limited to corporate merger across national boundaries or collaboration by independent national firms on common cross-national products."[4]

There is a vocal segment of the Alliance population on both sides of the Atlantic who are intrinsically opposed to the nuclear defense of western civilization. The manifestation of this anti-nuclear movement appears with the Freeze initiatives in the United States as well as the Greens movement in West Germany. The debate has brought to light the potential for nuclear devastation in the event of a miscalculation on the part of either side in the Cold War. There is fundamental agreement between those who advocate an increase in the nuclear capabilities of NATO and those who would rather negotiate a reduction in force levels of both the USSR and the U.S. This agreement concerns the necessity that NATO retain the capability to defend itself against the threat of Soviet confrontation - both military and political. It is also recognized that it is imperative that the means with which NATO defends itself remain non-nuclear for as long as is possible in light of a Soviet conventional attack. The avoidance of crossing the nuclear threshold is a fundamental necessity. The nuclear umbrella that has been provided by the United States during the post-war period has served to allow an inherent inequality of conventional forces vis-a-vis the Soviet Union. While Europe was attempting to rebuild its ravaged industrial base, the U.S. policy of Massive Retaliation would serve as a shield against the hordes

from the East. The U.S. vital interest in a Europe that was democratically oriented became a cornerstone of U.S. strategic policy.

This umbrella remained relatively waterproof as U.S. policy moved from Massive Retaliation to Assured Destruction and then Mutual Assured Destruction. The threat to the Soviet Union remained viable as long as the U.S. TRIAD (Bombers, missiles & submarines) could inflict a level of damage deemed unacceptable to Soviet planners. European states could utilize expenditures to upgrade industrial facilities, improve social programs and create a robust economy, often at the expense of competing U.S. economic interests. The prospect of an overwhelming Soviet conventional threat could be dismissed as long as a tripwire of American forces threatened the introduction of U.S. strategic nuclear weapons to any Soviet incursion.

A massive Soviet buildup, both of Strategic and Theater Nuclear Forces, has cast doubt upon the sincerity of the U.S. commitment to the security of Western Europe. The prospect of a withdrawal of U.S. troops from Europe is no longer dismissed as an idle threat. In the light of increasing economic competition, Americans want to know why they should underwrite the security requirements of competitors in the World marketplace. These people are demanding a more equitable contribution from the Europeans toward their own defense. In light of this historical relationship, an increasing number of Americans are in favor of applying the "Nixon Doctrine" to Western Europe. The strategic policy that emerged during the period that followed the Vietnam War centered upon the necessity for each nation to defend itself from external threats. The U.S. shield of strategic nuclear weapons would be provided to deter nuclear aggression. When other forms of aggression were involved, the U.S. would provide appropriate military and economic assistance, the threatened nations would be called upon to provide the manpower.

The U.S. policy for force structure planing was directly affected by this doctrine. Secretary of Defense Melvin R. Laird further interpreted this doctrine in 1972 to mean that: "It is neither practical nor the most effective way to build a lasting structure of peace to rely solely upon the national and manpower resources of the United States to provide this capability .... many of our allies are already prosperous; others are rapidly becoming so. Therefore, it is realistic and more effective that the burden of protecting peace and freedom should be shared more fully by our allies and friends .... In planning to meet (existing threats to the Free World) .... we intend to use the Total Force approach. We will plan to use all appropriate resources for deterrence - U. S. and Free World - to capitalize on the potential of available assets."[5]

This new approach to the defense force structure was to be the basis for new initiatives in achieving a better balance between the U.S. and its allies in terms of politics, economics and security.

The concept of a balance of obligations is not reciprocated by many Europeans. There is a disagreement as to the means of allocating responsibility. Many fear that the doctrine is merely the first step in a series of maneuvers whereby the U.S. seeks to decouple itself from its European commitments. Others feel that the U.S. seeks to guarantee its sanctuary from a regional nuclear war involving NATO and the East.

It is generally accepted by most responsible military and political analysts that a significant upgrading of NATO forces must be accomplished if the stalemate is to be maintained. There are several methods by which this could be done. The need for an upgrade in nuclear capabilities has been accepted - on paper - by NATO Europe. The introduction of Pershing II and cruise missiles is merely an attempt on the part of the allies to counter a Soviet nuclear buildup of the last several years. While this action may effectively negate the threat of a Soviet escalation to nuclear level, it does not address the fundamental disparity in conventional force levels. There is a general agreement between those who advocate a policy of No-First-Use of nuclear weapons (McGeorge Bundy et al) and those who would retain the nuclear threat as trump card i.e., discourage conventional invasion through the threat of nuclear escalation by allies. They agree that the disparity of conventional systems between NATO and the Soviet bloc is inherently destablizing and requires immediate redress.

A prime factor in the determination of a nation's willingness to accomodate the goals of RSI relates to political realities. A fundamental precept in international relations is the concept of national interest. A corollary to that precept is the concept of sovereignty.

We may see that, as Morgenthau tells us: "Independence signifies the particular aspect of the supreme authority of the individual nation which consists in the exclusion of the authority of any other nation. The statement that the nation is the supreme authority--that is, sovereign within a certain territory--

logically implies that it is independent and that there is no authority above it."[6]

This sovereign right must be maintained, even in the environment of an alliance. The control of military forces-troops and logistics - must not be removed or relegated to the concept of the greater good.

National security, may be viewed in the context of capability and credibility. If a nation has no capability, the credibility of its actions is not significant. NATO has been viewed by its members as a vehicle whereby the synergistic sum is greater than its parts. The viability of NATO will ultimately depend upon the willingness of the individual states to sacrifice their individual national interests for the advantage of projecting a combined capability sufficiently credible to act as a deterrent to Soviet aggression.

Three factors enter into this decision: "This interplay between a common supernational interest, separate national interests, and American power will determine whether or not NATO will accomplish what it has set out to do."[7]

The division of loyalty between alliance and nation is not the issue. Rather, the question of perception of threat and selective response becomes critical. There is a very fine line between a defensive military alliance and the growth of a potential adversary. Soviet perceptions are critical. A resolute willingness to defend Western Europe is imperative if a deterrent force capability is to be respected.

The current dialogue over contribution to the NATO force loading is an ongoing issue. While there is a significant disagreement relative to the allocation of obligation, there is a fundamental agreement that a significant Soviet buildup must be countered by a similar NATO increase in capability.

This increase in capability may be accomplished by a number of possible approaches. The increase in contributions on the part of the individual members is one alternative. This approach is not considered to be especially attractive in any economic climate, but least of all in the current worldwide recession. It is becoming more and more difficult to finance increased military requirements as the total pie (government budgets) shrinks. Many Europeans blame U.S. policy for their economic malaise, and are therefore less than sympathetic to U.S. demands for increased European contributions.

A second alternative to increase the security of the Alliance would be the possibility of significant mutual balanced force reductions (MBFR). These reductions do not appear likely, and to count on the Soviets to assist the West in its dilemma is neither prudent nor reasonable.

A third approach to increased capability relates to RSI. This approach stresses the increased effectiveness that may be attained through more efficient logistical managerial procedures. Rationalization, Standardization and Interoperability, while hardly a panacea, offers some hope of reducing costs, avoiding duplication and increasing effectiveness of currently displayed systems.

In his article "NATO Standardization: An Organizational Analysis", James R. Carlton identifies four distinct periods of NATO efforts: A. the institutional phase (1949-57), B. a consortium or extramural period (1957-68), C. the European initiative phase (1968-74), and D. the two-way street period (1974-80). Insofar as this format provides a vehicle to understand the way things came to be as they are today, I will also utilize the format.

A. Institutional Phase - due to the overwhelming presence of the U. S. weapons systems, thanks in large part to the American Military Assistance Program, de facto standardization existed during this period. The rehabilitation of a Europe devastated by WW II eventually included a resurrection of the arms industries. Standardization represented a solidarity of will on the part of NATO to resist Communist aggression. It was also good for U.S. arms producers who would otherwise have had to scale down production due to the demobilization.

B. Consortium on Extramural Approach - In large response to the perceived threat associated with the successful Soviet Sputnik tests, Europe was pursuaded to assume its "fair share" of defense requirements. NATO was successful in standardizing five major U.S. systems during this phase; the M-44 torpedo, the F-104 Fighter, the Hawk, Sidewinder and Bullpup missiles. Standardization meant the purchase of American weapon systems by NATO European allies.

C. European Initiative Phase - The U.S. was suffering through the pangs of disllusionment with foreign commitment engendered by the disaster in Vietnam during this phase. An increase in Soviet threat perception coupled with a fear of U.S. disengagement-i.e., the Mansfield Amendment - forced a reassessment of the viability of NATO. The creation of the Eurogroup in 1968 was to stimulate increased European cooperation in the acquisition of

weapon systems. This organization represented an attempt to provide a forum for European views on political and strategic issues.

D. Two Way Street Period - With the conclusion of the Vietnam episode America once more looked to Europe and the Alliance. The legacy of Vietnam was twofold in relation to NATO. First, and perhaps foremost, the moral attitude of righteous anti-communism had been tarnished by European opposition to our involvement in Southeast Asia. America was labeled imperialistic aggressors by many in those nations for whom it had fought two wars to preserve.

Second, the cost to readiness of robbing Peter (NATO) to pay Paul (Vietnam) was significant. Combat readiness of NATO forces had declined drastically. In order to upgrade our capabilities, standardization was stressed both by the President as well as Congress: The United States began an initiative to make standardization in research and development--as well as procurement and support--an integral part of the NATO planning process. Public Law 93-365 instructed the U.S. Secretary of Defense to: "Undertake a specific assessment of the costs and possible loss of nonnuclear combat effectiveness of the military forces of the North Atlantic Treaty Organization members, including the United States, to standardize weapons systems, ammunition, fuel and other military impediments for land, air and navel forces. The Secretary of Defense shall also develop a list of standardization actions that could improve the overall North Atlantic Treaty Organization nonnuclear defense capabilities or save resources for the alliance as a whole."[8]

A major impediment to European-American cooperation in arms procurement was the "Buy American Act" which required U.S. firms to discriminate in favor of American companies when competing with European ones. The "DOD Appropriation Act of 1977" instructed the Secretary to waive the "Buy American Act" whenever there was an acceptable European system available; thus it recognized the Eurogroup's success and the need for even greater cooperation. PL-94-361 states: "That standardization of weapons and equipment within the Alliance on the basis of the 'two-way street' concept of cooperation in defense procurement between Europe and North America could only work in a realistic sense if the European nations operate on a united and collective basis. Accordingly the Congress encourages the governments of Europe to accelerate their present efforts to achieve European armaments collaboration among all Euorpean members of the Alliance."[9]

Two additional attempts were made during this period to reduce tensions between the U.S. and NATO. First, the removal of restrictions relating to the procurement of specialty metals by the Appropriations Act of 1977. Second, the Long-Term Defense Program.

The most authoritative statement of the NATO Alliance position regarding standardization is found in the Long-Term Defense Program (LTDP). Adopted in May 1978 by the Heads of State and Defense Ministers of the NATO member nations, the LTDP represents a unified attempt to identify, acknowledge and resolve continuing alliance deficiencies in light of the Warsaw pact buildup of forces. It was accepted that the criteria for the mutual defense effort must be:

a. collective

b. affordable and realistic

c. cooperative

d. prioritized

e. specifically planned

In 1978 receipt of a study by the Defense Science Board the Undersecretary of Defense for Research and Engineering presented a plan to Congress for cooperative arms development and procurement in NATO. The plan proposed four elements:

Element 1. General Memoranda of Understandings - waived Buy National Requirements under bilateral MOU's with several NATO nations.

Element 2. Dual Production - a cooperative venture whereby one nation makes available to another those armaments and systems it has developed. Economic compensation to the industry of the nation sponsoring the R&D would be made via licensing agreements.

Element 3. NATO Organization - in order to present alliance wide weapons requirements early in the acquisition cycle a Periodic Armaments Planning System (PAPS) is being developed. The PAPS encourages early consideration of multilateral requirements, identifies opportunities for collaboration in development and provides for an annual written report of planned armaments development in support of NATO.

Element 4. The Family of Weapons (FOW) - seeks to eliminate waste and duplication in R&D programs for improved NATO armaments.

Weapons proposals which satisfy similar missions should be "examined in the aggregate and allocated development." This process requires formation of a consortia to be headed by an industry of the big three (United Kingdom, France or Germany). The ultimate result would be improved competition and involvement by both European and American Industry.[10]

The evolutionary nature of RSI within the Atlantic Alliance has been in conjunction with the changing economic relationship between Europe and the United States. As Europe assumed the role of an equal with the U.S. they desired a more comprehensive role, both in the decision-making process and the implementation of those decisions. This change was inevitable since the U.S. wanted to defray the cost of arming NATO while Europe wanted more control over decisions that could ultimately impact their national security.

It is apparent that the ultimate success or failure of the evolving cooperative efforts will depend upon the ability of each nation within the Alliance to demonstrate to the rest, the sincerity of their commitment.

CONCLUSION

There is a fundamental agreement on the part of the NATO Allies that significant changes must be made to the force structure. Improved theater nuclear force capability has been agreed upon. The disparity in Conventional Force levels must be rectified.

What has not been determined is the actual implementation of the "grand design" of RSI. The economic imperatives of collaborative procurement are such that political realities must be addressed. With unemployment a major factor, it is important that the rationale for weapon system production selection be disseminated extensively.

The problems associated with the transfer of technology is another issue that must be addressed. Competition in the international marketplace for weapon systems is extremely keen. Countries often depend upon the sales of these systems to alleviate cash flow problems associated with a negative balance of payments. Without proper control over technological data, companies can not reasonably be expected to participate in any RSI implementation.

Another important consideration involves the tradeoff between economic, political and strategic facets of NATO Policy. The relative failure of NATO to successfully implement a policy of standardization across the board does not mean that areas of strategic import can not be accomplished. Two highly visible areas are Command Control Communications (C^3) and Consumer Logistics.

The burden of responsibility toward accomplishing RSI will inevitably fall upon the U.S. In light of the historical relationship between NATO Europe and the U.S. there must be evidence of good faith. Platitudes of "two-way streets" are not acceptable in lieu of substantive actions.

The goal of an effective RSI Program is to ensure enhancement of effectiveness with a commensurate savings in cost. "Most immediately, interoperability confers flexibility and perhaps staying power. With greater standardization, the argument runs, a simplification of logistics should be feasible, making it possible to put more resources into front-line forces. This sort of reasoning merges imperceptibly into the more general assertion that all savings arising from collaborative acquisition may be used to put additional resources into the cutting edge of the alliance's order of battle."[11]

While this may indeed be the case regarding military effectiveness, economic priorities must be addressed as well. The impact of weapon system acquisition cost savings versus a resultant loss of jobs in the host country must be balanced quite delicately. There must be significant dialogue between all members when determining the producibility of each NATO country. It is not always the most effective policy to reward solely on cost consideration. Nonetheless cost savings may be attributable to effective application of the principle of RSI. "To do so would be to acknowledge, correctly, that the alliance's sole purpose is not to minimize the expense of equipping itself. Other values and interests relevant to security have a place in the policy reckoning. Ideally, that place is alongside the efficiency criterion in an explicitly-stated framework, where proper account can be taken on the important tradeoffs to be considered. For no one really wants optimum-efficiency if the price is too high in terms of political dissension or economic distress."[12]

In other words a little common sense and respect between the members of the Alliance would go a good deal further than all the pompous pronunciations of Allied cohesiveness. As wars are often too important to be left to Generals, Logistics are too important to be left to Politicians.

FOOTNOTES

1. The Role & Meaning of Logistics, Air Command & Staff College, Course 30 B, p. 24-3.

2. Ibid, p. 24-6.

3. Rationalization in Europe, Bernard Udis, ORBIS, p. 106.

4. Ibid, p. 167.

5. Statement of the Secretary of Defense, Melvin R. Laird, Before the House Armed Services Committee on the FY 72-76 Defense Program, p. 19-22.

6. Politics Among Nations, Hans J. Morgenthau, p. 309.

7. Ibid, p. 508.

8. Appropriation & Authorization Act of 1975, P.L. 93-365.

9. U.S. Congress, Department of Defense, Appropriation & Authorization Act of 1977, P.L. 94-361, 94th Congress, 1976 HR 12438, p. 2.

10. A Plan for the Cooperative Development of Arms in NATO, William J. Perry, Nov 16, 1978.

11. NATO the Next Thirty Years, Allied Cooperation in Armaments Development, Production and Support: A European View, David Greenwood, p. 325.

12. Ibid, p. 325.

FMS (FOREIGN MILITARY SALES) SUPPORT OPPORTUNITIES OF THE 1980/90s IN SE ASIA

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AD-P002815

ABSTRACT

The future sales of modern high technology aircraft and systems to SE Asian countries will establish an extraordinary demand on resources and funds for operational support. The countries will specify in-country assembly of aircraft and/or production of systems and items in the sales agreement. The countries are presently establishing or improving depot level repair capability.

The U.S. aircraft and weapons system industry realizes that the world competitive market requires cost offset programs that enable higher technology work to be placed in the buying countries. DOD and the State Department have recognized the need to assist the SE Asian (ASEAN) countries in developing a higher technology capability through training and assistance in development of more sophisticated electronics and heavy industry.

The stability of the ASEAN countries is very important and deserves every consideration.

INTRODUCTION

During the Vietnam war in 1973-1975, severe problems were encountered in providing support to the Vietnamese Air Force (VNAF) because of the 9,000 mile logistics pipeline to the CONUS for depot level repair. The basic logistics problems were: time required to obtain replacement spares (45-180 days), funding to cover cost of spares pipeline, and transportation.

The funding problems were caused by the expensive cost of transportation, mostly by air lift, and the cost of filling the logistics pipeline that averaged from 120-180 days. It was recognized that the 120-180 day pipeline added an additional $30-50 million dollar funding requirement to the $200 million dollars active spares level required by the VNAF.

In 1973 when the cease-fire was signed, the USAF turned over all the Air Force stock to the VNAF, including a tremendous amount of reparable items. Most of these items could not be repaired in Vietnam and many required major depot level repair. The USAF civilian advisors to the VNAF established many special programs o return the reparables to the CONUS where the carcasses were urgently required to keep the depot (organic and contractor) repair lines flowing. Also, depot level repair facilities for jet engines, helicopter transmissions and rotor blades, that had been previously planned in Vietnam, were established.

In late 1973, it became apparent that an excessive amount of the available funds for operational support of the VNAF was being spent on transportation and filling the logistics pipeline. In addition, the unemployment rate in Vietnam was around 23 percent, which was causing severe internal problems for the Vietnamese government. The large U.S. and third country contractor facilities were shut down or operating at minimum capacity; thus, their workforce, that had been trained, was operating with a minimum amount of workload. The hourly wage for the U.S. trained employees was also very low since it was based on the national wage rate; for example, a U.S. trained and certified welder earned 25 cents an hour or $2.25 for a nine hour day.

The U.S. Ambassador asked the Chief of the Defense Attache Office and the Chief of the Air Force Division to establish a plan with the Commercial Attache on how reparable items could be overhauled in-country. This would utilize some of the excess trained work force and improve operational support by reducing the logistics pipeline and transportation costs. An in-country joint venture depot overhaul program was developed.

The plan in 1974 was to have U.S. contractors establish joint venture operations in facilities that were built to support the U.S. forces. The U.S. companies would provide management, technical data, special depot equipment and start up funding. Unfortunately the war took a turn for the worse and higher priorities were established to requisition, for immediate delivery, the items needed to fight the North Vietnamese. This caused the program to be delayed, and eventually cancelled because of the continuing increase in the war.

In 1977, the Republic of Korea Air Force (ROKAF) desired to build an organic capability to accomplish depot level maintenance of fighter aircraft, (F-4 & F-5) engines (J-79, J-85, etc) and Cargo Aircraft (C-123, C-54 and C-47). This would enhance the operational support of the ROKAF. It would also develop a depot level trained workforce and provide lower logistics costs through use of a lower hourly wage rate and reduction of the logistics pipeline back to the United States or another country.

The International Logistics Center, Air Logistics Centers, Joint United States Military Assistance Group and ROKAF worked together to

develop the plans, identify the depot level equipment, spares, training and level of funding required. After the plans had been approved and the initial group of items ordered, the President of Korea decreed that the capability would be placed at Kim Hae so Korea could start development of its national aircraft industry. Several high level ROKAF officers retired to manage the aircraft and engine overhaul companies.

The Asian countries have stated in the Pacific Area Senior Officer's Logistics meetings that they want the U.S. to take the lead in development of joint use logistics support facilities that will increase the capabilities of the region, shorten the logistics pipeline and provide cost offsets. (3)

In addition, all countries around the world that are buying new generation aircraft are requiring maximum in-country production, assembly, technology exchange and offset prior to agreeing to the purchase. It is hoped that the above has set the stage to look at logistics support problems and opportunities of the future in Southeast Asia.

CONCEPT

Southeast Asia is very important to the security of the free world since it has critical natural resources and control of strategic waterways through which naval forces and commerce must pass. (1) (2)

Many long range planning documents indicate that the ASEAN part of the world will continue to grow in importance in the future. The purpose of this article is to identify ways to:

- Improve depot level support for
  - New aircraft
  - Engines
  - Systems
  - Support equipment
  - Modifications
- Reduce FMS workload on USAF depots in critical areas
- Foster cooperation
- Develop
  - Foreign engineers
  - Logistics program managers
- Enhance technology/educational base of region
- Develop surge capability
  - Maintenance
  - Forward supply point(s)

Some of the major problems facing the ASEAN countries or any country acquiring new aircraft or aerospace systems are:

- Complexity of future aircraft systems
- Expensive lifetime support for avionics, software and engines
- Security consideration of hardware and software
- Technology transfer and proprietary restrictions
- Costs of depot level equipment, management effort, stocks of spares and material needed for operational support
- Securing cooperation between the U.S. and the acquiring country.

The above problems have been experienced by the European Participating Group countries in support of the F-16 aircraft.

A primary consideration is to identify ways to provide cost effective and timely depot level support for the new aircraft, engines, systems, (primarily avionics, weapons delivery and software) support equipment and modifications, and the new technologies that are used. A quantum leap in technology is being built into the new aircraft; therefore, reliability and maintainability are vastly improved. However, random failures may complicate operational support. Also, the extremely expensive "life cycle" costs for avionics and software have not been a serious problem for the F-5 or C-130.

Some of the major problems for the U.S. government and contractors will be:

- Transfer of modern technology and use of contractor proprietary data, especially for the F-16/F-20
- Ensure that releasability constraints of electronic warfare (EW), operational flight programs (OFP), software and hardware programs are maintained
- How to pay management costs for support of these new requirements

The cost of an F-16 depot is expected to exceed $100 million dollars. The engine and government furnished systems are not included and will be significant additional costs. Estimated cost and lead time of avionics depot equipment is:

	Lead time	Cost
- SASS	5-7 years	$ 6-10 M
- AIS	5 years	$10-12 M

- F-16 Avionics Depot (ITAs only)
  - -- Analog tester (203 SRUs) 14.2M
  - -- Digital tester (247 SRUs) 18.2M
  - -- Microwave tester (26 SRUs) 5.2M

- F-16 Avionics Depot (ATE)
  - -- Analog tester 1.8M
  - -- Digital tester 1.6M
  - -- Microwave tester 2.4M
  - Total $60-65 M

In addition, system testing may be required.

Some of the major problems that have plagued the F-16 European participating industry competitive repair program are:

- Licensing for repair and spare parts
- Data for repair and proprietary processes
- Lack of cooperation between U.S. & European participating industry
- Spares production
- Cost of repair
- Royalties
- Training
- Qualifications

New countries acquiring new aircraft or weapon systems will need to plan for ways to meet the following:

COUNTRY LOGISTICS REQUIREMENTS

- People
  - Managers
  - Engineers/Technicians
- Data Systems
- Facilities
  - Storage
  - Overhaul
- Functions
  - Aircraft overhaul - crash/battle damage repair
  - Avionics repair
  - PMEL
  - Software reprogramming capability
    - OFP Simulators
    - EW
    - ATE
  - Engines
  - Missiles
    - AIM-7/AGM-65/NEW Missiles
  - Support equipment
  - C3

The above has hopefully portrayed the magnitude of the logistics problems that are facing the ASEAN countries.

CONCLUSION

My recommendation is that the USAF and U.S. industry take the lead in developing joint venture/joint usage capabilities that can provide the most support at the least cost to the foreign countries and the U.S. It could build up the regional industrial base and further improve the cooperation between the individual countries and with the U.S. It could provide the following positive aspects:

- shorter pipelines
- use existing or new country facilities
- develop management capability
- reduce duplicate efforts between countries
- reduce costs
- use regional manpower with its economical labor rates
- further develop regional industrial base(s) and improve cooperation among countries
- provide alternate logistics sources for the USAF and perhaps U.S. Navy
- provide a stockage and maintenance surge capability

It would have the following opportunities that must be worked very diligently:

- Develop working agreements between USAF, contractors and ASEAN countries
- Develop changes to regulations, laws, etc., through use of memorandum of agreements between countries.

I propose the U.S. sponsor a Lean and Mean SE Asia Support Activity (SEASA) which could hold the U.S. government umbrella over the program and manage the joint venture contractors. This would give us the capability to use the U.S. data. It would also enable us to control the transfer of technology. The contractors could provide the required engineering skills, peculiar equipment, management, and quality assurance expertise. In addition, it would also provide the countries with an easily identifiable source for repair and common stockage. This could provide

improved visibility of country requirements for follow-on support. It could also enable lateral support to or from PACAF. It would increase visibility of country logistics capabilities, and provide additional opportunities to use training being furnished by colleges, industries, mobile training teams and service schools. Also, it could enhance configuration management which is a mandatory requirement for modern aircraft. It could also help develop a number of qualified second and third tier foreign industrial manufacturing and repair sources. It could also be a central storage location for high cost critical and/or limited use items, i.e., engines, wings and boat tails, casting, forgings, avionics repair items (LRUs/SRUs) and perhaps CAD/PAD/munitions.

The management costs for U.S. management of joint venture contractors can be met by using a variation of the Technical Coordination Group management cost process and/or by applying a minimum FMS administrative surcharge to the contracts.

The "lesson learned" from the F-16 EPI depot repair program is: Agreement on use of data, data rights, royalties, manufacturing or purchasing repair parts, etc, must be established in the contracts with aircraft, engine and systems, manufacturers and their subcontractors prior to signing the first purchase order.

In order to further analyze and develop a program, I propose that the USAF and Industry Associations do the following:

DEVELOP A PROPOSED STUDY GROUP CHARTER

- Review - Existing or readily attained technology
  - Conduct capability study
- Obtain industry assistance
- Develop milestone charts
- Start supporting FMS aircraft
  - U.S. joint venture contractors
- Provide proposed alternate source(s) of support for PACAF

If the above is successful then a further step could be the development and refinement of the proposed solution:

- Establish MOUs
- Review industry advances vs country/contractor capabilities; develop milestones/critical paths
- Identify contractors/training/facilities
- Develop proposals for contractor repair/training
- Identify additional items/subsystems

It may be politically feasible to have the avionics repair work accomplished in countries A&B, and engine overhaul in countries C&D. Crash damage repair could be performed in several countries based on aircraft population and software reprogramming in country Z. The management organization could be in any country or on a U.S. governed island. This would spread out the workload, the technology, and provide at the same time common benefits to each country.

It would also provide a cost effective method of having "behind the lines" surge capability in maintenance and resupply.

In summary, the "lessons learned" from the past and the rapidly changing technology provides a great opportunity. We should plan now how timely and cost effective depot level support can be provided to the Southeast Asian area. The principle motivation should be a desire to provide for a strong defense capability in the area that will be economically sound.

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NOTE

Most of the information in this paper is a result of the authors personal experiences while working for the USAF in Vietnam and in the International Logistics Center. The opinions expressed herein reflect only those of the author and are not necessarily those of the Department of Defense, USAF, or other Federal Agencies.

PRODUCT ASSURANCE

Panel Moderator: Mr. John V. Lavery
Director of Product Assurance
Martin Marietta Orlando Aerospace

Papers:

Quality Assurance--Air Force Logistics Command
by Paul Brown

The Avionics Integrity Program (AVIP)
by Thomas J. Dickman and Lee F. Cheshire

Quality at the Crossroads
by Charles R. Henry and James C. Albini

Incentives for Product Quality Need Contract, Cost, Production and Field Co-Operation
by Edward Theede

A Quality Improvement Strategy for Systems Acquisition
by George J. Thielen

Engine Product Performance Agreements and the Future
by Juanita Vertrees

ADP002816

QUALITY ASSURANCE - AIR FORCE LOGISTICS COMMAND

Colonel Paul Brown, Headquarters Air Force Logistics Command

INTRODUCTION

This paper examines the scope of the Air Force Logistics Command's (AFLC) mission and focuses on current management *indicators and initiatives* related to Quality Assurance. The Quality Assurance discipline within AFLC is tasked with the responsibility of corporate oversight of the quality of workmanship of the commands' products, goods, and services. Since fiscal year 1976, adverse trends have been noted in frequency of customer reported defects on these weapon systems, and several innovative and dramatic steps have been taken to reverse the decline in the technical competence of our work.

In February 1981, the command established a Maintenance Industrial Quality Study Group that was chartered to examine the entire spectrum of quality, with special emphasis on five major categories. The five categories were:

(1) Policy Guidance;
(2) People Programs;
(3) Technology;
(4) Investment Benefits; and
(5) Management Systems.

The ultimate goal of the study was to formulate a quality effort which placed maximum emphasis on defect prevention rather than defect correction. The study concluded with 22 major initiative recommendations, many of which are currently in effect and in operation in our depots. It was anticipated that the fruits of such initiatives would not be visible in the short-term, but the fiscal year 83 operating results do show specific evidence of the favorable impact of the initiatives and the long-term outlook is even more promising.

TEXT

Scope of the AFLC Mission: To support the Air Force weapon systems worldwide, AFLC utilizes five large industrial complexes called Air Logistics Centers (ALCs), and a myriad of other repair sites that include both contractors and other Department of Defense specialized activities. The five ALCs are: (1) Warner Robins, Georgia, responsible for airborne avionics, vehicles, helicopters, the C-141, the C-130s, and the F-15 air superiority fighter; (2) San Antonio, Texas, has the C-5, numerous jet and reciprocating engine responsibility, nuclear ordnance, as well as fuels and lubricants; (3) the Sacramento ALC has the F-111 inventory, the A-10, ground communications electronics, and fluid driven accessories; (4) Oklahoma City ALC is home of the B-52, C-135, and AWACS aircraft, as well as jet engines, hydraulic/pneudraulic transmissions, and the A-7 fighter; and (5) Ogden has the F-4, the F-16, missiles, air munitions, and landing gear. AFLC specialized activities include the Aerospace Guidance and Metrology Center at Newark, Ohio, and the Military Aircraft Storage and Disposition Center (MASDC) in Tucson, Arizona. Contract maintenance centers are in such diverse locations as: Tanagra, Greece (jet engines); Kim Hae, Korea (aircraft); and Bristol, England (aircraft).

In the past fiscal year, over 2,000 aircraft received depot maintenance services, over 6,500 engines, and over 2 million exchangeable items such as radios, pumps, actuators, and other components and subsystems. The five ALCs have a total of some 39,000 blue collar workers devoted to the overhaul effort. When we tally up our 39,000 industrial workers, we find that it ranks us at the "140" position on the Fortune 500--a little smaller than Campbell Soup, and a little bigger than Coca-Cola. The contract effort is more difficult to measure in employee terms, but over 40% of the total depot maintenance program is accomplished on contract.

Quality Indicator Data Sources: Management indicator data comes from two basic categories of sources, internal and external. Internal source data is generated via audits, evaluations, and an automated defect reporting system. External data is available via customer reported defects, audits, consumption data, and mishap investigations. Aircraft and engines are our best product lines to measure workmanship and technical compliance since they have clear and distinct audit trails. These product lines also have mandated customer acceptance inspections, which allow us to examine and analyze variations in customer satisfaction levels worldwide. Exchangeables are a lot tougher. They often sit in serviceable status on the supply shelf for several years before a demand or order is placed; and the particular source of repair may no longer be in that line of business. In any event, our discussion will concentrate on the aircraft and engine product lines, but we recognize that we have a distinct internal weakness in tracking the exchangeable program.

Customer Reported Defect Trends: In our business, defects are categorized as critical, major, or minor. A critical defect could lead to loss of the aircraft and aircrew, while a major defect could lead to loss or unserviceability of a major subsystem or component. Minors accommodate those defects that don't meet the critical or major category. As you might presume, a particular defect on one engine might be classified as critical, but the same defect would be a major on a different engine. For instance, an out-of-rig fuel control on one of the eight engines on a B-52 might be coded as a major defect, while an out-of-rig fuel control on a F-16 is critical (single engine aircraft). In the FY78 time frame, our command noted an alarming increase in the ratio of critical and major defects versus 100

units produced. The adverse trends were not limited to pure organic Air Force depot sources or to contract sources, but rather a linear climb across-the-board at all of our sources of repair.

Our analysis did highlight the increasing age of our weapon systems, and it did focus on the newer technology engines coming into our depots, but those two factors were not enough to justify downplaying the trends. In February 1981, our command established a Maintenance Industrial Quality Study Group that conducted on-scene evaluations at all of our depots and at contractor facilities and other service depots. The group proposed some 22 recommendations, but the major initiatives are as follows:

(1) Implement a tool control program at the organic depots and revise the Defense Acquisition Regulation (DAR) to allow tool control to be a contractual provision with our vendors.

(2) Implement a worker task certification program that would shift the responsibility and credit for properly accomplishing production tasks to the technician (go back to the "craftsman" era).

(3) Enhance the career opportunities of the professional quality work force.

(4) Design and implement Quality Cost Systems.

(5) Standardize and streamline our deficiency reporting system.

(6) Move out on Software Quality Assurance programs.

(7) "Beef up" of the work packages, technical data, and inspection activities on the newer technology engines.

Actions Taken and Results to Date: The 1,700 quality assurance and quality control personnel assigned within the Air Force Logistics Command are now included in a logistician career enhancement program that allows the stellar performers to advance in nontraditional career fields. Production planning and production management career fields now consider quality personnel as eligible for advancement in their arena and vice versa. The Product Acceptance Certification, or PAC Program, is in full swing at our San Antonio ALC. Certain production workers are responsible for their own self-inspection with a minimum of sampling by the quality organization. The "Craftsman" designation is prominently displayed at the work station and the motivational aspects are self-evident. We have completed a pilot project quality cost system at one repair facility, and we have a second test bed in full swing at another. A new, real-time, deficiency reporting system has been designed and funded and is now on the street for source selection. We have published our initial regulatory guidance on software quality assurance and taken action on creating software quality positions at the ALCs.

The customer defect indicators for FY83 show a reversal of the adverse trends, and in the engine area especially, we see dramatic progress toward our pursuit of zero defect goals. Mishap rates are down, and the mishaps attributable to logistics cause factors is ½ of the previous year.

Conclusion/Summary: We have a long way to go, but we are on track and on schedule. Management indicators alerted us in FY78/79 that our work force and our contractor's work force were not producing at an acceptable quality standard. We got on the road, we asked a lot of questions, and we made a lot of observations. We tried to copy the success factors of major industries in the aerospace arena and to apply as many of those "secrets of success" to our own operations. We have not found a way as yet to institute meaningful management indicators on our exchangeable work loads, but we accept that shortfall as a challenge for next year. Our craftsman program is a step toward a return to the cottage industry era, but that step is coupled with the acquisition of the latest equipment for production and inspection. The overhaul and repair business doesn't have the glamour that is bestowed on the acquisition side of the house, but with 75% of the Air Force aircraft inventory now past the eight year old point, it is absolutely essential that the "tired iron" receives the same level of scrutiny and quality assurance that is going into the B-1 bomber.

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THE AVIONICS INTEGRITY PROGRAM (AVIP)

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ADP002817

ABSTRACT

The Avionics Integrity Program (AVIP) is an Aeronautical Systems Division initiative to develop an orderly procedure to assure that we acquire reliable, high quality, and supportable avionics systems. A draft military standard has been prepared and has been distributed for review and comment. The draft standard outlines an orderly process using existing tools in order to assure integrity. The orderly technical process combined with an appropriate contract strategy using incentives is expected to yield the highest probability of success in achieving integrity.

This paper introduces the Avionics Integrity Program (AVIP) and answers the questions often asked regarding the program.

INTRODUCTION

What is the Avionics Integrity Program (AVIP)?

AVIP is an Aeronautical Systems Division, Deputy for Engineering initiative to develop an orderly plan and procedure to assure that we acquire reliable, high quality, supportable avionics with a higher availability than we presently achieve. The effort, modelled after the successful Aircraft Structural Integrity Program (ASIP) and the newer Engine Structural Integrity Program (ENSIP), utilizes a multidisciplined systems engineering approach to identify and eliminate causes of lowered system integrity. AVIP is a guide to both Air Force and industry to identify a proper balance between cost, performance and schedule where the trades may influence system integrity throughout the life cycle. Integrity is a combination of such measures as reliability, maintainability, quality, producibility, lifetime, supportability and availability. AVIP will identify the procedures to achieve that balance in the system acquisition phase. The prime thrust is to define all of the key technical and management activities which must be accomplished at particular times during the acquisition process and assure a balance of cost, schedule, performance and integrity over the avionics system's projected life.

TEXT

Where is AVIP to be applied?

AVIP is to be required for each avionics system acquisition program to guide the "system integrator", who may be the government but more often is a contractor, in considering those aspects of the avionics design that influence integrity. It can be applied at system and subsystem levels. Integrity criteria, reflected in an avionics master plan, will be weighed on a par with cost, schedule and performance criteria during source selection.

What is the scope of AVIP?

AVIP is targeted for avionics systems which include flight critical functions such as flight controls as well as mission essential functions. AVIP techniques are to be applied to any electronics hardware design. Another separate integrity program will address software issues.

How is AVIP applied in an acquisition program?

A draft military standard has been written and has been distributed for comments. The completed AVIP military standard will be used by the avionics system integrator to tailor a program which assures avionics system integrity. A handbook is planned which will support the military standard in providing specifics for tailoring the program to various applications. The handbook will be a dynamic tool and will require updating and training support. An accompanying video taped training package is also being planned as the most efficient way to meet the training needs of management and engineering personnel. The tailored program, submitted in an Avionics Integrity Master Plan with the system proposal, will be a factor in source selection. Furthermore, the Avionics Integrity Master Plan will be used by the program office to monitor progress. The master plan provides a vehicle for establishing and monitoring subvendor requirements. It is recognized that proper business strategies must accompany AVIP for overall program success. Strategies such as contract incentives and reliability improvement warranties (RIW's) may still be needed to supplement the technical discipline provided by AVIP.

What is in the draft military standard?

The draft military standard includes a series of activities organized in stages of the system life cycle. These activities, outlined in table 1, are tailored to the needs of the program in the avionics integrity master plan prepared by the system integrator. A simplified version of the process flow diagram found in the draft standard is

AVIP PROCESS TABLE
(SYSTEM/SUBSYSTEM)

Stage I Design Information	Stage II Preliminary Design	Stage III Design, Analysis & Development	Stage IV Compliance & Production Control	Stage V Force Management
Para 5.1.	Para 5.2.	Para 5.3.	Para 5.4.	Para 5.5.
1. Data Base 2. Integrity reqmnts Reliability Manufacturing Economic Life Maintain/Testability 3. Environ Assess (Mission Profile) 4. Historical Documnt (AIHD) 5. Sys Critical Anal 6. Integrity Allocate 7. Master Plan (AIMP) Environ Mgt Plan Thermal Mgt Plan System Safety Plan Reliability Plan Derating Plan Piece Part Screen Plan Stress Screen Plan Corrosion Plan Qual Assur Plan Worker Qual Prog Plan CAD/CAM Plan Manufacturing Plan Economic Life Plan Maintain Prog Plan Testability Prog Plan	1. Prelim Predict Anal Environ Rel Predict Manu/Produc Cost Pred Economic Life Predict Maintainability Pred 2. Environ Impact Assessment 3. Design Assessment 4. Manufacturing Assess 5. Prelim Sys Trades Sys Avail Prediction Supportability Anal	1. Stress Analysis 2. Environ Impact Assess 3. Design Computer Aid Design Reliability Predict 4. Failure Pred Anal FMECA Fault Tree Analysis Sneak Circuit Anal 5. Trades & Analysis Representative Models Thermal Management Producibility Economic Life Logistic Support Testability Design 6. Derating 7. Revised Install Req 8. Piece Part Control 9. Build Lab Prototype 10. Stress Screening 11. Test, Anal & Fix 12. Failure Diagnosis FRACAS	1. Piece Part Control 2. Build Line Prototype 3. Stress Screening 4. Compliance Tests Laboratory Flight/Ground Qualification Reliability Qual Thermal Management Product Sampling Sys Eff Data Sys Testability Demo Acceptance 5. Environmental Survey 6. Build to Print 7. Process Control Manufacturing Control Computer Aid Manufactrng Product Readiness Review Component Source Control Assembly Control Workmanship Spec & Std Qual/Product Improvement Incoming Inspection Manufact Efficiency Prog	1. Data Base Warranty Life Supportability Data 2. Failure Reporting Sys Expanded Govrn Data Sys Testability On Site Failure Test 3. Environmental Survey Prog 4. Reprocurement to Print

TABLE 1

AVIP PROCESS FLOW DIAGRAM

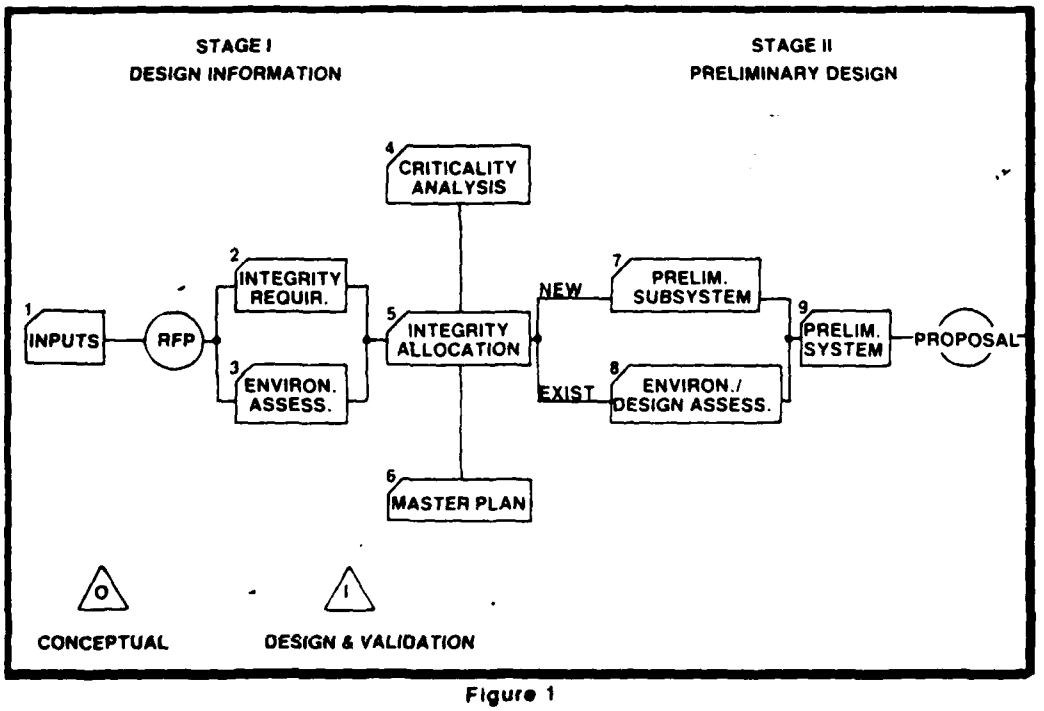

Figure 1

AVIP PROCESS FLOW DIAGRAM

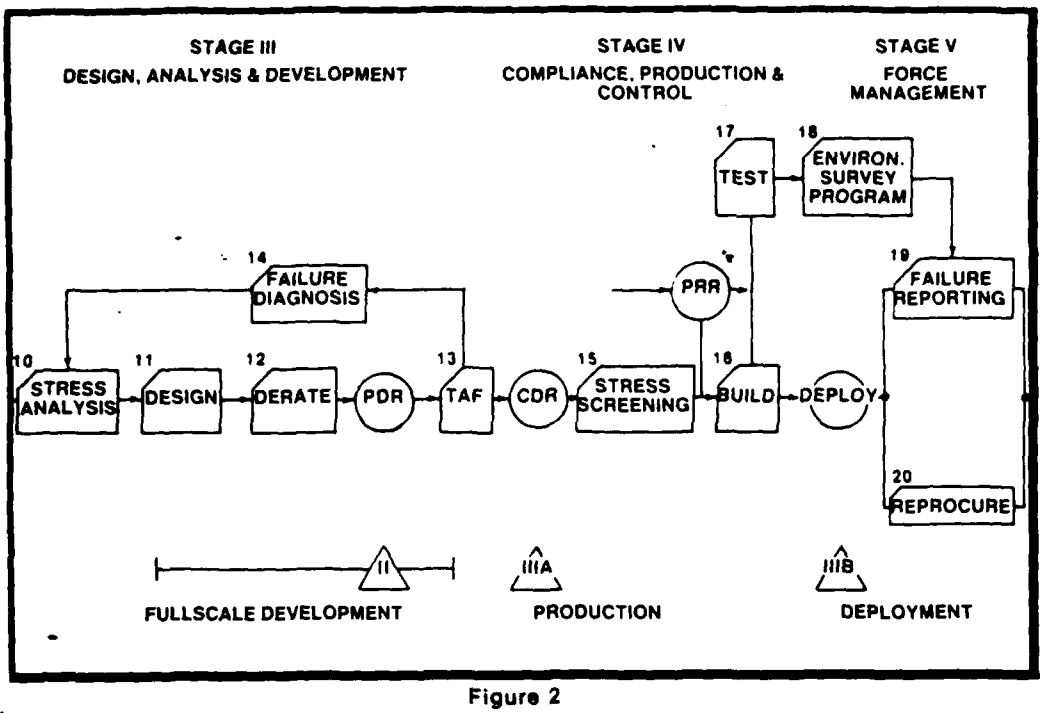

Figure 2

included in figures 1 and 2. The draft standard is written in statement of work language for ease in application to contracts and is organized around the process flow diagram and table. A review of the draft standard will provide a more detailed explanation of the various activities listed.

How will AVIP be applicable to new technologies and architectures?

In future aircraft the use of digital technologies is quickly changing the traditional boundaries between avionics, flight and engine controls, weapon delivery systems and man machine interfaces. Greater amounts of integration and commonality of functions are already becoming a reality in such programs as the F-16 MSIP, Integrated Fire and Flight Control System, HH-60D Nighthawk helicopter and in the commercial development of the Boeing 757 and 767 aircrafts. With flight critical functions and mission essential functions becoming more integrated, integrity requirements of avionics will become more important to future aircraft. New techniques in fault tolerant and low failure electronics will be used to a greater degree in future designs. AVIP establishes the disciplined process for assessing, designing and deploying avionics systems which transcends technology!

What benefits are to be derived from AVIP?

AVIP has been created to improve the avionics acquisition process by establishing design process discipline and increasing awareness of the tradeoffs made during the system life cycle. A fundamental objective of AVIP is to identify and eliminate failure mechanisms that lower integrity. The AVIP support handbook will provide lessons learned and guidance to both the SPO team and the system integrator in order to improve integrity. Since all programs must contend with the limitations in manpower, a benefit to be strived for is to allow the SPO team to function more efficiently with this constraint. Other projected benefits are listed below:

-Standardized process for competitive evaluations

-Improved process control for product consistency

-Reduced risk and improved end product quality

-Improved projection accuracy (costs, schedule, performance,quality)

-Enforcement of common sense in trade offs in development process

-Provide a product assurance reference point for deviations in the technical process

-Provide dynamic lesson learned feedback

-Provide for working level engineer training and input to the process

-Improved field data feedback system

-Identification of physics of failure and reduction of the mechanisms associated with the failures

What is the problem that AVIP is to address?

The current perception is that our complex avionics systems are often not living up to their reliability and availability predictions when they reach the field. The causes of this may be many. Often, it is perceived, that the time, budget and manpower constraints faced by programs today reduce the amount of emphasis placed on the measures of avionics integrity during the system's life. Tradeoffs may be made in the early phases of a program which do not take the measures of integrity fully into account. Hardware problems that appear after the validation and full scale development phases may still impact program costs through ECP actions. The aim of early emphasis on integrity by the Air Force/Industry team will be to identify integrity requirements and provide the technical emphasis needed to eliminate surprises when the systems are fielded.

How is AVIP going to tackle these problems any differently than we do today?

The AVIP heightens awareness of the influence of early program decisions on avionics integrity. It outlines the disciplined process to be followed by the SPO to search for mechanisms which influence integrity. It provides a guide to both USAF and industry which describe lessons learned and techniques that have yielded success in the past. AVIP will provide "assessment points" during the acquisition process (see figure 1 and 2) that will allow the monitoring previously set integrity requirements. The AVIP will not upset the present acquisition process but rather it will supplement the existing regulations. AVIP will also foster improved data feedback from the field within the current Air Force 66-1. In addition AVIP recommends including installation of environmental stress, electrical stress and data bus error recorders in some aircraft. As AVIP matures, the forms of support documentation and emphasis during the design process may be modified as successful approaches are identified. Initially, AVIP is to cause minimum impact on the data requirements that are now standard for fielded systems.

What kind of techniques does AVIP advocate as successful?

We have included many techniques in the draft military standard. A comprehensive list is provided in figure 1. Early definition of and design to the total environment is crucial in achieving integrity improvements. Combined environmental reliability testing (CERT) will yield a demonstrated reliability more representative of that expected in the field. Incoming parts screening in the vendors plant pays dividends to the manufacturer by reducing rework cost and to the government by reducing early infant mortality failures in deployed systems. Line replacable units (LRU's) and shop replaceable units (SRU's) stress screening accomplish similar reductions in deployed system failures. We advocate the reduction or elimination of environmental stresses which increase failure rate. We emphasize stress reduction in the design phase and we track progress through development and deployment. Guidance on derating and environmental stress screening (ESS) are also included in the process.

How does the system integrator use AVIP?

We expect the final documentation products to be a military standard and an associated handbook to highlight those processes which have demonstrated success in the past. In this respect the standard and handbook are written like a MIL-PRIME. A program meeting the criteria of the military standard will be required by contract. The handbook is then usable by the system integrator in developing his proposal and in tailoring his program to the contract. The AVIP provides a means of identifying and quantifying "goodness" characteristics for both the system integrator and the system program office. AVIP will establish mutually accepted quantities of integrity at the outset of a program and will measure these quantities through the development and deployment phases. AVIP notifies the system integrator that the measures that comprise integrity are important and that they are to be assessed during normal review and audit processes. The system integrator will submit an AVIP master plan which defines how the integrity requirements and proposed procedures for testing and monitoring the measures of integrity are to be met.

CONCLUSION

What has AVIP accomplished to date and what will AVIP do in the future?

Our Avionics Integrity Program was

outlined during a special session on Avionics Integrity held at NAECON '83 in Dayton, Ohio in May. Since that time we have prepared the draft military standard and we have solicited comments and recommendations from both government and industry. We have begun the process of incorporating recommendations received and we expect to submit the military standard for formal approval in early 1984. A regulation addressing all integrity programs is being drafted at this time. We have placed Battelle Columbus Laboratories on contract to assist us in developing the supporting information for the military standard and handbook. The final technical report on that contract will be submitted in March 1984. We will apply the disciplined process to typical programs in the coming year in order to improve the implementation steps. Further study contracts will be necessary to expand the handbook and to develop the training program usable for government and industry.

ADP002818

QUALITY AT THE CROSSROADS

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ABSTRACT

In the coming years, American product quality will continue to be severely challenged in the world marketplace. We have lost much business and many jobs to foreign suppliers. Our nation's industry has suffered excessive loss of profits due to waste of materials and resources. Although foreign suppliers at one time held a substantial price advantage, this is no longer true in many instances. We are losing markets because of quality and reliability deficiencies.

For the most part, American management has not fully grasped the impact of this quality challenge. They fail to recognize that effective quality control and assurance systems contribute significantly to profits, along with a product that conforms to specifications. Certain tasks are clearly defined for American industry and the military establishment; high quality performance is essential.

This paper is concluded with what is needed if we are to regain our position of leadership in the world marketplace.

INTRODUCTION

One of the most important issues confronting logistics management today is quality improvement. When we talk about quality improvement we must also talk about productivity improvement for the two go hand-in-hand--and we must talk about both quality improvement and product improvement as they relate to the U.S. industrial base.

How do we in the Defense Establishment fit into the picture of what appears to be essentially an issue for the U.S. private sector? We are involved as buyers and consumers of products and items produced by the U.S. industrial base. The Government has certain missions, such as providing for the common defense, as spelled out in the Constitution. This is a unique function of the Federal Government. Today, this means designing, building, and maintaining the most modern and sophisticated equipment that technology is capable of producing. It also requires assurance that the equipment will perform efficiently and without failure.

There is growing conviction among those at the highest levels of the Department of Defense (DOD) that the quality of items being bought must be improved. In the Defense Logistics Agency (DLA), one of our objectives is to support force readiness by elevating product quality and to give quality equal status with production and schedule considerations. Changes are being made in our procurement quality assurance and contract administration manuals now that will help us achieve those objectives.

Within DOD, the role of the Government quality assurance professional has changed. The future success of our defense programs demands that we have managers of quality assurance functions who fully understand the concept of performance oriented quality systems. In other words, the systems approach must be applied to quality assurance, whereby our efforts are directed toward detecting system deficiencies as opposed to detecting product defects. This means we must continue to bring better educated and more dynamic military and civilian personnel into the various defense agencies and furnish extensive quality assurance training to those already on board.

You might well ask at this point why quality considerations have become such a major issue. In order to put the issue into perspective, we must look backward as well as forward.

OUR CURRENT STATUS IN THE MANAGEMENT OF PRODUCT QUALITY

The growth in science and technology over the last decade has dramatically focused world attention on our landing of a man on the moon, flights of the space shuttles, and the introduction of highly sophisticated weapon systems like the cruise missile. Along with this scientific and technological growth has come management problems that did not exist when the United States and its allies held positions of undisputed military and economic superiority.

In recent years, our leadership has been challenged on military, political, and economic fronts. To defend and preserve that leadership, we must look with concern to our industrial base--the primary source of our economic, political, and military strength. We are being challenged both as a Nation and industry-by-industry. We don't have forever to regain our leadership as a producer of quality products.

We have lost much business and numerous jobs to foreign suppliers. Our Nation's industry suffers loss of profits from the waste of materials and resources. While foreign suppliers at one time held a substantial price

advantage, this no longer is true. In many instances, we are losing markets not because of price, but because of deficiencies in product quality and reliability.

Whether dealing with Government contracts or with commercial orders, American industrial management has not fully come to grips with the fact of the quality challenge. Managers fail to recognize that effective quality control and quality assurance significantly contribute to profits and assure markets by providing products that conform to specifications and perform to expectations. Far too many chief executive officers do not recognize the criticality of quality, either to corporate productivity or to competitiveness in the market. Make no mistake about it: we are fighting a war today--a war of economic survival.

In waging that economic war, certain tasks already are clearly defined for the Military Establishment and for American Industry. Among those tasks are intensive efforts to build a more effective fighting force, capable of successfully engaging any enemy. That task is not simply one of "crashing through" with dramatic new weapons (although these have great military and political significance) but of building a general level of preparedness for our industrial base.

New demands are being made on the scientific and engineering capabilities of our industrial and military organizations. We already have considerable experience with complex weapon systems and the stringent performance requirements these systems must meet, but industry will have to apply its greatest ingenuity if it is to meet still higher quality and reliability standards that new systems under development will require. The ability of industry to describe, predict, and control the performance of the equipment it creates must be systematically improved.

Quality control becomes one of today's most valuable management tools that will not only serve America's defense industry well, but will profit the entire private sector. Quality control tasks are greater today than at any time in the past because manufacturing processes must yield previously unmatched quality levels. The new and complex weapon systems have demanded tremendous increases in the quality levels of military hardware. Any failure or deficiency resulting from poor quality control not only increases the already high cost of such materiel, but also decreases industrial productivity and profits. When we make the product right the first time, we virtually eliminate cost associated with quality controls and we greatly improve productivity.

WHERE DO WE GO FROM HERE?

Productivity lag in defense industries is as vital an issue as economics because of its impact on defense capability. Many actions are underway in the defense acquisition improvement program to further the productivity of defense contractors, of which quality is an inseparable part. Quality professionals continue to emphasize the importance of quality and its positive effect on productivity and profitability. It doesn't make much sense to improve productivity unless quality is at least commensurate. There's no advantage in making products cost less if the price of the lower cost is poor quality.

Rear Admiral F. C. Collins, DLA's Executive Director of Quality, has, over the last year and a half, visited American, Japanese, and European contractors and reports that of 160 contractors that he has visited, only 14 percent of them knew their scrap and rework rates. That brings home the point that if one doesn't know how bad his manufacturing process is, how can he know how good it is? A corollary to this is that once a manufacturer becomes aware that he has quality troubles, he "axes" his quality chief. This is akin to shooting the messenger who brings bad news.

Certainly, the number one challenge facing American industrial management is to meet the quality and productivity standards being set by foreign competitors.

It is phenomenal how the perception of quality has changed in little over a decade. Take for example the perception of products from Japan. Consumer advocates, Government bureaucrats, business executives, and the general public now perceive that Japanese products mean better quality than similar products produced in this country. That's quite a turnaround in thinking, for who, over the age of 40, will not remember when the perception was, "If it's made in America, it's good; if it's made in Japan, it's junk."

To gain a foothold in the marketplace, the Japanese had to change that image. They conducted vast training programs at all levels of their organizations and implemented statistical quality control techniques with the assistance of Drs. Deming and Juran. They organized small groups of workers to solve problems in quality

and productivity at the operational level. The employees took a greater interest in their work. The outcome--productivity improved and quality was raised. After a manufacturer instituted an effective quality control program, the emphasis shifted to suppliers. They realized the ideal situation was to have their suppliers control manufacturing processes. As a result, they demand and, by working with their suppliers, obtain high quality parts. By comparison, the American industry is plagued by the poor quality of material it receives from suppliers. All of this, whether a lack of confidence or lack of quality in American cars, adds up to foreign car sales gaining 28% of the United States car market in 1982.

Evidence exists today that consumers over 30 consider Japanese products superior. In reality, many American-made products have never enjoyed higher quality, witness the U.S. computer industry. Why then is there a widely shared perception of a quality decline in American-made products? Foreign competitors have, for one thing, based their sales attack not on poor quality of American goods and services, but on the superiority of their own.

GETTING THERE FROM HERE

We need to take a page from the Japanese manufacturer's notebook. We need to adopt his systematic approach to quality management. The realization is taking hold that the design and production of high quality goods is not just a quality manager's technical problem on the factory floor, but it is also the chief executive's problem that permeates the entire corporation. Quality is the business of anyone involved in any way, shape, or fashion with the item being produced.

High technology will play a crucial role in the future of improved American product quality. Some examples are robotics in welding and other processes and microcomputer-controlled manufacturing processes.

Even if we accept the fact that new standards of quality are essential, we are left with the main question: What do we have to do to meet the challenge?

I suggest consideration of the following six points to quality recovery:

Top management must commit itself to quality. Top management must openly and actively work to improve quality. Quality improvement is the task of everyone in an organization, regardless of the person's position or responsibility.

Set concrete goals for quality improvement and tie their achievement to incentives such as bonuses or pay increases. Tie managers' pay and promotions to quality measurements such as scrap and rework rates.

Conduct training programs to help managers understand quality control techniques so they can pinpoint causes of defects and devise ways of eliminating them.

Furnish adequate resources for producing quality products. You can't scrimp on resources and expect to get a quality product.

Work to establish an atmosphere of mutual trust. There must be trust and cooperation among Government and industry, labor and management, and buyer and seller.

Secure participation from all organization groups in the quality improvement effort. Quality must become a primary consideration to assure productivity; and there must be a conscious, detailed evaluation of how well our products satisfy the needs of our customers.

CONCLUSION

In summary, let me again emphasize that U.S. product quality will continue to be severely challenged in the world marketplace. Japan and other foreign competitors have a long lead and are concentrating on increasing that lead. Competitive pressures on U.S. industry is escalating. For us, the stakes are high. We cannot risk weakening our defense posture because of lessening quality, nor can we allow the erosion of our economic strength from the same cause. We can meet the challenge. I believe quality stands at a crossroad. There should be no doubt in anyone's mind the road that U.S. industry must take. The road to quality leads to economic survival!

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INCENTIVES FOR PRODUCT QUALITY NEED CONTRACT, COST, PRODUCTION AND FIELD CO-OPERATION

Edward Theede, Defense Logistics Agency

ABSTRACT

The quality of a deliverable item, be it hardware or software, is dependent upon the controls in place and the adherence to those controls. Military procurement generally requires an inspection system (MIL-I-45208a) and a quality system (MIL-Q-9858a) to assure product quality. Monetary incentives must be available to the individual complying with the controls that produce the characteristics. Material inspection via statistical means only provides a clue as to how many defective units may be in the lot. Statistical sampling is obviously advantageous to a contractor since the government accepts the probability of receiving a defective product. All topics presented today are trying to help the government get the most for its money. The negative cost effects of material review boards, standard fixes (shop arrangements and field activities), statistical quality control, surplus parts procurement and contractor field service are usually figured in overhead and are not carefully examined and/or controlled. This paper will point out experiences in these areas and leave to your imagination how the heavy manhour involvement and costs associated with these areas could be minimized if quality incentives are provided at the point of manufacturing.

INTRODUCTION

Product Quality Assurance is indeed a result of the application of the "Synergism" theme which is the leading thought of this symposium. Quality is not an independent topic but is the result of cooperation between the government and the contractor. All actions of the contractor, including Manufacturing, Accounting, Engineering, Production, and Top Management, must be concerned with quality as the end result of all procurement and have to result in a product usable to the man in the field. This means quality is of prime importance.

There have to be incentives written into contracts that will reward quality goals. A recognized quality level must be determined and an improvement of quality above this level must be encouraged. Money is generally considered the important reward by corporations for corporate level persons and it is obviously the same for the employees.

All symposium topics should consider quality implications as they directly or indirectly have an impact on Quality. Actions by cognizant personnel in the following topic areas do directly affect quality (i.e., Contracting, Management, Pricing, Government-Industry Interaction, New Procurement Technology, Acquisition Information Management, Cost Estimating and Analysis and Contract Cost Growth Control).

Quality assurance and defect analysis specialist talents must be part of each of these topics.

The paper will explain cooperative actions needed between contracting officer activities, quality control and assurance, production expediting activities, accounting (cost control), and engineering. There is no way to determine which of the above basic activities will direct the activities of each of the topics described in the seminar. The topics selected were considered but all other topics contribute.

COSTS OF QUALITY

MATERIAL REVIEW BOARD ACTIVITY

This is a process or procedure that has deteriorated into one of the most costly parts of contracting activity after the hardware manufacturing cost. All of this activity is in overhead and is rarely identified as a cost of failure. A Material Review Board generally consists of an engineer, a quality control person to discover and describe the defect, a manufacturing person and clerical persons to write the forms, record and tally results of computer data. Time needed for decisions varies, of course, depending on the depth of the problem. Several examples are quoted below. On average each Material Review Action would consume about four hours to which overhead costs will be added. Repetitive MR actions need the same board and are almost the same cost as the original meeting.

Aircraft Spar - A critical rotating aircraft spar had special requirements for shot peening, cooper and chrome plating on a bearing surface. Some mishandling at the machining vendor and plating source caused irregular plating and chips. Ten or more MRB actions were accomplished with corrective action being "vendor notified," "operator cautioned."

An analysis determined the cause of the defects to be uncontrollable and a drawing change was issued relaxing the requirements. This was obviously possible because some units in the field were already functioning as MRB accepted items. If some are acceptable, all must be acceptable. Many MRB actions would have been avoided with immediate determination of cause

of defect. Numerous contractor and vendor department lines had to be crossed to determine the exact cause.

There were at least ten people involved in the search for the cause but this was subsequent to many costly Material Review Board actions--the first defect properly investigated would have saved considerable money as the price in subsequent contracts revealed a considerable increase in cost because of this effort. Recommend that this type of defect allows failure analysis cost and prohibits future costs because of possible defects.

Forgings - Procuring seven different critical transmission mount forgings, purchasing department accepted the vendor's statement that a AISI 4135 material was not available. Purchasing authorized the use of AISI 4130 to save additional costs. On delivery of the forgings, Purchasing requested engineering approval via material review for this material. Because of the critical nature of the material, four typical forgings were selected and destructively tested. Hardness readings at .380 inch below surfaces in eight areas, ten readings in each area, were carefully documented. It was assumed, with these readings on a sample of forgings, the substitute material was acceptable. It was obvious that the Purchasing people, not aware or trained in considering quality costs as they apply to the government, were making decisions. The dozens of engineering, shop machinists, quality assurance, and non-destructive test people, plus the destruction of four forgings, were all in overhead rates along with the actual time. This massive testing on four forgings cost the contractor nothing because of the Material Review Board actions as overhead. In addition, subsequent information from another government agency indicated that although this particular contractor did not have the correct material, it was available from a national stockpile. Another thought--with the sectioning of forgings, certain heat was developed which obviously affected the below surface areas that were to be hardness tested. The decision to accept all forging based on this sampling was difficult for the government Quality Assurance Representative. Future field failures would not identify this problem as heat numbers were not part of the requirement. This experience should cause a set-aside of equivalent funds that would be required of future MRBs of this type to be used to determine the cause of this failure. Obviously quality assurance talent should be required on all calls to vendors and a quality assurance-trained person must review purchase orders for clearly outlined instructions. Incentive money could be offered for all units received that required reprocessing other than receiving inspection.

Conclusion:

It is here that a careful analysis of costs can separate acceptance of defective characteristics on hardware from overall costs. Here Material Review Boards are an important cost element. These are presently overlooked because it becomes part of the overhead and is not considered a "Cost of Quality" as defined in MIL-Q-9858. Contracting cost analysis too must become aware of the need for getting the contractor to recognize the basic cause for the defect and then prohibit any further costs after the first discovery. Incentives can be arranged at this point too. The Material Review theory has generally been accepted as a manufacturing technique. Putting MRB costs in front and solving the problem rather than tolerating repetitive Material Review actions should be the newest trend. These actions are profit centers but quality improvement incentives can also be profit centers.

STANDARD REPAIRS OR FIXES

Helicopter Rotor - On a critical rotating device an incorrect length bolt was used on the folding arm causing damaging interference on flight line procedures. It was determined that the correct length bolt was not available and the shop management substituted a different bolt without using procedures established for changing work instructions. Planning would not have authorized the change. There were many hundreds of dollars spent removing the rotating device and replacing bolts on the folding arm. Units in the field also had to be changed. The incentive to follow the work instructions was not strong enough. The standard fix in this instance was substitution of next length bolt if specified length was not available.

Composite Material Rotor Blade - In a shop traveler for a composite aircraft structure (rotor blade) the limited unbonded acceptance criteria caused hundreds of special forms to be processed.

On composite material aircraft structures, a diameter or square inch area designated as one and one half inches was permitted on a multiple layer structure for an unbond condition. Larger areas were put on standard repair for resin injection.

A large percentage of hardware exceeded this requirement. Each failure then required preparation of a standard repair form. The hundreds of forms needed with quality assurance, engineering, foreman, time study recording adds up to large dollars. This is all in overhead or in the case of a particular assembly, future contracts had larger prices attached to include this extra cost.

Engineering finally agreed to change the drawing to allow the manufacturing process to accept much larger unbonded areas and allow the work instructions to guide the operator (he is the quality developer anyway). Money to study the cause or identify the problem is much better spent at the start.

One of the attempts to control the rejections of not only unbonded areas but ten other rejections such as nicks, broken pins, untrimmed areas, etc., was a letter written by the foreman threatening disciplinary action if these defects were discovered. Better the letter could have offered a contractually authorized incentive bonus to the employees for delivering no-defect assemblies. The funding from historical rework costs would have certainly cost considerably less.

Each of these type costs must be isolated and repetitiveness should not be allowed.

Conclusion:

To gain "Product Quality," the drift of contracts toward paying for more failure costs, risk and uncertainty and rework or assembly at using activities must be reversed. Rework or standard "Fix" at manufacturing facilities must also be severely restricted. Quality problem solving teams must be established that include: accounting, production and management skills in addition to the quality expertise. The quality decision to find the cause of the failures before more manufacturing must be the governing factor after a non-biased look at first time failures. If parts have previously been made acceptably, something is wrong in the processing through the shop. Discovering these causes must be controlled by incentive for problem solving instead of penalties.

STATISTICAL QUALITY CONTROL

Turbine Alternator - A recent experience involving turbine alternator (air driven) assemblies (bomb fuses) indicated an abuse of statistical sampling by groups that did not consider the possible failure costs.

The specification written for this specific assembly allowed sampling per table with modification as below: "The (lot) sample shall be subjected to the tests specified below. . .Alternators used in these tests shall be sampled per 4.4.2 and assigned to the test group below. . .

Test Group	Test Requirement	Test Procedure	AQL% AQL%
1	Low pressure-50°F	para	*
2	Low pressure+145°F	"	*
3	High pressure-50°F	"	*
4	High pressure+145°F	"	*

*If more than 50 percent of the allowable rejects occur in any one group, the lot shall be considered rejected regardless of total rejects."

Lot size developed was 15,000 units with a sample of 315 pieces. The 315 sample is divided into four groups as above. This is a sample of 78 pieces in each test with accept on four failures, reject on five failures.

History indicates test groups 2 and 4 had significant failures. From 1981 through June 1983, 23 lots were processed.

-- Seven of the lots had failures in Group 2 tests. One had eleven failures rejecting the lot, six had one failure.

-- Seven of the lots had failures in Group 4--one had eleven and one five failures--rejecting the lots.

-- Four lots had failures in Group 1.

-- Three lots had failures in Group 3.

-- The second and fourth lots had two failures in Group 1 and one failure in Group 4. Contractually the lot was accepted although total failures were three but not more than 50 percent in one group.

-- The remainder of lots with failures were less than 50 percent of reject number so were considered acceptable.

-- Five failures in the 15th lot triggered the contractor to send two people--engineers-- to the using activity laboratory. The result of the visit was a TWX from the contracting officer to "accept the second sample in light of acceptance results obtained from use of properly calibrated equipment. The initial test should be declared no test and results of the subsequent test be used as the basis for acceptance." There was no indication at the time of the first test that equipment was not properly calibrated.

Significant of course is that the failures are in one fourth of the sample, 12 of the lot samples had up to four failures although not in a single group. Considering a full sample, 16 failures in 315 pieces could result in 748 failed parts in a lot of 15,000 parts. This does not seem to be "cost effective" to the U.S. Government defense agency if this number of bombs does not detonate because the alternator failed.

The cost of sending people to the laboratory 300 miles away, the time of the government engineer, the ACO TWX and subsequent contract

mod, and the contractor failure costs are in overhead and are not identifiable to this failure.

Since all the samples and test results are sent to the laboratory, the contractor is not required to determine the cause of the failure. Obviously the using laboratory must do significant screening of these lots by some retesting. Again these costs are not identified to this specific failure. The failure is one characteristic--not properly controlled.

Control of Characteristics - In the average statistical plan, the percent defective allowed will result in a piece or car or other product being shipped that is defective and the person or agency receiving the piece or car has a problem. The characteristics are controlled as they are manufactured. This inspection operation is a verification that the control was adequate. It is too late when the characteristics are stacked up so that they produce a defective part or inoperative auto.

The Defense Logistics Agency Quality Assurance Manual DLAM 8200.1 lead us to IPI Section and the point of control of the characteristics. It could be a fixture, a drill, a milling cutter, an automatic machine or a procedure telling the operator what steps to take to control the manufacturing of the characteristic. This is the control point and where the financial incentives should be concentrated. Statistical measurements taken after this are redundant in that they measure AOQL. There would be no need for percent defectives because there would be no defectives.

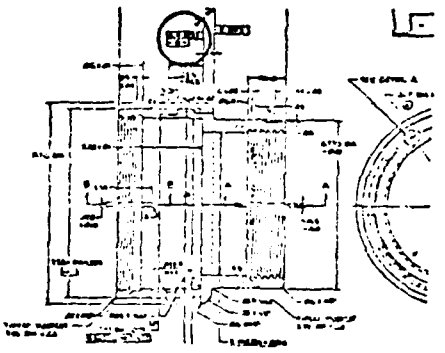

Figure 5. Part Manufactured by Numerical Control

Figure 5 is representation of a part manufactured as a spare. The dimensions circled are critical but not economically measurable at final inspection on a surface plate using a sampling plan. The contractor has a shop procedure that requires the operator measure each of them with dial indicators prior to removing the part from the tape controlled machine. This is the point the incentive for the operator's performance plus the government verification on a random basis should take place. It is important that the production schedule and the government's representatives time should be carefully coordinated.(1)

In addition to the above, there is a program written for this part on the tape controlled machine used for the manufacture. The program is designed to provide the cutting of the thread with a single point tool as the last operation. As soon as the thread is cut, the program holds until a thread guage is applied. If more work is needed, it must be recut as once the machine releases the part, the timing cannot be picked up again. Here the quality is built in and here the incentive plus the government surveillance should take place. If the operator is following the procedure here, final inspection with thread guages can be eliminated.

Standard Parts - Some tendency to use industry standard parts to enhance cost effective systems results in allowing statistical program to predict the accurate number of defects in a given lot of parts. In the critical systems that need careful risk and uncertainty studies, the defective parts, without screening, would be installed causing failures. The standard answer is that we must live with some defects because of the lower cost of permitting defective units to be accepted and stocked.

Each service and contractor has sufficient repair and replacement cost records and history to determine that the inspection of these items to provide no defects in a stockroom would be far more cost effective for the user. The incentive should be in the front of a product manufacture as the important characteristics are generated rather than after the fact defect processing.

When a complex assembly is produced, it many times contains standard small parts that could be considered as nuts or bolts, resistors, or capicitors. Some small parts that under the present purchasing systems in manufacturing are bought on a lot by lot basis. The contractor who buys these parts to install in the critical system, must take the risk of accepting defective parts. This, unfortunately, is the statistical system under which these units are manufactured and shipped. Here again the incentive must take place. The vendor who is delivering these parts to the purchaser could be persuaded to deliver only effective good parts if, when on receipt at the manufacturing facility, all the parts are good and he receives additional money for the good parts which were delivered.

Conclusion:

Present statistical methods for determining how many defective parts can be in a lot and still be shipped and accepted and paid for have to be looked at again. The customer or user provides 100 percent inspection. Quality is not determined by how many defects can be allowed to be shipped; quality is determining that each part shipped be correct. Unacceptable parts delivered to any customer, whether it be government, the automobile user or the average person buying groceries must be identified and should be corrected. Unacceptable parts give a false picture of military readiness and for the average customer it becomes frustrating when the parts that they buy and try to use are not effective or are useless. The costs for scrap, rework or for requisition of replacement parts from the customer's point of view are certainly not cost effective. Perhaps, from a manufacturing point of view, allowing certain defects to be shipped could be considered cost effective but the overall costs in the loss of business and the lack of response to customers complaints due to poor quality are costs not very many manufactures of today consider.

SURPLUS PARTS PROCUREMENT

Aircraft Bearings (Critical) - A contract allowing surplus parts was issued for "critical" items. The contract specified "surplus" items would be used. This is probably a cheap way to buy 476 precision bearings. The QA representative was faced with there not being a way of determining materials used, balls to be within .000005", annular 10°, heat treating or finish requirements. Presented was a seemingly logical precision bearing manufacturer's logo, part number and an air frame assembler's part number. There had to be an assumption that all was OK because the prime contractor had no shop and was operating from his home. The procurement contracting officer issued a modification deleting inspection system requirements and substituting an inspection clause that allowed only a few final chosen characteristics that could be measured in final inspection. He had a friend, who owned a shop, physically inspect the parts (what could be measured on a completed bearing assembly). Some of the bearings from surplus were in unidentified sealed packages (could have been commercial), boxes with a government contract number as part of the marking, and some were in cans. Anything could have been inserted in the boxes once out of government stock controls because all resealable packages can be opened, something else substituted and resealed. The QA finally signed the acceptance document.

Field Bearing Problem - A recent procuring activity, responsible for a complete helicopter weapon system, discovered that all bearings having certified contractor identification were not made by him. The source drawing control requirement was weakened when all the critical aircraft bearing procurement was turned over to a government hardware purchasing office. Parts were purchased--lowest bidder, no inspection requirements--and suddenly the agency found defective bearings with design contractor part number and no source control. It was decided to scrap (sell surplus) every bearing in the stock and repurchase from the original patent manufacturer to his drawing number.

There are, now, all bearings with a manufacturer's part number, not made by him floating around in some surplus buyer's stock awaiting a procurement action to resell them to the government.

Conclusion:

Contracting officers must give prior consideration to quality. Removing requirement for an inspection system MIL-I-45208 merely because a supplier of "surplus" parts does not normally have quality management consideration in mind when buying surplus parts, is no assurance that the part is usable. A surplus parts buyer has no incentive for quality in the products he buys. A government part number is not always an indication of a part visible in all hardware systems and all documentation and control is lost as the parts leave stock control. Contracting and production persons must have quality training to understand the quality impact on contractual decisions. QA can only measure envelope dimensions. Surplus parts are usually provided without material certifications, heat treat, finish and non-destructive testing records.

CONTRACTOR FIELD SERVICE ACTIVITIES

Aircraft Fuel Pumps - Some aircraft fuel pumps were continually causing problems in field service operations. The field service teams were providing "on the spot" assistance and replacement of parts (O-rings, etc.) to avoid large numbers of unsatisfactory reports. Review at the factor indicated the assembler had not seen the work instructions for O-ring installation in several years and was omitting two of the five important steps in O-ring installation. At final test, pumps were set up and had to be reset sometimes two or four times before they would operate properly when controls were activated, the reason being that the bellows needed activating. The activation was part of the test. Had passing final test been an incentive goal on the first attempt, the standard exercising of the bellows would have been part of the manufacturing process rather than a test option. Those that started by chance, on the first try had bellows that were not exercised and therefore might not operate on the aircraft after installation.

This happened and resulted in high service costs. The incentive to have pumps pass test the first time by identifying the cause of the non-start would save money.

Tail Rotor Blade Housing - A critical aircraft structure holding a rotating aerodynamic control was continually failing. Two years had produced more than 15 aircraft failures, including one aircraft lost. Consideration was given to "beefing up" the gear box casting which was bolted to the frame through four independently located forgings. Investigation revealed the forgings were not being assembled and riveted in the plan with the faces meeting the casting not parallel. Once this manufacturing technique was revised, no further failures occurred. Field personnel had not notified factory quality assurance personnel of the failures. Cracked units were replaced. Factory quality assurance was not able to cross department lines for corrective action.

Conclusion:

Contractor field service teams must be severely restricted. All field problems can be related to a specific characteristic defect. Once the cause of the defect is discovered, no further failures will occur in the field. Contracting officers, production personnel, accounting and financial persons must receive quality training so a decision to have field teams report failures to manufacturing for resolution will be made. All the costs for field activities of contractor personnel except for specialized training must be restricted or eliminated. It should not allow for growth in contract costs.

SUMMARY

The actions of all the participants in all the topics of the symposium directly affect quality or have quality (characteristic production) as part of their considerations. They must all understand basic quality thereby in order to relate to a quality system at a far less cost than we presently see.

All of the symposium topics are directly related to product quality assurance but are often not recognized as such: "Contracting Management," "Pricing," "Government-Industry Interaction," "New Procurement Technology," "Acquisition Information Management," "Cost Estimating and Analysis," "Legal Systems Influences," "Contract Cost Growth Control." Quality assurance and defect analysis specialists talents must be part of each of these topics. Others such as: "Program Management," "Productivity," "Preplanned Product Improvement," to name some are also directly related to quality but they were not specifically addressed in this paper.

Each part has characteristics that have to be considered for their impact on the critical parts of the system. The experience of the writer indicates that practically none of the negotiated contracts in the military procurement system has quality as a goal in the initial negotiating processes. The procurement contract will list a part number, some overall requirements, a delivery schedule and cost factors. One of the requirements in a contract could be MIL-Q-9858, which outlines quality system definitions. There are generally money incentives in the contract for shortening of schedule times, Equal Opportunity Employment, and also value engineering for design changes. There are generally no quality goals in the contract for quality improvement. Quality goals would be related to elimination of repetitive defects. When defects appear in any part the identification of any problem must be made immediately. The elimination of repetitive defects would also be a subject for money incentives. This paper has examined experiences needing better management control of quality, which will lead to reducing the impact of risk and uncertainty by improving quality.

Extensive statistical information analyzing all defects discovered and their relation to the problem resolution have not been accomplished. They are too diverse on the various products. The one factor consistent in all analyses was the discovery that there is a basic cause for each problem. All of the causes have also been in some process of the manufacturing sequence when the engineering is adequate.

REFERENCES

(1) Programming coordination provided by Mr. Jeffrey Snow, Cumberland Machining, New Britain, Connecticut.

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NOTE

THE INFORMATION IN THIS PAPER IS THE RESULT OF EXTRACTION OF SOME OF THE AUTHOR'S PERSONAL EXPERIENCES WHILE WORKING FOR PRIVATE CONTRACTORS, THE DEPARTMENT OF THE AIR FORCE, AND THE DEFENSE SUPPLY AGENCY AND SHOULD NOT BE CONSIDERED A STATEMENT OF U.S. DEPARTMENT OF DEFENSE AGENCY OR SERVICE POLICY.

ADP002820

A QUALITY IMPROVEMENT STRATEGY FOR SYSTEMS ACQUISITION

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INTRODUCTION

Affordability and readiness are among the most prominent concerns in the defense establishment today--to say nothing about the Congress and the media. Any number of techniques, procedures and controls have been established to improve management of systems acquisition and to minimize cost growth, the perennial nemesis of large, complex human endeavors. Cost/schedule control systems and reporting, for example, are now standard practice. No one technique, or combination of techniques, has yet been found to provide a satisfactory solution for today's acquisition managers. The "War on Costs" and "Project Cost" are programs which encompass many current initiatives for grappling with this pervasive issue. And yet, besides costing too much, there is continuing evidence that many newly acquired systems fall short of user expectations in the operating environment, or fail at a frequency which strains the capacity of the supporting logistics network and thus degrade readiness of our operating forces. In engineering circles, renewed attention is being directed at the reliability and maintainability disciplines that contribute to reduced weapon system downtime and provide confidence that a system will work when it is needed. Likewise, quality assurance requirements are being emphasized since QA is generally accepted as relevant to DoD readiness objectives--anything can happen if items are not produced under controlled conditions. However, stressing quality is not often looked upon as the path to minimum costs. In fact, quality is often seen as a cost driver and a manifestation of undue government involvement in contractors' internal business. When a new program runs into funding troubles--as most of them seem to do-- contractors invariably offer up elimination of quality-related tasks and standards as some of their first suggestions for trimming costs.

It was in a strikingly different vein that in 1931, Shewhart first documented quality control technology as an outgrowth of the Bell System's efforts to reduce manufacturing costs. [1] Statistical process control methods spread quickly throughout American industry, proving their worth as the nation responded to the heavy production demands of World War II. The American Society for Quality Control was founded in 1946 to preserve and foster this technology, but interest and support waned--in the USA at least. Today, after decades of neglect, we are seeing increased interest in statistical quality control tools by commercial companies. Along with some modern techniques of quality/productivity improvement, these older, proven tools are being applied with new vigor by many companies as a key to their survival in a marketplace characterized by international competition and more discerning customers.

It is our purpose to portray quality in systems acquisition from this commercially-oriented perspective. An improvement strategy which is relevant to both readiness and affordability is outlined. It treats "quality" in its broadest, multifunctional sense. The bottom line is that if quality/productivity improvement is important to us in defense, then we must "manage" to get it. The strategy to be discussed is not a one-shot "program" or a quick fix. Rather, it is a basic shift in how we approach our work and is based on application of successful commercial practice to the system acquisition environment.

As Air Force Systems Command's largest purchasing activity, Aeronautical Systems Division, with annual purchases of about $14 billion, is displaying a dedication to product excellence that demands commitment by its contractors to a formal process of quality/productivity improvement, built around a "do it right the first time" philosophy and backed up with quantifiable measures of quality. Furthermore, we look upon quality improvement as synonymous with cost improvement. [2]

BACKGROUND

Quality Defined:

A quality product or service is one that satisfies the expectations of its users. According to Juran, quality means fitness for use. [3] Within this context, Crosby's use of the term quality as meaning conformance to requirements is a necessary adjunct to any attempt to manage or to improve quality. [4] A spokesman for the American Productivity Center, Michael T. Midas draws a useful distinction between product quality and production quality. The first he sees as a level of relevance, uniformity, and dependability as seen by the customer. Its improvement, then, is driven primarily by better design specifications. Production quality, on the other hand, is improved by eliminating waste, delays and poor workmanship. [5] For the average consumer, a quality product is simply one that performs as advertised and does not cost too much to buy or to own.

Product Assurance:

Teamwork among many functions is necessary to achieve product excellence. Feigenbaum's "total quality" concept first popularized this idea which has become widely accepted as the keystone to product quality and manufacturing efficiency. [6] In Air Force terminology, product assurance encompasses the functional areas of quality engineering, quality management, reliability and maintainability engineering to bring to bear on our programs an integrated product assurance strategy. Its primary emphasis is on improving quality of design

during the formative stages of programs, insisting on employment of proven methods of work, particularly during a program's design, development and test stages. Current efforts to define an Avionics Integrity Program and to publish it as a military standard is one manifestation of this multifunctional collaboration at Aeronautical Systems Division. The Avionics Integrity Program and other product assurance initiatives are an integral part of quality improvement at ASD.

Assumptions:
The quality improvement strategy to be described is based on the assumptions listed below. While time and space do not permit their full development in this paper, their correctness is generally accepted.

- Quality is the result of a state of mind that can be managed--the mind of the customer, of management, and of the individual worker.

- Proven tools and techniques are available. There are no technological barriers to prevent us from designing it right and building it right. For example, MIL-STD 785 summarizes current assurance technology and provides guidance for its effective contractual application.

- As customers, we get what we demand. It takes more than words in a specification or contract to ensure compliance. Those requirements which are subject to continual review and scrutiny, particularly by the program manager, usually get satisfied.

- Delivering marginal equipment can be a profitable business--at least for some of our contractors. It is not unusual for a contractor to be paid cost and profit to redesign or rework items which were incorrect or defective initially.

- Work not done right the first time translates into big dollars. Most of these costs are not measured adequately, and their causes are accepted as normal for the business. They are a part of the "actual cost history" which is the starting point in cost estimating in both competitive and negotiated contracting.

IMPROVEMENT POTENTIAL

In the acquisition cycle, a formal process has been established to translate an operational need into structured technical requirements, to allocate these to various systems and subsystems, and to convert them into "build-to" specifications and detailed engineering drawings. After testing is completed, the latter form the basis for manufacturing work instructions, inspection, test and maintenance procedures governing production units. In this acquisition cycle, as in all activities, any work not done right the first time costs additional time and money. Scrap, rework,repair, delays, troubleshooting, retest, retrofit, overtime, reinspection, waivers, redesign, rescheduling, and processing service reports are examples of the kinds of activities that can be reduced through assertive quality improvement efforts.

The pertinent quality cost equation may be described as follows:

[COST OF RUNNING
THE QUALITY PROGRAM]

+ [SCRAP/REWORK/REPAIR
COSTS (RECORDED)]

+ [HIDDEN PLANT COSTS
(NOT RECORDED)]

= [?] % ACQUISITION $

The Quality Costs requirement of MIL-Q-9858A covers the first two terms of this equation, so such data is available for Government review in any major contractor's plant. These terms typically equate to 5-10% of sales. At one ASD contractor, this amounts to $1 million each week. At another contractor, the figure is $1 million per day--a corporate-wide measure.

The term "hidden plant" includes all the unmeasured effects of work not done right the first time. It refers to that portion of a factory's productive capacity--people, floor space, machines, material, energy--devoted to identifying nonconformances resolving problems and doing things over again. The hidden plant masks any number of chronic problem areas that are accepted as normal. One simple example in electronics assembly is the planned touchup that often follows a flow solder operation. Planned rework such as this keeps attention away from the flow solder process parameters or the associated cleaning procedures which cause most defects. As a result, a labor intensive operation is maintained which is not only expensive but can also create other heat-induced defects causing circuit board rejections.

Most existing scrap/rework/repair or failure cost systems capture only direct manufacturing labor. Such touch labor constitutes only a small percentage, less than 25%, of the cost of a typical acquisition program. The soft tasks such as engineering, purchasing, configuration management, program control, and logistics make up the bulk of any program's labor costs. When these tasks are not performed in conformance to job standards, procedures or customer requirements, delays, rework and scrap may be the

result even if the only product involved is one of paperwork.

Estimates of the magnitude of a plant's efforts and productive capacity devoted to fixing what was not done right the first time reach as high as 40%. At this year's Bottom Line II Conference at Fort McNair, Deputy Defense Secretary Paul Thayer indicated that the cost of correcting defects runs in the range of 10-30% of the total cost of the weapons. [7] Commercially, experience with formal quality/productivity improvement processes indicates that dramatic savings are attainable. If we are concerned about stretching acquisition dollars, the attractiveness of such techniques is obvious.

THE STRATEGY

The quality improvement strategy developed for Aeronautical Systems Division is built around an organization-wide commitment to product excellence, and serves as the basis for each organizational element to establish specific management objectives and action plans.

Key Results Areas:

There are three broad areas in which quality improvement efforts must have high priority and in which tangible results can be achieved.

1. PROGRAM MANAGEMENT: More than any other single factor, management commitment influences quality. As agents for our customers, the using commands, acquisition program managers must demand quality from contractors just as actively as they demand performance, on-time delivery and adherence to budget. Quality-related issues, risks and improvement trends need to be a regular part of the program reviews held with contractors and be included in internal, corporate level, program reviews. Full compliance to requirements must become the minimum standard of acceptability for delivered products and services. Contractual reliability requirements, not goals, must become the norm.

2. SYSTEMS ENGINEERING: The systems engineering process must be closely attuned to user needs, the operating environment, manufacturing and producibility, and to supportability. The systems engineering function at ASD has been restructured to emphasize system integrity and supportability design requirements and their validation methods based on analysis of operational needs, available technology, cost and risk. The key here is to design the reliability maintainability, quality and producibility into the system.

3. CONTRACTORS/INDUSTRIAL BASE: Quality and productivity at the factory level are determined by a contractor's business system (including the quality system), people, facilities, plant layout, manufacturing operations, as well as by the engineering design and the specific contractual requirements. The goal is to reward contractors that are committed to eliminating waste and inefficiency through disciplined business systems that measure and reward quality achievement. We must continue efforts which encourage contractors to refine processes or procedures or to exploit new manufacturing technology to achieve more consistent product quality, reduced unit cost, and improved ability to react to surge delivery needs.

Short Term Objectives:

1. Demonstrate determination by ASD management to improve the quality program.

2. Provide information to ASD managers on how to improve their quality programs.

3. Get ASD contractors committed to a formal improvement process.

4. Begin to measure what lack of quality costs.

5. Take the first steps to apply the quality improvement process to ASD's internal operations.

The Quality Improvement Process:

Quality improvement is a long-term and never-ending process. It must not be seen as just another program with discrete milestones and a fixed time span. The elements below describe the general process. Within this framework, contractors and ASD Program Offices will do the detailed planning to put the process in place within their organizations.

STEP ONE, MANAGEMENT COMMITMENT- Visible management commitment to quality improvement is essential. Directives, regulations, policy letters and speeches are important and, in large measure, adequate commitment has already been expressed in these forms. This commitment must also be displayed in day-to-day actions, for there is real danger that statements will be heard as hollow rhetoric unless action follows.

STEP TWO, TEAMWORK-Improvement can occur only when all functional managers accept their responsibility for quality and know what to do to make it happen. Many successful QI efforts have used multifunctional teams, committees, councils, or task forces to coordinate and steer broad-based improvement activities. Just as the quality organization is not responsible for achieving quality, the quality manager should not lead the QI team.

STEP THREE, MEASUREMENT-In systems acquisition, the ultimate measure of quality is how well and how economically the acquired system performs

in operational use. In this sense, quality improvement means improved readiness--quantified by system reliability and maintainability parameters. Among these are: Mission Capable Rate (MC), Mission Reliability (MR), Utilization Rate (UR), Mean Downtime (MDT), and Mean Time Between Maintenance (MTBM). These measures are at one end of a chain of requirements-setting conformance-verifying actions which begin with statement of need(SON) and continue through the systems engineering, design, development, test, production and deployment phases. The physical attributes of a product which correlate with satisfaction in use must be identified and controlled. Known as quality characteristics, examples of these attributes are dimensions, weight, hardness, surface finish, voltage, resistance, etc. Quality is measured by conformance to the specified requirement for that characteristic. The quality of production is measured by inspection and test yield rates, removal rates, and by the costs incurred by work not done right the first time. The quality of engineering design is reflected in the results of development and qualification testing and by the number and nature of changes to engineering drawings and specifications. While the quality of a product or a service can always be measured by its conformance to requirements, the kinds of quality measures most useful for triggering improvement are those which are stated in terms of cost. The major contributors to the "hidden plant" should be made visible, improvement goals set, and the value of improvement efforts assessed.

STEP FOUR, FAILURE COST EVALUATION-By making visible the major costs of unquality, fertile areas for improvement projects can be identified. Major systems contractors are expected to use such an approach in managing a Quality Program per MIL-Q-9858A.

STEP FIVE, CORRECTIVE ACTION-The quality measurement systems and the analysis of failure data described above provide the basis for systematic resolution of problems. Beginning with the most important problems, causes are identified and corrective actions taken to preclude recurrence. This process must exist at each level in the contractors' and subcontractors' organizations as well as in the System Program Offices. By using the corrective action process, management can find ways to move from a measured quality baseline to the established quality goal.

STEP SIX, AWARENESS OF A "DO IT RIGHT THE FIRST TIME" ATTITUDE-A contractor's quality system that operates to a "find it and fix it" philosophy can not be considered acceptable. Our contractors must organize and discipline their their business systems for defect prevention. We must insist that quality be designed in and built in to the products we buy.

STEP SEVEN, RECOGNITION-A contractor's record of quality and productivity improvement will be an important part of our evaluation of past performance in source selection. Likewise, those acquisition personnel who make significant contributions to quality improvement goals need to be lauded publicly. Existing awards, appraisals, and decorations can be used for this purpose, and additional awards should be considered.

STEP EIGHT, REFINE & EXPAND-Assess the effectiveness of the above improvement efforts. Adjust the process, if necessary, and expand to other organizational elements.

CAO SUPPORT

Since contractor participation is an essential element of this strategy, there must be heavy reliance on the Contract Administration Office (CAO) to develop contractor commitment to a formal improvement process (Step 1), to monitor improvement planning (Steps 4 & 5), and to validate the measured quality baseline and improvement results (Steps 3 & 7). Whenever more than one purchasing activity is driving a contractor toward quality/productivity improvement the CAO will ensure that the contractor is not given contradictory guidance, and that the resulting process is effective and efficient.

Because of their in-plant presence and continuous management system evaluation mission, the Contract Administration Offices have a strong influence on contractor management. The CAO, therefore, can play the key role in Step 6 of the QI process which calls for contractors to adopt a "do it right the first time" attitude that permeates all aspects of their operations.

A current example of CAO support in the QI process is the Air Force Contract Management Division's cost of quality project which will provide purchasing activities like ASD with insight into costs of "unquality" and relevant data for a quality baseline.

CONCLUSION

The job of quality improvement can never be finished. ASD is prepared to pursue successive "breakthroughs" which ensure better performing systems, reduced life cycle costs, unit acquisition cost reduction, and increased organic workforce productivity. The many related efforts of this type already underway will be nurtured and expanded. Only with continuing breakthroughs will we measure up to providing the Air Force with the new systems and technology needed to meet future threats and remain within anticipated budgetary and resource constraints.

NOTES

[1] Shewhart, Walter A., Economic Control of Quality of Manufactured Product, D. Van Nostrand Company, 1931.

[2] The strategy described in this paper was developed by the Product Assurance/Quality Assurance offices at ASD. It should not be interpreted as the official position of the Aeronautical Systems Division. The strategy has been approved for implementation in two of ASD's program organizations. A decision is to be made in January, 1984 on expansion (Step 8) to other organizations and on formal publication of a refined strategy document.

[3] Juran, Joseph M., Quality Control Handbook, Third Edition, McGraw-Hill Book Company, New York, 1974, Chapt 2, p. 2.

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[5] Midas, Michael T., "The Quality/Productivity Connection," Quality, February, 1982.

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ADP002821

ENGINE PRODUCT PERFORMANCE AGREEMENTS AND THE FUTURE

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ABSTRACT

Engine Product Performance Agreements may take many forms. One of these is warranty. The Model Engine Warranty developed by Air Force, iteratively, over a three year period is one of the many variations. It is to be tailored to fit the situation and was designed to help engine program managers formulate a warranty if one is part of their strategy. One possible outcome of considering warranty is that a warranty is not needed. This paper explores aspects of the Model Engine Warranty and its improvements over earlier warranties. Future forms of engine product performance agreements are mentioned. The concept of future commonality or standardization is discussed, with some of its perceived benefits.

INTRODUCTION

Engine Product Performance Agreements may take many forms. One of these is warranty. (See Figure 1) The Model Engine Warranty developed within Air Force is one warranty out of the many variations that exist. This warranty was developed iteratively over a period of nearly three years during which draft parts of it were released by the Air Force in Requests for Proposals (RFP)s. It was designed to help engine program managers formulate a warranty if one is part of their program strategy. That warranty is not needed is one possible outcome of the assessment and strategy formulation process in program management. Even when warranty is included in program strategy, there are points at which that decision is reviewed. The probable benefits to be received are evaluated against the cost to obtain and administer the warranty. This is an important part of the assessment and analysis process which must occur when warranty is considered.

BACKGROUND

Only recently has the government moved beyond the policy of being a self-insurer and wanted to incentivize and motivate the contractor with an extended warranty, particularly on engines for military aircraft. Warranty gives the government additional time after delivery to assert its rights.(1) General Alton D. Slay, then Commander of the Air Force Systems Command (AFSC), as a part of the Slay Initiatives in 1979, urged the investigation and use of more commercial practices where they are reasonable, including warranties. He spoke of affordable and meaningful warranties. The Product Performance Agreement Guide was published in 1980. Secretary Carlucci's 32 Initiatives included one which encouraged use of incentives to motivate the contractor in regard to readiness and support. This initiative became Defense Acquisition Improvement Program (DAIP) Initiative 16. Currently, DAIP 16 is part of the fifth group in present Secretary Thayer's broad policies. Senator Mark Andrews (R-N.D.) succeeded in making funding in the Fiscal 1983 *Appropriations Bill* for the Air Force's Competitive Fighter Engine contingent upon inclusion of specific warranty coverage.

The problem with the self-insurer concept is that the contractor is not financially incentivized to make a high quality, low repair product. (2) Building in greater reliability usually has a cost which rises as the reliability rises, reducing profitability on fixed price contracts. Although many firms value their reputation for a quality product, aside from this, a contractor could actually benefit from products which have a higher failure rate since spare and repair parts are sold at a profit. With warranty, the contractor may consider other outcomes more profitable. Warranty is viewed as an *incentive*, in that the contractor must do something if the product does not perform as long as promised. Thus, with warranty, the contractor shares the burden of poor performance after delivery with the customer, in this case the government.

The term "incentives" in government contracting may also mean dollar amounts paid to a contractor for progress toward or gaining contractually stated desired goals. Con-

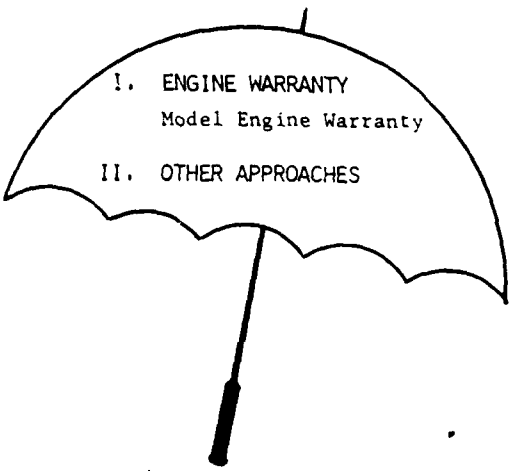

Figure 1 Engine Product Performance Agreements

tractors may also have to pay dollars to the government for failing to meet stated minimums in certain incentive provisions. Dollar incentives may be attached to warranties and other product performance agreements but they go beyond the incentive inherent in warranty, mentioned above.

Commercial engine warranties have been available to the airlines for many years. Due to the differences in mission, use of the engines, and maintenance compared to that of the airlines, warranties were not offered to the military. Commercial warranties are now offered to the military, but they do not always precisely fit the military environment. Often the language must be altered to avoid conflict with public law or regulation. Sometimes reporting procedures have to be modified. Airlines consume periods of warranty coverage quickly, compared with the low flying hours in some military programs. Thus, the airlines may reach the end of warranty coverage in two to five years while the same operating time for the military could extend years longer. Without a calendar limit, the contractor's liability could be extended much longer. Further, depending upon the program, the military may have its own depots for maintenance and repair and want to use them, rather than always returning warranted failures to the contractor.

Military engine warranties which are extended or comprehensive have been developed recently. The earliest ones for Air Force were placed on contract in 1980. They are an attempt to gain the benefits of commercial warranty while considering the military environment, existing reporting systems, available data, and maintenance practices.

The program manager's staff has the in-depth knowledge and facts necessary to formulate the objectives for a warranty and create a warranty which will fit the engine and the environment. Warranty is not something to be created in a few minutes with one, two or three people participating, however tempting that may seem. Applying good systems management procedures implies that to have a well developed warranty, a multi-disciplinary team of knowledgeable people must confront the issues, determine the objectives, and only then begin to construct and assess alternatives for reaching those objectives. The warranty team should consist of someone from each major functional area of the engine program office and its supporting staff functions. The input from those who will provide logistics support and use the warranted engine has proven to be valuable. Their participation as early as possible is desirable.

Without this team approach and consideration of pertinent facts from all disciplines, later reverses in direction and wheel spinning may result. These consequences are expensive in terms of wasted hours and effort plus possible degradation in the quality of the document that can be produced within the time given.

A number of functional areas have their own vocabularly. This is complicated by individual perceptions of word meanings which become evident as different disciplines interface. Using relatively standard terminology can reduce confusion in dealing with contractors as well as within the government. Thus, the need for a "model" warranty was born.

THE MODEL ENGINE WARRANTY

Program managers needed a document that they could understand and use quickly, but that could be tailored for their program. They needed a document that could be easily understood by many people. It would be used by people outside the contracting and legal fields so it must be understood by them, but it must be acceptable to contracting officers and attorneys. It must be as complete as possible so that important points would not be overlooked. The Model Engine Warranty was subsequently developed and used within the Air Force.

The Model Engine Warranty pulls together the advances gained program by program as experience in engine warranty expanded. It serves as a model for development of specific warranties for individual engine programs and presents a number of types of engine protection. Engines are warranted against defects in material and workmanship. The whole engine may be covered for a number of engine flight hours (EFH). Or, total operating time (TOT) or engine operating hours (EOH) may be used, depending on the equipment used to monitor the engine. A warranty based on engine cycles may apply to the internal part of the engine which is subjected to wide ranges of temperature. The warranty can provide coverage before failure for long life parts which may be subject to low cycle fatigue or other forms of deterioration. An important feature is coverage for performance retention, so that if an engine's thrust is too low but no failure has occured, the contractor is still responsible for engine maintenance and repair.

Language in the Model Engine Warranty is more favorable to the government than in earlier warranties. Also, when the contractor claims there is an exclusion, he must provide proof. The contractor has the responsibility to repair or replace failed or defective engines or parts of them. However, in this warranty, the government may choose to do repair during the warranty period. Doing repair does not void future warranty on the engine or the repaired part of it. This means the government can do the work at the most feasible location if they do not wish to send something

back to the contractor. The contractor must provide "Bill Back" credits (3) to the government for the work done when failed or defective parts were not returned to the contractor for repair. "Bill Back" credits can be used to support the engine program. This is a major advance in gaining benefits previously offered to the airlines but withheld from the military. The government no longer has to pay for repairs which are not under the warranty but are needed during the warranty period, just to protect future warranty coverage.

In this warranty, direct purchased parts can be used, but the contractor has no liability for them or the damage they cause if they fail. Of the direct purchased parts, only source controlled parts are covered by the warranty. Such parts are ones where the contractor has control over the manufacturing and inspection processes of the vendor or subcontractor. When these parts are direct purchased by the government, the engine manufacturer does not provide them or earn profit for handling them, so obtaining a source control warranty requires considerable negotiation.

There are enforceable turn around times with liquidated damages when the contractor keeps government assets beyond the time allowed. In some cases, we can allow the contractor to provide something more useful than money in lieu of liquidated damages. Money does not solve the problem caused by assets unavailable to use. In monthly reports, the contractor is required to report the number of days when turn around time was exceeded, the actions taken under the warranty and their costs.

There are blanks in the Model Engine Warranty where values will be inserted later. Since each engine is different, its use differs from others, and it may be installed in different aircraft, the values to be warranted will differ from one warranty to another. The entire warranty is to be tailored. Unneeded coverage is removed when it doesn't meet warranty objectives, words are changed as necessary to fit the situation, and blanks are eventually filled in. Figure 2 shows a generalized tailoring process.

The concepts behind the Model Engine Warranty are threefold. First, it is a beginning, a foundation, for constructing a warranty. Second, it requires new work only where changes must be made to fit the exact program and its objectives. Third, it can be used earlier in engine development, as a way to put the contractor on notice that a warranty will be considered for production engines and it may be tailored from this approach. That gives the contractor a longer time to influence design, but it does not require tailoring specific warranty coverage before the contractor and the government both can assess cost and risk as knowledge of the engine grows. (4)

Having some definitions, wording, and the structure remain the same from one warranty to another reduces the possibility of ambiguity. Uncertainty about the meaning of a warranty and what it covers is reduced when much of it is used program after program. Program managers know that the Model Engine Warranty was written in concert with the Defense Acquisition Requlation and it has been through

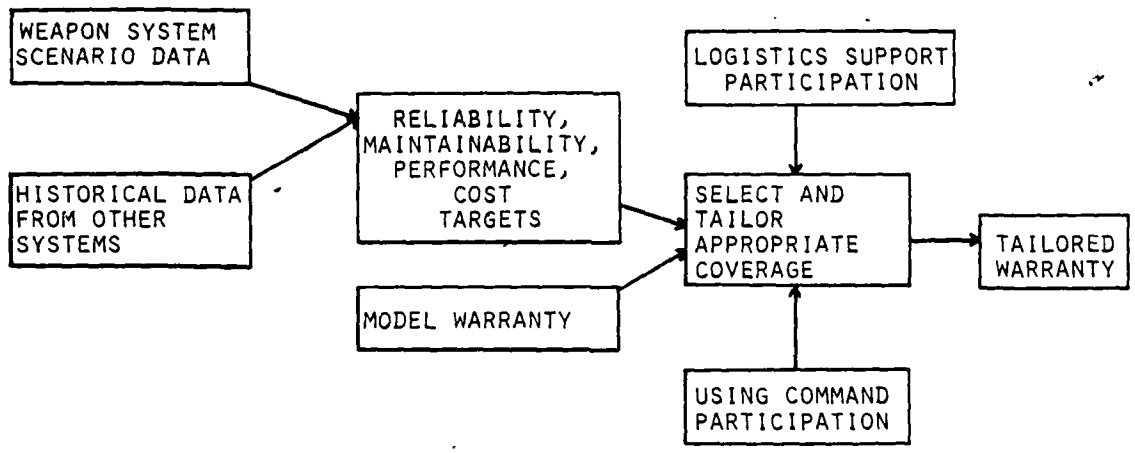

Figure 2 Warranty Tailoring Process for Air Force

legal review. Contractors have become familiar with this warranty since many parts of it have appeared in Requests for Proposal and some of it is on contract in recent warranties. One strength of this warranty is that is was developed iteratively with a variety of government and industry inputs.

THE FUTURE

There are only a few engine manufacturers. A move toward some standardization in military engine warranties can provide benefits for these contractors. When the same words are used in different warranties, there can be less confusion about what the government wants. Some standardization might avoid a proliferation of individually written warranties targeted for relatively common results, but using different wording. With all the military services developing warranties, contractors may face diversity in what is expected of them by each service. A heavy and costly burden might be placed on the contractors and the government through too much unnecessary diversity. With some commonality we can reduce this burden, work toward similar administration procedures, and refine the warranty process--instead of continuing to reinvent the wheel.

Especially when engines are interservice supported, if the services are able to agree on warranty administration procedures and achieve some commonality, problems in administration and possible loss of benefits due to confusion could be avoided.

Whether one service or all are involved, a greater commonality between warranties will accelerate our understanding of what we are getting and what it is costing us. Cost not only applies to the price of a warranty but to the administration of it.

Work in the area of warranty assessment has begun but it is too early yet to say how well we are doing. All the data is not in yet, even on the earliest warranties which are now coming to the end of their coverage. Even if the data were available today, what we see in the earliest lots probably isn't representative of what we will see with later warranties where we have made improvements as our experience grew. Relative standardization, or even commonality between warranties, and other forms of product performance agreements will help in the assessment process.

Innovation is not to be stifled for the sake of commonality or standardization. Innovation should be used where it gains benefits that more conservative approaches cannot.

Other approaches which measure a level of performance associated with one or more cost drivers could be developed on a "model" basis. Some product performance agreements for commercial customers guarantee the shop visit rate of engines, specific fuel consumption, gate departure delays, in flight shut downs, engine inlet temperature, and maintenance cost, or the scrapped parts cost. The accuracy, consistency, and appropriateness of data presently available from existing government sources is important when it is used in level of performance product performance agreements. Once the usefulness of the data has been considered, assessment of the worth of these approaches will be the key to intelligent use of them.

Operation and support costs are the most expensive part of system life cycle costs in today's Air Force, even exceeding acquisition cost. Aircraft engines can account for over 50 percent of logistics costs for an aircraft.

Commercial engines are overhauled not to preclude failures but to save fuel. Perhaps in the future it may be possible for contractors to determine the optimum point (for each military engine) when fuel savings would outweigh the cost of early overhaul or repair. Other approaches may be developed as contractors and the government work together to reduce operation and support costs.

CONCLUSIONS

There are direct benefits from warranty, such as parts and labor. There may be indirect benefits associated with enhanced product quality and performance. These may be increased readiness and supportability, reliability, durability and contractor motivation. Indirect benefits are not easy to quantify and often are hard to segregate and attribute directly to a warranty. Further, warranties do provide management visibility, both with the contractor and the government. This management attention can make a critical difference in program management, whether warranty or another form of product performance agreement is used.

The ultimate goal of warranty is to obtain quality products and reduce overall life cycle costs. Warranty is a tool to achieve closer alignment of contractor and government goals.

The readiness impact of applying the Model Engine Warranty to vital strategic weapons systems will be significant due to its ability to be used, untailored, much earlier than other warranties. Development of the Model Engine Warranty, some assertive aspects in it fostered by the Aeronautical Systems Division, and the concern for promoting commonality between warranties where it is reasonable are viewed as pioneering efforts. (5) These efforts will have a long term favorable impact

on the readiness and cost of operation of future engine programs. Beyond that, the concept of a standardized approach which can be tailored may be applicable to a wider range of products than engines.

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4. Request for Proposals Preparation Guide for Acquisition Logistics AFALDP 70-1, 30 April 1982. Wight-Patterson Air Force Base, Ohio. Air Force Acquisition Logistics Division (AFALD), published jointly for the Department of the Air Force, Hq. Air Force Logistics Command and Hq. Air Force Systems Command.

5. The Model Engine Warranty was developed in the office of Deputy for Propulsion Logistics, co-located in Aeronautical Systems Division. Copies of it may be obtained by writing to ASD/YZLR, Wright-Patterson AFB, OH 45433, or calling the author of this paper at AUTOVON 785-4125 or commercial 513-255-4125.

BIOGRAPHY

Ms. Juanita Vertrees is a Certified Professional Contracts Manager (C.P.C.M.), a Certified Professional Logistician (C.P.L.) and a Skilled Toastmistress (S.T.).

Ms. Vertrees recieved a Master's in Business Administration (M.B.A.) from Wright State University, majoring in Logistics Management, in 1983. She also received a B.S. in Business Management from the University of Dayton (Magna Cum Laude) and an Associate degree in Procurement and Materials Management. She is a member of the National Contract Management Association, the Society of Logistics Engineers, and the National Association for Female Executives.

Ms. Vertrees has been employed by three major commands in Dayton, Ohio, in positions of contracting, contract administration, and contract analysis. She presently applies both her contracting background and interest in logistics as a contract specialist co-located in the Propulsion Systems Program Office at Aeronautical Systems Division.

PROGRAM MANAGEMENT

Panel Moderator: Mr. David D. Acker
Professor of Engineering Management
Defense Systems Management College

Papers:

Defense Systems Acquisition Review Process: A History and Evaluation
by David D. Acker

A Concept for Mission-Oriented Planning for System Acquisition at the Defense Communications Agency
by Fred L. Adler, Bruce Baird, and Joseph S. Domin

Project Management: Evolution and Influence
by David I. Cleland

Program Manager's Support System (PMSS): An Update
by Jesse E. Cox, Ted Ingalls, and Harold J. Schutt

Mortality and Spareparts: A Conceptual Analysis
by Franz A. P. Frisch

Improving the Effectiveness of Award Fee Contracts for Program Management Support Services
by Arthur C. Meiners, Jr.

AD P002822

DEFENSE SYSTEMS ACQUISITION REVIEW PROCESS: A HISTORY AND EVALUATION

David D. Acker, Defense Systems Management College

ABSTRACT

This paper presents the salient points from a 650-page report, and some of my comments regarding the effectiveness and efficiency of the defense systems acquisition review process. At the outset, the origin and evolution of the Defense Systems Acquisition Review Council (DSARC) and the Defense Resources Board (DRB) will be reviewed. Then observations and perceptions of the review process will be made based upon an analysis of several defense system programs.

The fundamental question to be answered by the evaluation of the review process was whether experience has shown that DSARC reviews are still the most effective way to ensure a smooth transition of a defense system program from one program phase to the next phase. The experience data base used in answering this question was the result of (1) fact-finding investigations of 16 programs, and (2) interviews with current and prior DOD officials having defense system management knowledge and experience. Conclusions and recommendations are offered based upon the results of the evaluation.

INTRODUCTION

Under a contract to the Defense Systems Management College (DSMC), Information Spectrum, Inc., conducted an evaluation of the effectiveness of the defense systems acquisition review process. Alvin M. Frager and Eric Taylor led the contractor effort. I served as the DSMC project officer and a member of the team that interviewed participants in Defense Systems Acquisition Review Council (DSARC) activities and past studies.

To begin, it was determined that the basic defense systems acquisition review process has remained relatively stable since its inception in 1969; however, the procedures have undergone a continual maturation. The defense systems acquisition review process involves decentralized management with centralized control of key decisions. Changes in political leadership, incorporation of the results of various studies, and the emergence of new management techniques have contributed to its evolution. The programs selected for this study are shown in Figure 1.

One hundred and sixty defense system acquisition programs have been subjected to the DSARC reviews since its inception. By the end of 1982, the DSARC had conducted a total of 319 milestone and program reviews. See Figure 2.

An abbreviated history of each program was developed, concentrating on the DSARC review activities, and the histories were included in the appendices to the contractor's report. Figure 3 displays the spread of the DSARC reviews over the past 14 years for the programs included in this study. The review periods on each program, which

Figure 1. Programs Selected for Study in the Evaluation of the Defense Systems Acquisition Review Process

PROGRAM	TYPE		
	SINGLE SERVICE	JOINT	MULTINATIONAL
Army			
Blackhawk (UH-60) Helicopter		X	
Bradley Fighting Vehicle System (FVS)	X		
ROLAND Air Defense System			X
Copperhead Cannon-Launched Guided Projectile	X		
Stand-Off Target Acquisition System (SOTAS)	X		
Navy/Marine Corps			
Harrier Attack Aircraft (AV-8B)			X
LAMPS MK III Ship/Air Weapon System	X		
TRIDENT System (submarine, missile)	X		
FFG-7 Guided-Missile Frigate	X		
HARPOON Anti-Ship Missile	X		
Tactical Towed-Array Sonar (TACTAS)	X		
Air Force			
A-10 Attack Aircraft	X		
F-16 Fighter Aircraft			X
Air-Launched Cruise Missile (ALCM)	X		
Ground-Launched Cruise Missile (GLCM)	X		
NAVSTAR Global Positioning System		X	

Figure 2. Number of DSARC Reviews/Year

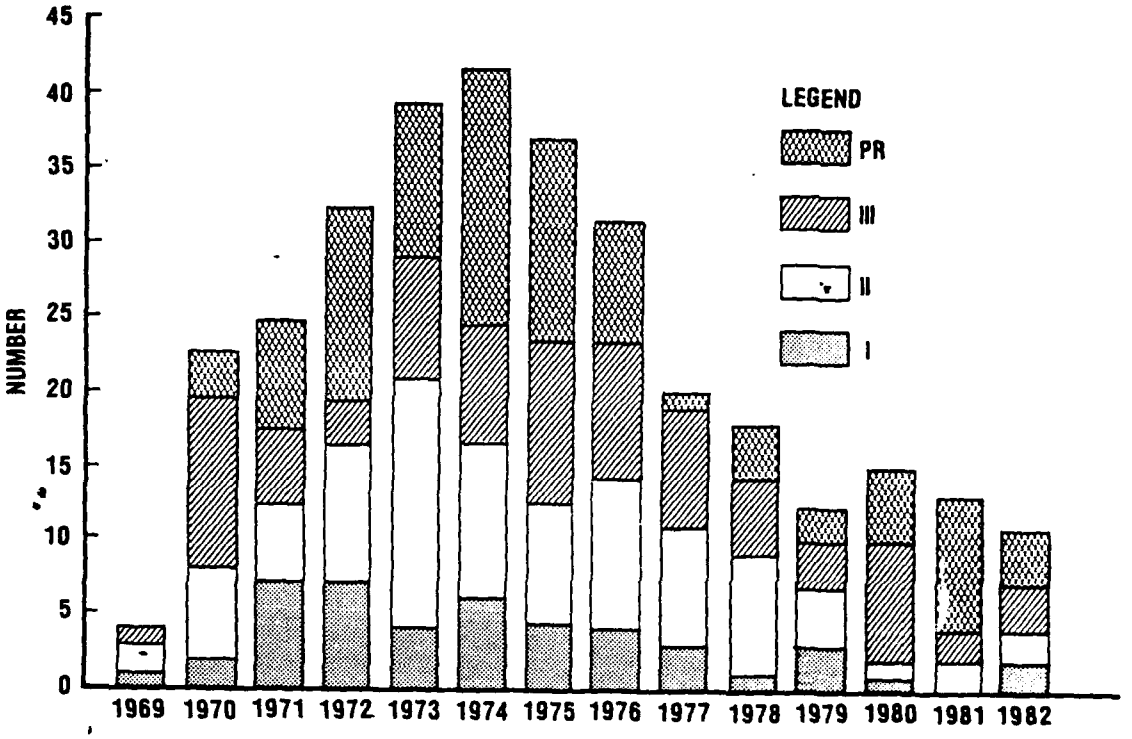


Figure 3. Spread of the DSARC Reviews on Selected Programs

		1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
ARMY	UH-60			I&II			PR		III						
	FVS					PR		II	PR				III		
	ROLAND						II	PR PR	PR		PR	III			
	COPPERHEAD							PR II		II		III			
	SOTAS										II			PR	
NAVY/MARINE	TRIDENT			I	II & PR	II	III		III						
	FFG				I&II			III							
	HARPOON			I		II	IIB	PR IIIA							
	TACTAS					I			II						
	LAMPS MK III				II	II			II		II			PR	III
	AV-8B								I			II			
AIR FORCE	A-10	I	PR			II	III	PR IIB							
	F-15							II		III IIB					
	GLCM									II				PR	
	ALCM						I III	IA		II			III		
	NAVSTAR					I				I		II			

encompassed both the DSARC preparation and decision/implementation time, covered 1-2 years—even more on some programs. Analysis of the programs indicated that certain events, which at first appeared to be program specific, had, in fact, many common characteristics with events on other programs.

ORIGIN AND EVOLUTION OF THE DSARC

In May 1969, then Deputy Secretary of Defense (DepSecDef) David Packard issued a memorandum establishing the DSARC.[1] The DSARC was charged with evaluating major defense system programs at certain points (milestones) in the life cycle and advising him (or the SecDef) of the status and readiness of each program to advance to the next program phase. The memorandum required the establishment of three basic milestone reviews. These reviews were to be held prior to the start of each major phase in a defense system acquisition program "... to permit coordinated evaluation and deliberation among senior managers ... to assure that advice given the Secretary of Defense is as complete and objective as possible prior to a decision to proceed to the next step of a system's life cycle."

Modifications to the review and evaluation process have been made since that memorandum was written. A series of DOD directives and instructions, along with service regulations, has evolved during the past 14 years. Figure 4 provides a chronology of the studies that have been made, as well as the directives and instructions. During this period, the political leadership changed several times, and with the leadership changes, the membership of the DSARC changed. Let's consider how the review process has matured since 1969.

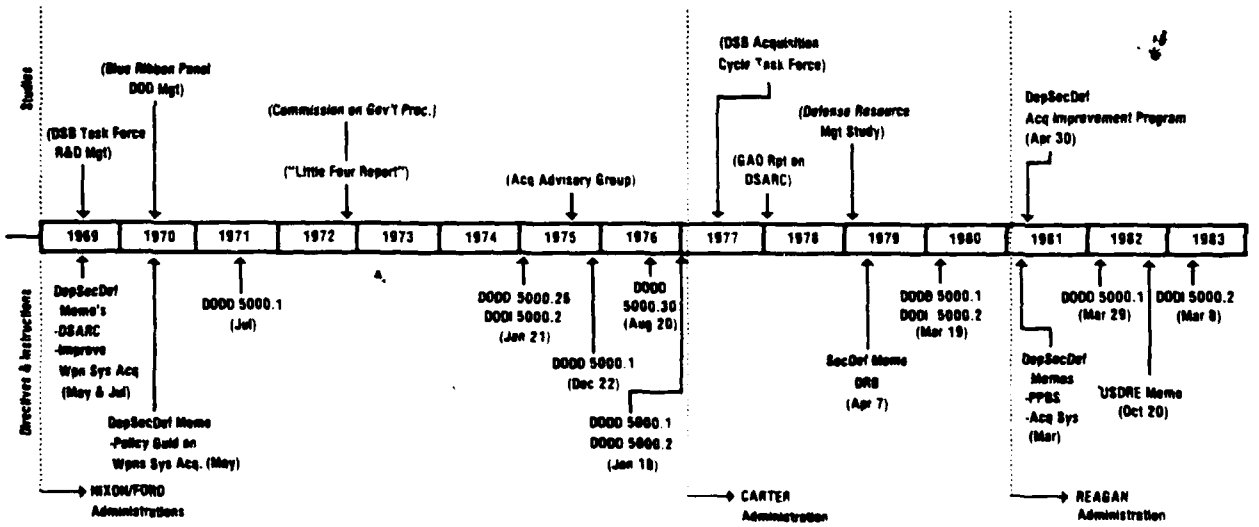
When Packard issued his original memorandum, he emphasized that the primary responsibility for defense systems acquisition and its management on a particular program must rest with the cognizant service and the program manager (PM) it designates. The PM should serve as the focal point within the service. Packard wanted to ensure that each major program progressed through its life cycle according to a plan—an acquisition strategy. To do so, he created the DSARC to review major programs at significant milestone points; namely, prior to the start of the contract definition phase (now the demonstration and validation phase), prior to the engineering development phase (now the full-scale development phase), and prior to the production phase. The DSARC was assigned the task of evaluating each program with regard to issues, thresholds, and matters covered in the Development Concept Paper (DCP), a document that had been in existence since 1967. At the outset, the DSARC was chaired by the Director of Defense Research and Engineering (DDR&E),* with the Assistant SecDef (Installations and Logistics), Assistant SecDef (Comptroller), and Assistant SecDef (Systems Analysis) serving as principals. The Council coordinated the milestone reviews, documented the findings, and made its recommendations to the SecDef through the chairman. In addition to the principals, the concerned Component Head was invited to participate in the first DSARC (milestone) review. Component Head participation in later reviews was not required, but the Head could be invited to participate at the discretion of the chairman.

In July 1969, and again in May 1970, Packard issued additional memorandums stating his concern about the defense systems acquisition process. The 1969 memorandum requested help from the services in his search for ways to improve the process.[2] The 1970 memorandum provided policy guidance for acquiring major defense systems.[3] The services were encouraged to tailor their acquisition practices to the peculiarities of each program. This memorandum, which included discussions of such things as management practices, program phases, contract types, and integrated logistics support, became the foundation for DOD Directive 5000.1, issued in July 1971.[4]

In 1975, DOD Instruction 5000.2[5] was issued to provide the procedure for complying with the policy contained in DOD Directive 5000.1. Also, about the same time, DOD Directive 5000.26 was issued to provide a charter for the DSARC.[6] The DSARC was described as a forum for open discussion of issues and alternatives on each major program by DOD officials. Two members were added to the DSARC as council principals for programs within their

*Now the Under Secretary of Defense, Research and Engineering (USDRE).

Figure 4. Chronology of Studies, Directives, and Instructions



areas of responsibility: Assistant SecDef for Intelligence (ASD(I)) and the Director of Telecommunications and Command and Control Systems (DTACCS). The DODI 5000.2 expanded Packard's original DSARC concept by adding more functions to its charter. The DCP (now called Decision Coordinating Paper) became the focal point for the DSARC review. The DSARC meeting associated with a specific program milestone complemented the Planning, Programming, Budgeting System (PPBS). The events leading to the DSARC meeting were defined with applicable time limits. Primary administrative responsibility for the DCP was given to the DSARC chairman's staff. Furthermore, the DSARC was given responsibility for review of program objectives memorandums. In December 1975, DODD 5000.1 was reissued, increasing the dollar amounts (based on 1972 dollars) used in defining a defense system as "major."[7]

In August 1976, the Director of Defense Research and Engineering was named the Defense Acquisition Executive, i.e., the principal advisor and staff assistant to the SecDef for acquisition of defense systems and equipment.[8] As such, he was to chair the DSARC. At that time, the ASD(I) and the DTACCS were made full-time members. The ASD (Systems Analysis) was re-designated Director of Program Analysis and Evaluation (PA&E).

Additional revisions to DODD 5000.1 and DODI 5000.2 became effective on January 18, 1977.[9,10] The 5000.2, which became a DOD directive and supplement to DODD 5000.1, provided additional policy and instructions designed to assist the SecDef in making decisions at program milestones. The major change to DODD 5000.1 was the incorporation of the concepts (not already a part of this Directive) contained in Office of Management and Budget (OMB) Circular A-109.[11] The OMB circular stressed the importance of considering alternatives at the front-end of a program; accordingly, the revision to DODD 5000.1 added the requirement for a Mission Element Need Statement (MENS) at a new Milestone "0." Other significant changes and additions to DODD 5000.1 included raising the minimum dollar values of "major" new acquisitions, a new emphasis on decentralization, the addition of the service system acquisition review council (SARC) reviews, and some revisions to the DSARC procedures.

The DSARC procedural changes (defined in DODD 5000.2) were as follows:

- DSARC would not participate at Milestone 0.
- DSARC would only be involved at Milestone I if the program under review was classified as strategic, nuclear, joint-service, multinational, intelligence, or command, control and communications.
- DSARC reviews would be held on all major acquisitions at Milestones II and III, unless waived by the SecDef.
- Administration responsibility to process the various versions of the DCP was assigned to the services.

In March 1980, these 5000-series documents were reissued with changes. The DODD 5000.1 contained only minor content changes.[12] For example, the DSARC review was to take place at Milestones I, II, and III, unless waived by the SecDef. Previously, DSARC reviews at Milestone I took place only under the conditions indicated above. Henceforth, SecDef approval at Milestone II was to indicate that deployment of the defense system could be expected. The DODI 5000.2 contained several changes: the dollar thresholds defining major systems were raised again; the ASD(I) and the DTACCS were removed from DSARC membership and the UnderSecDef (Policy) and the Chairman, Joint Chiefs of Staff (JCS), were added; and the presence of Component Heads was permitted during pre- and post-DSARC review activities, but not in the DSARC review itself.[13]

In 1980, the pre-DSARC review activities changed significantly. Rather than just reviewing the DCP, the DSARC members were tasked with structuring the DCP. Because of this change, the timetable for pre-DSARC activities was fixed at 6 months. In addition to the DCP, an Integrated Program Summary (IPS) was created to provide details of the implementation plan for the life cycle of the system. The combined DCP/IPS became the governing document for DSARC reviews. Further, because the amount of information accumulated for each milestone review was increasing, a Milestone Reference File (MRF) was established. The MRF became a temporary library of all documents relevant to each milestone review of the system.

In March 1982, another revision to DODD 5000.1 was issued.[14] By cover letter, then DepSecDef Frank C. Carlucci directed DOD Components to implement this revision, incorporating appropriate actions from the Department of Defense Acquisition Improvement Program, which he had launched in the Spring of 1981. This revision to the directive emphasized the following with respect to defense systems acquisition reviews:

- Achieving program stability through:
  - Preplanned product improvement versus new state-of-the-art program starts.
  - Realistic program funding at program initiation and projected in the funding documentation.
  - Emphasis on a DOD component-approved acquisition strategy throughout the acquisition process.
- Delegating program responsibility, decision-making, and accountability to the lowest organizational levels (decentralization). Program decisions made by line officials above the PM were to require documentation with appropriate accountability.
- Minimizing the acquisition time, including elimination or combination of program phases (with Secretary of Defense approval).
- Tying the defense systems acquisition review process to resource allocation, or the Planning, Programming, Budgeting System process by addressing program affordability at program initiation and throughout the acquisition cycle. The services were to prioritize their programs and identify resources they were willing to comm.. during design, development, production, test and evaluation, deployment, and support.

Considerable achievements were made in streamlining the acquisition process. Emphasis was placed on flexibility and tailoring to achieve what "makes sense" for each program. Four decision points and distinct programs phases remained. The "Milestone 0" decision for program initiation was replaced with the term, "Mission Need Determination." The SecDef remained the decision-maker for program initiation and Milestones I and II. The production decision was delegated to the appropriate service secretary. On an exception basis, the SecDef could retain his decision authority at Milestone III, if he chose to do so.

According to this policy, the program initiation decision for a new major program will occur during the PPBS proc-

ess. The DOD Component will submit a Justification for Major System New Start (JMSNS), vice the Mission Element Need Statement, no later than that point in time when the service Program Objectives Memorandum (POM) is sent to OSD. Approval and program directions will be included in the SecDef's Program Decision Memorandum (PDM), vice SecDef Decision Memorandum (SDDM). The SDDM will document a joint program decision. A JMSNS will be required for any program (major or non-major) for which the DOD Component estimates the costs (FY 80 dollars) will exceed $200 million in RDT&E funds, or $1 billion in procurement (production) funds, or both.

The new Component-prepared abbreviated Milestone I document, the System Concept Paper (SCP) will be used in place of the Decision Coordinating Paper and Integrated Program Summary. These last two documents (in abbreviated formats) will remain as the service's documentation to support Milestones II and III. The PDM will document the SecDef decision and direction. The services will be required to prepare, and submit to the DSARC for approval, Test and Evaluation Master Plans prior to Milestones II and III.

The Milestone II decision point timing will be flexible and it may occur at the traditional point (entry into Full-Scale Development (FSD)), or after entry into FSD if there is a need to more fully define the system being developed. The point of decision will be included in the service's acquisition strategy. If a delayed Milestone II is anticipated, FSD contracts will have to include provisions for early program termination at minimum cost to the government.

In October 1982, Dr. Richard D. DeLauer, the DAE, requested that the draft of a revision to DODI 5000.2 be used by program management offices preparing for a DSARC until formal coordination and promulgation of the revised instruction was completed. In a memorandum to DSARC members and others, he stated there was a general consensus that:

"The sea of paperwork associated with the acquisition process and the briefing burden on the program managers have to be reduced if we are to make the process more efficient than it is. This draft of DODI 5000.2 reflects that philosophy. It is important that the same philosophy be followed in implementation by the DOD Components. This is especially important in view of our past experience which indicates extensive pre-briefs and sequential reviews within the Component in preparation for a DSARC review.

"If our cooperative approach to decision-making is to come to fruition, we ought to be able to do in parallel a good deal of the preparation which we've done in series in the past. This means open lines of communication and shared access to relevant information required as a basis for a decision recommendation to SecDef. . . ."[15]

The revision of DODI 5000.2 was issued in March 1983 as an enclosure to a memorandum from the new DepSecDef, W. Paul Thayer.[16,17] Thayer reminded the defense systems acquisition management community that the basic purpose of the DSARC is to advise the SecDef/DepSecDef at key program milestones whether the program is ready to move into the next phase. He added that the DSARC may review other acquisition issues as determined by the DAE.

The revision to the instruction was intended to describe more clearly the defense systems acquisition process. One intent of the revision to the instruction was to ensure assembly and documentation of the information that is essential for decision-making. Thayer sees the need for "a continuous dialogue and personal interchange between the Office of the Secretary of Defense (OSD) and DOD Component participants in the acquisition process. Thus, information flow can be tailored to the needs to individual programs and circumstances." The revised instruction makes the milestone planning meeting optional; it may be held any time before the draft documentation is submitted to the DOD Components.

ORIGIN AND EVOLUTION OF THE DEFENSE RESOURCES BOARD

Assertions of inefficiencies in the area of DOD resources management were the basis of a presidential initiative that resulted in the commissioning of a Defense Resources Management Study (DRMS) in November 1977. That study was intended to provide a "searching organizational review into several resources management issues." Among the areas addressed were the resources allocation decision process, the planning, programming and budgeting system, and the defense systems acquisition process.

The DRMS report suggested that a Defense Resources Board (DRB) be established.[18] Accordingly, the DRB was established by the SecDef in April 1979 to enable the DOD to better respond "to signals emanating from Congressional budget reviews and meet Presidential decision requirements."[19] Membership is vested in USDRE, ASD(C), ASD(MRA&L), and Director, PA&E, with the DepSecDef serving as the chairman. Ex-officio membership has been given to the Chairman, Joint Chiefs of Staff. There are six associate members.

The DRB is an advisory body; its actions and recommendations have no authority until specifically approved by the SecDef, or the DepSecDef acting "independently of his role as DRB chairman." The DRB has performed this function, although the method of operation has been highly dependent on the chairman's management style. This style has varied from (a) members voting on alternatives to develop a consensus to (b) open discussion with the chairman to develop a final recommendation.

The DRB usually does not concern itself with particular programs, but is more concerned with the overall task of effective resource allocation within the DOD. Of course, if a program has major problems, for whatever reason, it could become a subject for DRB action. Final DRB recommendations consider the political sensitivities associated with their implementation. The DRB principals usually attend the meetings and the Chairman (DepSecDef) has not missed any meetings. Although not a member of the DRB, the SecDef has attended some of the DRB meetings.

The original role of the DRB was defined as being one of "supervising the OSD review of service POMs and the budget submission." However, in March 1981, then DepSecDef Carlucci revised the role to helping "the Secretary of Defense manage the entire revised planning, programming, and budgeting process."[20] The redirection of the DRB was designed "to assure that major acquisition systems are more closely aligned to the PPBS." The number of major issues to be raised before the DRB were to be limited. Lesser issues were to be resolved outside of the DRB forum, and presented only to the DRB when a

consensus could not be obtained. Carlucci's memo directed that "DRB members must be more than advocates of their particular areas of responsibility; they must take a broader and deeper DOD view. . . ."

Carlucci increased the membership in 1981 to that shown in Figure 5. Clearly, the enhancement of the DRB membership was for the purpose of strengthening the board, particularly with regard to the interactions between the PPBS and the DSARC reviews.

With this as a background, let's consider the issues and perceptions that have influenced the defense systems acquisition review process.

PERCEPTIONS

To obtain insight into the personalities and issues that have influenced the DSARC operation since its inception, interviews were conducted with 13 individuals in the Washington, D.C., area, who have played key roles in the review process (Figure 6). In addition to the interviews, telephonic and written comments were obtained from other persons who had an intimate knowledge of the review process, but who were not available for an interview (Figure 7). The perceptions of these individuals were extremely beneficial in identifying programs for review and issues of general interest. Also, these individuals gave the study team an appreciation of the relevant issues surrounding the process at the time they were personally involved with it. The findings from these interviews and the correspondence aided in structuring the 16 program studies.

A distillation of the principal perceptions of 21 people who were contacted follows. The sequencing of the perceptions is random. No attempt has been made to prioritize them.

- There is a general feeling of acceptance of the defense systems acquisition review process.
- The formation of a DRB was a desirable thing to do and it was a timely action.
- The defense systems acquisition review process provides clear, programmatic milestones that place an element of discipline on program managers.
- The defense systems acquisition review process should not serve as a substitute for other DOD functional activities. For example, the DSARC Principals should not conduct functional oversight responsibility during the review process. The activity should be handled through operations within the OSD.
- The DSARC has not acted like a "Board of Directors," although it has the appearance of such a board.
- DSARC Principals do not always have time to complete their "homework" before a DSARC meeting because of other pressing demands for their time.
- Monitoring his area of concern on more than 35 to 40 major programs is not a manageable workload for any DSARC Principal.
- The DAE management style changes with each new DAE and this impacts the process.
- The SecDef decisions are not taken to be binding budget decisions. For example, staff members who did not "carry the day" during the review process are able to open any aspect of a specific program for discussion during the PPBS cycle.

Figure 5. Defense Resources Board (DRB)

Deputy Secretary of Defense, *Chairman*
Executive Assistant to the Deputy Secretary of Defense, executive secretary

DSARC

- **Under Secretary of Defense (Research and Engineering)(1)**
- **Under Secretary of Defense (Policy)**
- **Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics)**
- **Assistant Secretary of Defense (Comptroller)**
- **Director (Program Analysis and Evaluation)**
- **Chairman, Joint Chiefs of Staff**
- **Secretary of the Army(2)**
- **Secretary of the Navy(2)**
- **Secretary of the Air Force(2)**

- **Principal Deputy Under Secretary of Defense (Research and Engineering)**
- **Director, Defense Advanced Research Projects Agency**
- **Assistant Secretary of Defense (International Security Policy)**
- **Assistant Secretary of Defense (International Security Affairs)**
- **Assistant Secretary of Defense (Health Affairs)**
- **Assistant Director, National Security and International Affairs, OMB**

(1) Defense Acquisition Executive and Chairman of the DSARC
(2) At DSARC meetings, only member(s) from involved service(s) attends

(Note: The permanent members of the Defense Systems Acquisition Review Council are also members of the DRB.)

Figure 6. Executives Interviewed and Their Principal Systems Acquisition Management Experience

EXECUTIVE	PRINCIPAL RELATED EXPERIENCE
James A. Abramson Lt Gen, USAF	Program Director Maverick & F-16; Dep Chief of Staff for Systems, HQ AFSC
Robert Bond Lt Gen, USAF	Commander, Armament Devel & Test Center; Vice Commander, AFSC
Dr. Alexander J. Flax	Asst Secty Air Force; President, IDA; Chairman, Acquisition Advisory Group
John R. Guthrie Gen, USA (Ret)	Deputy Commanding General, AMC; Commanding General, DARCOM
David R. Heebner	Asst Director, Sea Warfare Systems, OSD; Dep Director, Tactical Warfare Systems, OSD
Donald R. Keith Gen, USA	Dir, Weapons Systems Office, DCS/RDA; DCS/RDA, HQ Dept of Army; CG, DARCOM
Isaac Kidd, Jr. Adm, USN (Ret)	Chief of Naval Material
Rob Roy McGregor	OSD/RDA, HQ Dept of Army: Dir, Sys Anal & Review; Exec Director of ASARC
Raymond Moss Col, USAF (Ret)	F-15 Program Element Monitor; Asst for Prog Reviews, Office ASAF; AFSARC Secretariat
Ellilo Nucci	DSARC Executive Secretary (1969-1976)
Russell R. Shorey	Director of Acq Planning, OASD(I&L); DSARC Advisor on Support, OASD(MRA&L)
Leonard Sullivan, Jr.	Principal Dep Director, DDR&E; ASD(PA&E)
George Sylvester 't Gen, USAF	Dep for Systems, Vice Cmdr, and Commander ASD; Vice Commander, AFSC

Figure 7. Executives with Knowledge of Review Process Who Submitted Telephonic or Written Comments

EXECUTIVE	PRINCIPAL RELATED EXPERIENCE
Mr. Norman R. Augustine	Former Assistant Secretary of the Army; current Chairman, Defense Science Board
Dr. Solomon J. Buchsbaum	Former chairman, Defense Science Board
Brig Gen Aloysius G. Casey, USAF	Commander, Ballistic Missile Org; former Asst DCS (Systems), AFSC; original MX Program Manager
Dr. Malcolm R. Currie	Former DSARC Chairman and DDR&E
Mr. Charles A. Fowler	Former member of the Defense Science Board
RADM Rowland G. Freeman III, USN (Ret)	Former Commandant, DSMC
Mr. Robert A. Fuhrman	Member of the Defense Science Board
Dr. William E. Perry	Former DSARC Chairman and DDR&E

- The DOD Component staffs seem to lack a cooperative spirit when the PM is striving to meet program objectives. The staffs appear to have "hidden" agendas.
- Over the years, the DOD Components have sensed tighter control by OSD on major programs.
- DOD must demonstrate responsibility for acquisition management to the Congress. A great deal of DOD action is a reaction to congressional action, or threat of action.
- The changing DSARC procedures with successive administrations have made it difficult to efficiently manage programs that span 7 or more years.
- The SecDef Decision Memorandum, now the SDDM, sometimes contains items not covered in the DSARC review, especially when issuance of the document is delayed.
- A "macro" analysis of the program affordability is missing from many reviews.
- Items that are not expected to receive DSARC approval are not presented for consideration/action.
- There is no common method for effectively closing out a program.

OBSERVATIONS FROM THE SELECTED PROGRAMS

In analyzing the 16 selected programs, emphasis was placed on review of such documents as DCPs, SDDMs, Selected Acquisition Reports (SARs), and other program data relative to the program milestones and reviews. Data gathering was conducted at four levels, namely: OSD staff, service staff, material command, and program management office. Detailed information setting forth specific experience on the selected programs is presented in the appendices to the report prepared for DSMC by Information Spectrum, Inc.[2]

The findings are summarized below. Unfortunately, it is difficult to judge the findings as either positive or negative because criteria to measure effectiveness have never been developed. What might be considered positive to one DAE may not be considered so by another DAE because of differences in management style. Consequently, the findings summarized below are given without judging them to be either positive or negative, although, in some cases, such a judgment may seem to be obvious.

1. Administrative control of the defense system acquisition review process has been inconsistent.
   - There has been a wide variation in the timing of the SecDef decision after the DSARC review. Figure 8 displays the time for 46 decisions made on the 16 selected programs.
   - The method of documenting DSARC recommendations and SecDef decisions has not always been in conformance with published instructions.
   - Preparation and submission of the DCP is not always timely.
2. The DSARC has not ensured that:
   - Program content and technical parameters are adequately defined before program initiation.
   - Program changes are adequately controlled.
3. Monitoring of cost, schedule, and performance threshold compliance has not been consistent from program to program.
4. The greatest impact of the defense system acquisition review process usually occurs during preparation for the reviews rather than at the DSARC reviews.
5. The actions of the OSD staff during preparation for a review appear to be unorchestrated. The milestone planning meeting, in its present form, is not effective in identifying key program issues.
6. The DSARC Principals attend the DSARC reviews be-

Figure 8. DSARC Decision Time on Selected Programs

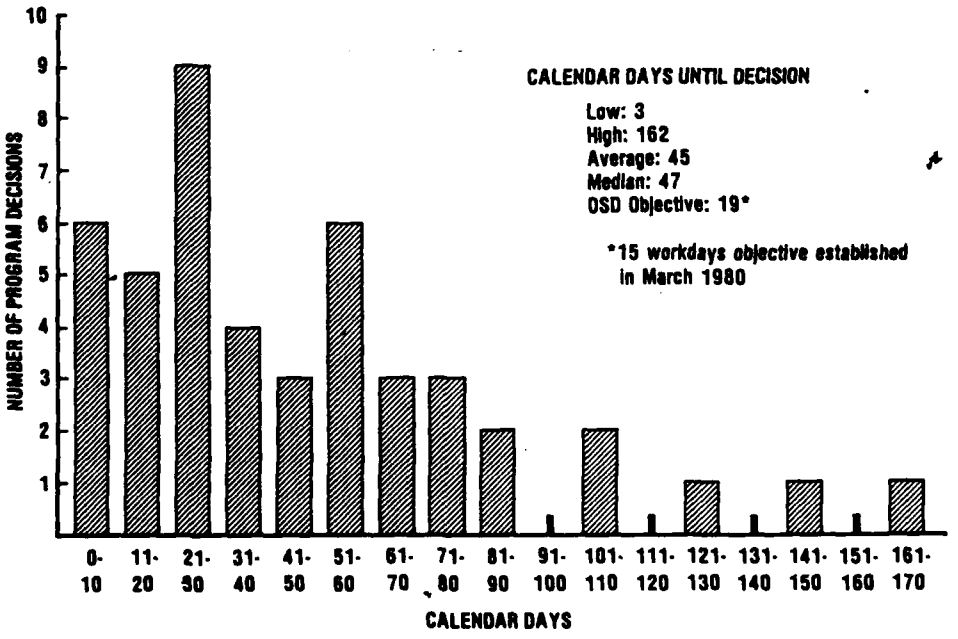


Figure 9. Summary of Attendance by DSARC Principals at Reviews on Selected Programs

DSARC Review	Total Number of Reviews	Number of Reviews Attended by Principals			
		USDR&E	PA&E	C	MRA&L
Milestone I	5	5	2	2	1
Milestone I/II	2	2	1	1	2
Milestone II	11	7	6	4	4
Milestone III	10	6	9	7	4
Program Review	8	6	5	6	5
Total	36	26	23	20	16
Percent	100	72.2	63.9	55.5	44.4

tween 45 percent and 72 percent of the time; however, their functional areas appear to be adequately represented when they are absent (Figure 9). A heavy DSARC workload over a short time span tends to reduce the attendance of the DSARC Principals. Also, reviews held during or just after changes in administration (after an election) increase the absences of DSARC Principals.

7. The program management office workload increases during the period before and after a DSARC review. The large number of pre-briefs is a major factor in the increased workload before a review.

8. External forces (i.e., the Congress, international agreements) can impinge on a program and pre-empt or override the DSARC recommendations made to the SecDef.

9. It is difficult to establish contractual agreements and program schedules that are closely attuned to the DSARC decision-making process. This has been a continuing concern to program managers.

10. Multinational programs and joint programs have encountered procedural difficulties during the defense system acquisition review process.

CONCLUSIONS

The concept of a defense system acquisition review process for major defense systems programs is sound. Although the process has undergone maturation for 14 years, the basic concept has not changed appreciably. The transition of a major program from one program phase to the next is controlled according to instructions based on a clear and adequate OSD policy statement.

The defense systems acquisition review process has fostered decentralized management of the acquisition functions, an underlying philosophy of Packard. Further, the milestone reviews have instilled a sense of discipline into the management of every major defense system program.

The defense system acquisition review process and procedures are effective, but not efficient. The failure of the process to provide early identification of critical issues is a weakness: on many programs, key issues are determined late in the coordination process—sometimes 1 or 2 weeks before a DSARC review.

The conduct of the defense systems acquisition review process on a specific program may not be in conformance with DOD directives/instructions. For example:

- A breach of threshold on one program may not be processed in the same manner as a breach on another program.
- Milestone review actions have not been consistent from one program to another.
- Previous SecDef decisions have been modified without benefit of the DSARC review process, i.e., sometimes the OSD staff has modified or revised the SecDef decisions set forth in the SDDM or PDM without the benefit of a DSARC review.

A major factor in program management office workload, and in the length of preparation time for milestone reviews, is the large number of pre-briefs requested by the services. The need for so many pre-briefs should be questioned by the service secretariats.

The substitution of other members of management for the DSARC Principals at DSARC reviews detracts from Packard's concept of deliberation among senior members of management before a program milestone or major program decision.

There is a need for clearly defined program baselines. The DCP, as originally conceived, was the document that served as a "contract" between the SecDef and the service(s) for the acquisition of a specific defense system. The DCP was updated following each DSARC review. Also, yearly reviews of the "contract" ensured that changes caused by a PPBS action, the Congress, or other activities were docu-

mented in the DCP. The PDM used today has not satisfied this function.

Finally, the functional responsibilites of the DSARC and the DRB are sufficiently different to warrant the continuance of their organizational separation. The DSARC looks vertically at each program to ensure it is performing within the fiscal constraints of the Five Year Defense Plan, whereas the DRB looks across programs.

RECOMMENDATIONS

The recommendations set forth here are based on the precept that the preparation time for DSARC reviews can be reduced and less burden-placed on the program manager if the following actions take place:

- There is senior management commitment to the process.
- The strategic planning for each program is focused.
- All participants in the program planning and review process have a moderate degree of currency with specific details of the program under consideration.

Specifically, the following actions are recommended:

1. Continue the defense system acquisition review process as currently designed.
2. Improve the efficiency of the process by implementing the following procedures:
   - Provide short, routine status reports on designated programs to the SecDef/DepSecDef, DAE, and other selected senior OSD staff officials.
   - Have the DAE exercise administrative control over, and focus on, the DSARC preparation activities of the OSD staff.
   - Have the DAE issue a policy statement on attendance of DSARC Principals.
   - Have the SDDM serve as a "contract" between the SecDef and the Service Secretary during the acquisition of a major defense system.

It is clear that better decisions have been made on defense systems programs because the people who have knowledge and expertise of each program have contributed recommendations along the pathway to each decision. However, it is acknowledged that conflicts as to approach have occurred at times because of the diverse interests of the members of the reviewing body—the DSARC. Normally, the DSARC chairman has ensured that each recommendation submitted to the SecDef has been a product of the deliberations of the DSARC members. In the end, the SecDef has made the major program decisions. After such decisions have been made, everyone concerned with the program has been expected to abide by them. This has to be judged as an effective process.

Copies of the report prepared by Information Spectrum, Inc., for the Defense Systems Management College are available from the Defense Technical Information Center (DTIC) under accession number ADA 129795 for Volume I; ADA 129796 for Volume II, Part 1; and ADA 129797 for Volume II, Part 2.

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A CONCEPT FOR MISSION-ORIENTED PLANNING FOR SYSTEM ACQUISITION AT THE DEFENSE COMMUNICATIONS AGENCY

Fred L. Adler, C. Bruce Baird, and Joseph S. Domin
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ABSTRACT

The Defense Communications Agency (DCA) is responsible for a broad range of system acquisition functions for Department of Defense (DoD) command, control, and communications (C^3) programs as well as analytic and automatic data processing (ADP) support to the Joint Chiefs of Staff (JCS) and the Office of the Secretary of Defense (OSD). To better accomplish these functions DCA has begun a corporate-wide system integration initiative based on mission planning consistent with Department of Defense Directive (DoDD) 5000.1, Major System Acquisition. The initiative has three objectives: higher quality mission analysis, a better bridge from mission analysis into system acquisition, and more effective consideration of supportability of C^3 systems and equipments. This paper describes DCA's planning initiative, its implementation approach, and the current status. The initiative, a mission-oriented planning concept, is currently under development and trial implementation within DCA.

INTRODUCTION

The mission of DCA, in broad terms, is to enhance the effectiveness, readiness, and sustainability of C^3 capabilities of U.S. Forces [1]. To do this, a well-structured planning process must be employed throughout the agency which must significantly strengthen the integration of numerous ongoing and planned acquisitions of C^3 capabilities while ensuring their affordability and supportability. Recent OSD planning and acquisition policy initiatives emphasize the need to more accurately quantify and document resource requirements for planned system enhancements and new capabilities and to stress supportability in system acquisition [2,3]. They require DCA to modify its current procedures and to develop new planning methodologies for which the emerging conceptual structure is described herein.

The primary function of the DCA planning process will be to serve as an "integration strategy" -- to explicitly link all parts of DCA and to better link DCA to the external C^3 community. The process is fundamentally oriented to complement DoDD 5000.1, Major System Acquisition, Department of Defense Instruction (DoDI) 5000.2, Major System Acquisition Procedures, and DoDD 5000.39, Acquisition and Management of Integrated Logistics Support for Systems and Equipment.

CONTEXT/BACKGROUND

DCA's mission-oriented planning initiative is in response to a variety of external factors such as acquisition and supportability policy evolution, the evolution of the Planning, Programming and Budgeting System (PPBS), and evolution of the C^3 community over the last decade. Equally important, DCA has responded internally to the need for further integration of the C^3 community by recently reorganizing (in 1981) and establishing key goals and objectives to achieve enhanced C^3 integration. Both external factors and internal factors are discussed briefly below.

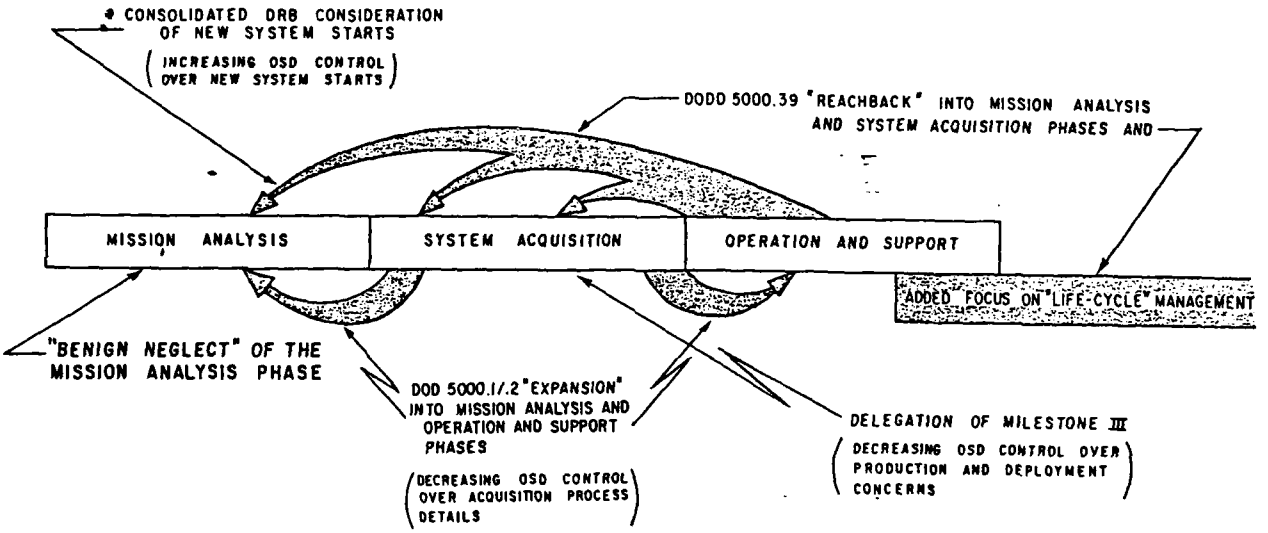
It must be noted that DCA's role in mission analysis is key to establishing a DoD-wide C^3 acquisition and support program responsive to DoD mission needs. C^3 acquisition planning is a challenging endeavor for many reasons: technology is very fast-moving as "computers" and "communications" merge into a highly integrated new field; multi-service implications abound; commercial telecommunications are being deregulated with worldwide impact; significant threats, such as the thermonuclear electromagnetic pulse, are being addressed for the first time; and the technological and programmatic impact of national policy goals of surviving protracted thermonuclear war are becoming more clearly understood. To meet this unprecedented management challenge, DCA is developing the concept described in this paper.

External Factors. A number of external factors have defined the need for the initiative, and these have evolved over the time since DCA was created in 1960. Of these, realignment of the defense acquisition process, from its focus on concept formulation/contract definition and "total package" procurement -- in vogue during the McNamara era -- to an "incremental" or milestone decisionmaking process, has been the most visible if not the most profound. The milestone decisionmaking process has been in a state of almost continual policy flux for about a decade and a half: Blue Ribbon Defense Panel/Laird-Packard era three milestone system; Commission on Government Procurement/Office of Management and Budget and Office of Federal Procurement Policy (OMB-OFPP) Circular A-109/ Carter-Brown-Perry era four milestone system; and the Weinberger-Carlucci era's "Acquisition Improvement Program" milestone-0-subsumed-in-Program Objectives Memorandum (POM), milestone-2-sometimes-later, milestone-3-delegated-to-services-if-all-goes-well. Nonetheless, these

process refinements represent a strong and continued policy commitment to "incrementalism" in system acquisition decisionmaking even though the perfect set of increments may never be found.

Equally important has been the emphasis on making durable, long-range plans on which to base acquisition programs, the most visible embodiment being the extended planning annex to the Five-Year Defense Program (FYDP). Finally, although not as visible as changes to the acquisition process itself, have been efforts to emphasize the "integrated" logistics support of defense systems -- primarily during the system design phase, with an emerging emphasis on "life cycle management" as shown in Figure 1.

FIGURE 1. THE EMERGING POLICY ENVIRONMENT - A CONCEPTUAL VIEW



Internal Factors. Three other important factors bear on DCA mission planning: the DCA 1981 reorganization, the development of DCA goals and objectives subsequent to the reorganization, and evolution of roles and responsibilities to implement DCA's goals and objectives [4]. The reorganization of DCA has put in place four mission directorates (responsible for communications, for command and control, for ADP, and for planning and system integration) in addition to two mission support activities (comptroller and personnel/administration). The planning and system integration directorate is responsible for C^3 mission analysis, architecture, and integration.

In 1980 DCA began concerted efforts to identify goals and objectives to complement the restructuring. The goals and objectives, which were approved and distributed in July 1981, address service to DCA customers, DCA personnel matters, and improved management of DCA. Eight of the 15 goals established by the Director provide the basis for the development of a mission-oriented planning concept in DCA. These goals address DCA response to goals of higher authority, service to users, agency relationships, integrated logistics support, center of excellence, management effectiveness, integration and the corporate view, and mission plans and programs. Examples of specific goals are listed below:

- Maximize the readiness, preparedness and operational effectiveness of those national C^3 assets which permit DoD to perform the crisis, wartime command control and support functions of the National Command Authority (NCA), Commanders-in-Chief (CINCs), Services, and other DoD and Federal Agencies (e.g., National Security Agency (NSA), Defense Logistics Agency (DLA), Federal Emergency Management Agency (FEMA), General Services Administration (GSA), thus improving the ability to support national objectives and national security policy. Capitalize on these assets to reduce the cost of supporting peacetime functions.

- Integrate the efforts of DCA in a cohesive capability that assures DCA programs/products complement each other to effectively achieve the goals of DCA.

- Develop C^3 plans and programs that are accurate, well-structured, prioritized, and timely enough to influence the Defense

Guidance and serve as a working document for all concerned.

- Significantly improve overall DCA management effectiveness.

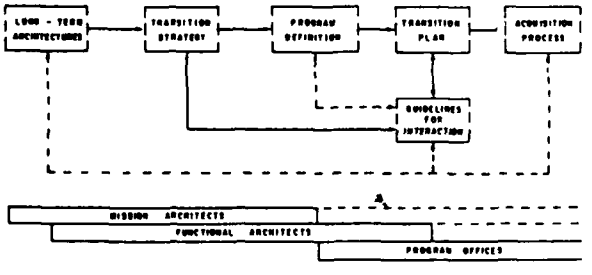
- Enhance the management of integrated logistics support throughout the life cycle of DCA-managed systems in order to better support the users as the systems are fielded.

Development and implementation of the mission-oriented planning concept are being led by the Deputy Director, Planning and System Integration. The concept is being refined and evaluated by integration strategy, system integration, and system acquisition and supportability personnel, involving DCA-wide personnel on a case-by-case basis.

MISSION ANALYSIS IN DCA

The basic DCA mission-oriented acquisition planning process as it has evolved to date is shown in Figure 2. The process emphasizes DCA's primary role in acquisition "front-end" mission analysis leading to initiating specific system acquisition programs that are affordable. Long-term "architectural efforts" produce "transition strategies" to evolve the C^3 architecture. These guide DCA's system engineers responsible for "program definition" of system acquisitions (generally executed by the Services) and ongoing programs within a framework described by a "transition plan." The process is "tailored" for specific architecture, program or system acquisition issues to determine how different organizations best interact in carrying out the plan. This process includes a DCA mission structure, a structure of C^3 architectures, and the process to transition from architecture to definable programs; these are further described below. Affordability in mission analysis is also discussed briefly. Program definition and system acquisition are discussed later.

FIGURE 2. DCA ACQUISITION PLANNING PROCESS



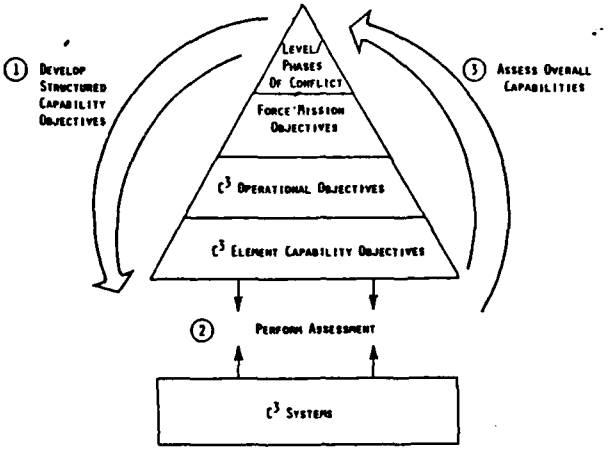
DCA Mission Structure and Capability Assessment

Mission analysis in DCA is being conducted within a framework established by DCA and is consistent with tasking from the JCS to develop a C^2 Five-Year Summary Plan. As part of this effort, an annual assessment of C^3 capabilities is undertaken.

The mission structure is thus further defined by the C^2 Five-Year Summary Plan [5] which describes mission planning in terms of strategic C^3, tactical/theater C^3, and defense-wide C^3 missions under increasing stress levels -- from peacetime through protracted nuclear war.

Generally speaking, the C^2 Five-Year Summary Plan embodies a C^3 capability assessment process to evaluate the effectiveness of C^3 programs in meeting the documented goals of U.S. policy and guidance. A three-step process is used, as illustrated in Figure 3.

FIGURE 3. C^3 CAPABILITY ASSESSMENT PROCESS



First, a hierarchical structure of capability objectives is developed consistent with the mission structure. These capability objectives are derived from a review of the threat, composition of U.S. forces, doctrine, and potential scenarios. Four levels of capability objectives are defined in order to obtain the granularity needed to accurately assess a wide range of C^3 programs: at the highest level, distinct levels or phases (of the conflict); force mission objectives required during each phase of conflict; C^3 operational objectives (e.g., Emergency Action Message (EAM) Dissemination) which reflect the C^3 needs of the forces for successful completion of their mission objectives; and, finally, a set of C^3 elements consisting of command centers, sensors, communications, and ADP. Intelligence elements are also considered. The resulting structure shows an explicit relationship between C^3 element capabilities (e.g., sensors) and the accomplishment of broad force mission objectives. The second step consists of identifying C^3 systems, determining their capabilities and then comparing them with corresponding element capability objectives. This comparison identifies deficiencies that need to be addressed. The final step consists of aggregating the C^3 element assessments

upward through the structure so that overall performance at each higher level capability objective can be displayed.

In the 1982 C^2 Five-Year Summary Plan, three sets of systems are considered. The first assessment considers current C^3 systems; the next considers C^3 improvements programmed in the FYDP, which includes both new systems and significant improvements to existing systems; a final assessment uses a list of additional "candidate" improvements to determine which post-FYDP deficiencies could potentially be eliminated. These candidate improvements are traceable to approved plans, studies, or guidance documents, but the improvements themselves are not necessarily fully approved and are not funded.

Architectural Structure. "Architecture" represents a description of C^3 capabilities, characteristics, and generic systems which, together, satisfy a set of mission-associated requirements, as well as specify a set of future objectives (typically 10 to 20 years ahead) [6]. There are two kinds of architectures: mission and functional. "Mission architectures" state broad concepts and policies, establish reference for functional architectures, respond to projected threats, specify functions to be performed and their desired performance characteristics, and identify capability objectives. "Functional architectures" describe the technical structure of large-scale systems or programs, define preferred methods or techniques that might be used to satisfy requisite performance objectives, provide feedback to mission architectures, develop transition strategies, and refine capability objectives. Three mission architectures (strategic, tactical/theater, defense-wide) and five functional architectures corresponding to C^3 elements (command centers, sensors, communications, ADP, and intelligence) are evolving.

The "transition strategy" is prepared as an architectural product, primarily by the functional architect. It includes discussion of mission capability objectives as a function of fiscal year; threat as a function of fiscal year; requirements characteristics as a function of fiscal year; cost envelope, including funding for POM years and extended planning and life cycle cost (LCC) and affordability; technology evolution assumptions; example functional capabilities (first order application of technology to capability objectives); and identification of relevant programs. The transition strategy is coordinated with the "program definition" community, namely, all affected system engineers and program managers.

Program Definition. Program definition in DCA is primarily a system engineering function oriented to integrated system acquisition program management. It is to harmonize and guide ("orchestrate") interrelated system acquisition and operational programs which are generally executed by the Services. Program definition in DCA is conducted by systems engineers in the Defense Communications Systems (DCS) Office, the Command and Control Technical Center, and the Command and Control Engineering Center. The program definition function is performed to translate the transition strategy into a "transition plan," showing how the program should dynamically evolve based on the constraints imposed by the guiding architectures' transition strategy.

The program definition task consists of scheduling, interfacing, and integrating a number of program elements over which there is generally little direct funding control. Program definition is conducted with a program management perspective, looking at a variety of systems acquisition programs being conducted in the Services. The system engineer performing program definition functions must identify specific program elements that will be required to implement architecture alternatives; identify how they should be time-phased and how they might enhance technical performance, cost, schedule, and supportability baseline measures; achieve program tradeoffs among cost, schedule, performance, and supportability; balance near-term improvements or product improvements with longer-term new capabilities; resolve critical issues -- e.g., technological thresholds, preparing the market place, etc; and coordinate with the architects and system acquisition managers. Further, tradeoffs among program alternatives must be accomplished to provide transition plan direction.

Affordability in Mission Analysis. DCA is primarily concerned with macro-funding implications at the architecture and program level, and in maintaining oversight of specific service acquisition programs at the system acquisition level. As part of a new start, funding implications must be discussed, per DoDI 5000.2, as follows:

> Discuss affordability, including the level of funding the Component is willing to commit to satisfy the need. When a concept has been selected, provide gross estimates of total RDT&E cost, total procurement cost, unit cost, and life cycle cost.

At the architecture and program level, the concern is whether the accumulation of LCCs of the various systems within the architecture or program exceeds the allocated funding level within the mission or functional architecture in all appropriation categories. Affordability determination must be made at the architecture level as well as at the agency level.

THE BRIDGE FROM MISSION ANALYSIS TO SYSTEM ACQUISITION

The bridge from mission analysis is based on the transitioning framework established by the

architects and the program definition elements of DCA. In particular, the transition plan provides a departure point for system acquisitions. It is discussed below. Affordability and cost-benefit analysis, service interface, and evolutionary acquisition are also discussed.

Transition Plans and System Acquisition. The "transition plan" is prepared as a system engineering product to complete documentation of the program definition effort. The transition plan includes discussion of relevant transition strategies; identification of system alternatives, including reprocurements, modifications, and new system developments; identification of key subsystems; realizable and unrealizable capability objectives by fiscal year; and LCC estimates and funding requirements. It is coordinated with all architects affected. It provides the foundation for tailoring acquisition strategy on specific system acquisitions.

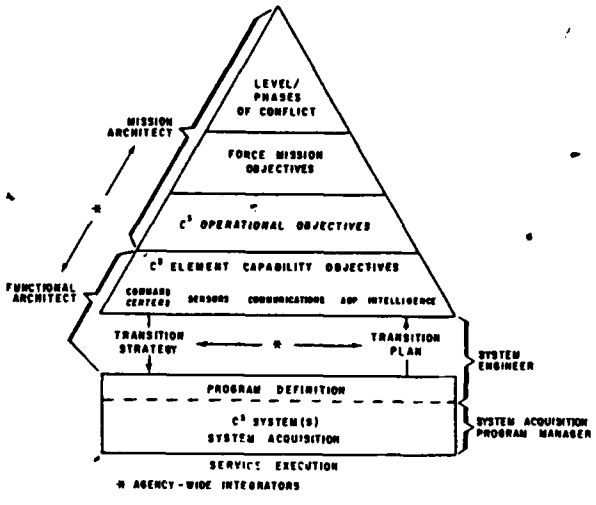
System acquisitions managed by DCA are directed by acquisition program managers (in accordance with DoDD 5000.1) who execute specific system acquisitions to implement the overall transition plan documenting program definition. Most of the acquisitions DCA is concerned with are, however, conducted by the Services and are monitored by DCA. In either event, the transition plan includes guidelines for tailoring acquisition strategy once the acquisition program manager has been assigned.

DCA integrators assist in working out guidelines for interaction ("rules of engagement") that are developed by affected DCA personnel and the Services for Service-operated systems as particular architecture, program definition, or system acquisition questions arise. Generally, the guidelines identify actions and achieve answers. Guidelines are to be flexible, and they are to be tailored consistent with mission-oriented acquisition planning.

Implementing Mission-Oriented Acquisition Planning. Four major groups of DCA personnel will carry out functions and responsibilities within the DCA mission-oriented acquisition planning concept: architects (responsible for mission and functional longer-range planning); system engineers (concerned with timing and phasing current proposed programs, i.e., acting as program "orchestrators"); program managers (responsible for operation and execution of specific acquisition programs); and DCA agency-wide integrators (concerned with ensuring that technical efforts are consistent and complementary). Each has a role with respect to both specific subprocesses and the system acquisition model and capability assessment discussed above and as illustrated in Figure 4.

Affordability assessments and cost-benefit analyses must be conducted throughout all phases of mission-oriented acquisition

FIGURE 4. MISSION-ORIENTED PLANNING IMPLEMENTATION IN DCA



planning. Architects, program managers, and system engineers are responsible for ensuring that the funds required by mission and functional architectures, programs, and specific system acquisitions are within the projected funds likely to be available for support of the mission or functional area or system. Also it is imperative that the C^3 systems supported represent the most efficient use of DoD funds to achieve capability objectives. Affordability assessments and cost-benefit analyses consider all elements of LCC including research and development, investment, and operation and support.

OSD and the Services work together in developing requirements, defining programs, and managing system acquisitions and improvements to ongoing programs. DCA is the architect and program manager on DCS systems while the services procure and operate most other C^3 systems on which DCA provides architectural support and other guidance to ensure interconnectivity and operability of interdependent C^3 networks. Specific roles of DCA and the Services are defined in guidelines for interaction mentioned previously.

C^3 System Acquisition Attributes. C^3 systems generally require an evolutionary acquisition approach [7,8,9]. This is an adaptive, incremental approach where a relatively quick fieldable "core" is acquired initially. The approach includes (1) a description of the overall capability desired, (2) an architectural framework where evolution can occur with minimum subsequent redesign, and (3) a plan for evolution that leads toward the desired capability. Evolutionary acquisition is a new approach to acquiring Defense C^3 systems that has not been fully tested. However, C^3 systems requirements are highly dependent on specific doctrine, threat, procedures, geographic constraints, and mission scenarios, which are

complex and change frequently. A flexible acquisition policy is needed in this environment.

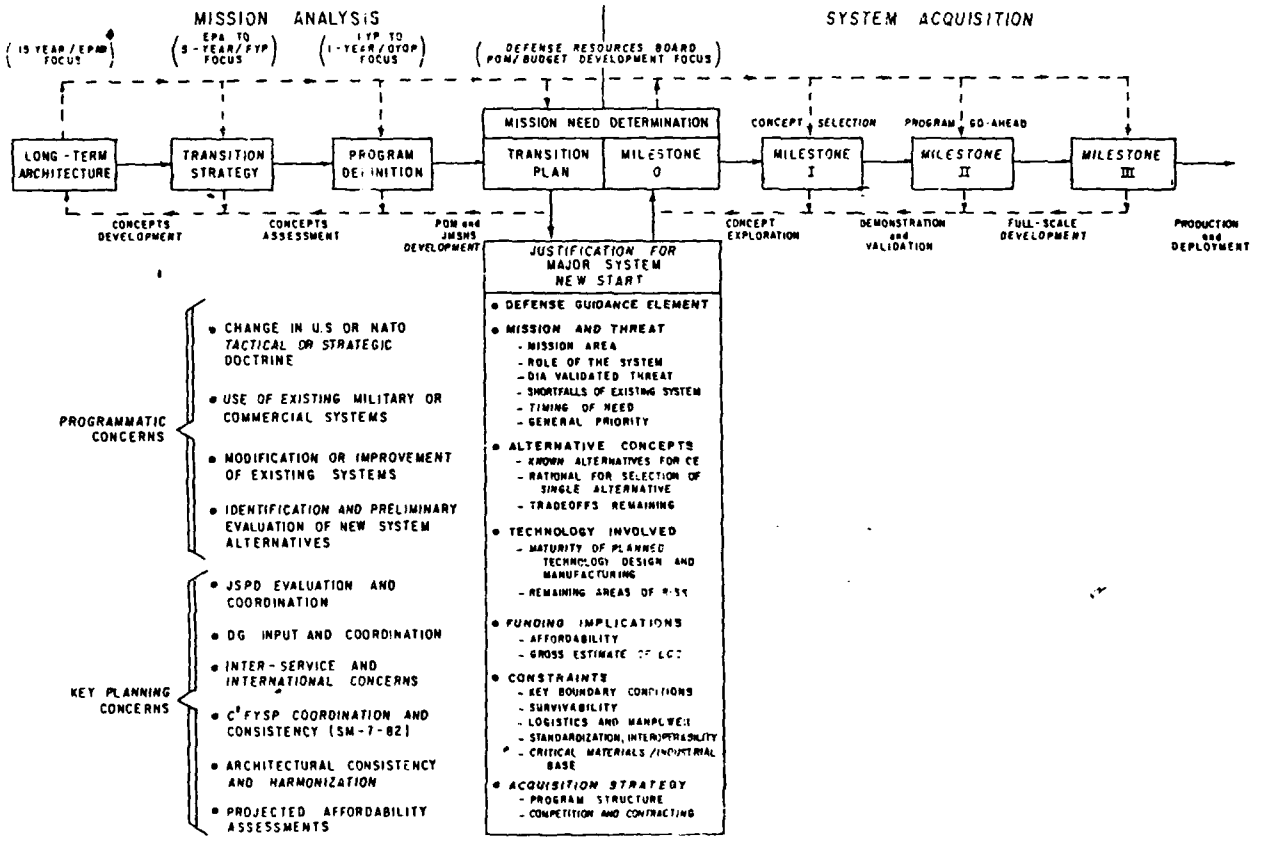
LIFE CYCLE SUPPORTABILITY OF C^3 SYSTEMS

The mission analysis (pre-system acquisition) portion of the DCA mission-oriented acquisition planning process is to be keyed to harmonize with the major system acquisition process as shown in Figure 5. The key confluence of the mission analysis process end product -- information required for justifying the mission need -- occurs when the Defense Resources Board and the Secretary of Defense consider the POMs. The key planning concerns are designed to provide a smooth and deliberate progression from mission analysis to new program starts.

time frame upon which the planning framework is constructed. Readiness and supportability considerations generally appropriate to each phase of the planning horizon are shown in Figure 6, Support and Readiness Considerations in the DCA Mission Planning Structure.

Since the conceptual essence of "integrated" logistics support is that logistics considerations influence system design, the highest "leverage" occurs where long-term-oriented architectures are converted to transition strategies. For this reason, a somewhat more extensive treatment of the supportability dimension during the architectural phase appears warranted so that transition strategies can be constructed in a meaningful way to reflect supportability considerations.

FIGURE 5. THE MISSION ANALYSIS TO SYSTEM ACQUISITION TRANSITION



The central product is the output of the program definition activity, the transition plan, which provides the rationale in support of the justification for new system starts (or Justification for Major System New Starts (JMSNS) for major systems) that is a major segment of the transition plan.

Incorporating readiness and supportability considerations into the DCA mission planning framework recognizes the limitations on information precision over the approximately 15-year

Likewise, the program definition activity is focused on immediate pre-acquisition program considerations, resulting in supporting documentation for new system acquisitions embodied in the transition plan.

Several case studies are proceeding to demonstrate supportability payoffs within the mission-oriented planning initiative of the Minimum Essential Emergency Communication Network (MEECN) Master Plan [10]. Supportability planning for the MEECN recently has

FIGURE 6. SUPPORT AND READINESS CONSIDERATIONS IN THE DCA MISSION PLANNING STRUCTURE

LONG TERM ARCHITECTURE (10-15 Years)	TRANSITION STRATEGY (Architecture Emphasis) (5-10 Years)	PROGRAM DEFINITION (POM-5 Years)	TRANSITION PLAN (Program Emphasis) (POM YEAR)
Macro-feasibility and Macro-economic tradeoffs	Supportability cost "drivers" and effectiveness "drivers" of alternative generic systems	Supportability goals derived from baseline measurements of current generic systems	Further ILS tradeoffs remaining - resource requirements are adequate for study and demonstration
Technology potential for enhancing readiness and reducing costs	Platform/geographic support cost sensitivities	Development of support concepts and alternatives for new systems	Support technology risks remaining and plan for resolving
Robotics - man/machine balances RPVs - reusable v. expendable platforms	Clear delineation of reliability/maintainability/system effectiveness requirements	Focus on ILS elements of alternative systems concepts	Clear identification of support, readiness and cost goals vis-a-vis existing systems
Emerging civilian infrastructures and pricing/integrity/support structures	Assessment of technology risk implications in meeting supportability objectives	Extensive tradeoffs of supportability vis-a-vis system design	Preliminary assessment of critical OT&E needs and sensitivities
Clear scoping of useful system "life times" for evaluation of investment alternatives	Clear recognition of ILS equality in system design	Scoping of acquisition strategy considerations from the standpoint of logistic support	Service implementation of ILS management for effective program execution
	International/inter-service issues identified	International/inter-service issues resolved	

been influenced by evolutionary changes in national policy seeking survivability through a protracted strategic conflict. Planning elements were only partially accomplished during program definition, with scant attention evident from either a mission or functional architectural perspective, primarily from the dimension of how long the system is to remain viable in the post-attack strategic environment. In general, this important mission element is couched within the rubric of "reconstitution," although how this might be done after exhaustion of a few weeks or months of spare parts and other resources remains a continuing technical challenge.

In order to stress supportability in MEECN master planning, supportability factors are being identified for strategic C^3 mission support and for communications, command centers, and ADP at the functional architecture level. Transition strategy is to be developed including supportability. Supportability initiatives for MEECN as a whole and for the individual integrated logistics system elements are to be identified. High priority operations and support (O&S) initiatives may be adopted in the MEECN Master Plan and reflected in MEECN transition plans. Agreement with the Services on specific supportability initiatives is to be pursued.

CONCLUSIONS/SUMMARY

For the first time an agency of the Department of Defense has conceived a mission-based planning structure to guide its C^3 acquisition program while incorporating consideration of supportability and affordability at the earliest planning stages under all levels of conflict, from peacetime through surviving protracted nuclear war. The DCA mission-oriented acquisition planning process is to be directly coupled with the analytic, planning and programming framework of OSD and JCS, both the PPBS and the Joint Strategic Planning System.

The need for an overall mission-oriented planning framework is paramount. The DCA concept is based on the analytic framework of the C^2 Five-Year Summary Plan expanded to adopt an extended-planning architectural approach to include generic system solutions as part of pre-program initiation decision in C^3 programs. This is a highly innovative feature of DCA's initiative which promises high payoff.

Issues like life cycle cost, affordability, and supportability are now to be treated to optimize both overall mission capability and cost effectiveness while obtaining maximum innovation and competition among generic systems solutions to meet deficiencies in C^3 operational capabilities.

It is recommended that unique features (such as architecture, affordability and supportability, and mission-oriented assessment against a continuum of stress level scenarios) should be implemented defense-wide.

ACKNOWLEDGMENT

Much of the information in this paper is the result of the authors' personal experience while working with DCA corporate planning personnel and other members of the C^3 community during the evolutionary development and initial evaluation of the concept described herein; it should not be considered a statement of DoD or DCA policy.

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AD P002824

PROJECT MANAGEMENT: EVOLUTION AND INFLUENCE

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INTRODUCTION

This paper will briefly examine the evolution of the theory and practice of project (program) management as an integral part of the management discipline. This examination will hint at the origins of project (program) management and how it has influenced the management of contemporary organizations. The evolution of project (program) management in the Department of Defense has been reviewed by Professor Acker.(1) The author will not continue that review; rather I will review some of the influences that project management has had on contemporary organizations.

Project management, although practiced in some form for centuries, emerged as a sub-discipline in the management field in an unobtrusive manner in the early 1960s. The terms "project", and "program" were used interchangeably to describe a management approach which already existed in an informal form in many organizations. No one can claim to have invented project management; its beginnings are often cited in the ballistic missile program of the United States. Its origins can be found in the management of large scale construction projects, in the Manhattan Project, or in the use of naval task forces. Some writers have attempted to trace the origins of project management from antiquity, citing the building of the pyramids as one example of the management of a large ad hoc project. No one doubts the antiquity of the practice of project management. More important, in modern times it is clearly established as an important sub-discipline of contemporary management theory and practice.

In the early 1960s theorists and doers began to conceptualize project management as a philosophy for the management of ad hoc activities in organizations. Early authors, such as Fisch, writing in the Harvard Business Review, spoke of the obsolescence of the line-staff concept and the growing trend in the use of a "functional teamwork" approach to organizations. (2) In the same year IBM established system managers with overall responsibility for various computer models across functional divisional lines. In the early 1960s and 1970s a wide variety of organizations experimented with the use of alternative project-management organization forms. One of the first changes project management caused was a change in the structure of companies.

ORGANIZATIONAL CHANGES

The early "principles" or organization set forth various organizing techniques. Centralization, decentralization, functional, departmental, product, process, and geographical are the primary patterns and techniques for "structuring" the organization. Line and staff concepts and the vertical, hierarchical chain-of-command beliefs provided basic points of departure from which to organize activities. In the early 1960s, the emergence of project management precipitated the serious study of the alternative organizational structure. Project-driven "matrix" structures emerged in companies in the Defense Industry to satisfy several operating and strategic needs: Resource sharing, profit center integration for projects, customer requirements, competitive pressures, and to serve specific market segments. Although the concept of a "matrix" organization emerged in practice, it was not until 1964 that the term was conceptualized in the literature. The term was used in the literature by Professor John F. Mee at Indiana University. In describing the two-dimensional organizational model found when project teams are superimposed on an existing functional structure, Professor Mee commented: "A matrix type of organization is built around specific projects. A manager is given the authority, responsibility, and accountability for the completion of the project in accordance with the time, cost, quality, and quantity provisions in the project contract. The line organization develops from the project and leaves the previous line functions in a support relationship to the project line organization." (3) Professor Mee's definition of the matrix organization set the tone for subsequent literature which described the specificity of the project-driven matrix organization. Today project management has reached substantial maturity in theory and practice. Its use has significantly influenced the culture of contemporary organizations.

The Cultural Ambience of Project Management: Project management's cultural ambience is the social expression found in the organization when it manages projects. This ambience, or cultural system, influences the skills, knowledge, and values of the people who are the project organizational clientele, a team of people with a vested outcome in the success of the project.

Thus, project clientele include the managers and professionals collectively sharing the authority and responsibility for completing a project on time and within budget. The cultural ambience that ultimately emerges is dependent on the way the primary clientele feel and act in their professional roles both on the project team and in the larger organizational context. Some of the more significant cultural characteristics found in the mature project-driven matrix organization include: (4)

- An increased organizational openness.

- Increased use of participative management.
- Increased human problems.
- Extended practice of consensus decision making.
- The use of dual merit evaluation techniques.
- Development of new criteria for salary classification.
- Recognition of new career paths.
- The emergence of acceptable adversarial roles.
- Greater organizational flexibility in use of resources.
- Improvements in productivity.
- Increased innovation.
- A realigning of supporting systems -- finance, information, etc.
- Greater opportunity for the development of general manager attitudes.

As many managers have discovered, understanding the culture of the organization is a prerequisite to introducing project management. An organization's culture reflects the composite management style of its executives, a style that has much to do with the organization's ability to adapt to such a change as the introduction of project management.

The maturity of project management can be judged in part by reviewing the growth of the Project Management Institute (PMI), as a professional organization dedicated to advancing the state-of-the-art in project management.

THE PROJECT MANAGEMENT INSTITUTE

Starting in 1970, PMI today has over 3500 members. PMI's objectives are to:

- Foster professionalism in project management.
- Provide a forum for the free exchange of project management problems, solutions, and applications.
- Encourage industrial and academic research.
- Improve communications through dialogues and discussions about terminology and techniques.
- Provide an interface between users and suppliers of hardware and software systems.
- Provide guidelines for instruction and education and to encourage career development in the field of project management.

PMI membership includes a broad cross section of individuals from industrial and manufacturing companies, engineering-design and architectural firms, construction companies, utilities, educational institutions, pharmaceutical companies, aerospace companies, consulting firms, and all levels of government. The membership is widely dispersed throughout North, Central, and South America, Asia, and Europe. The largest concentration of members is in the United States and Canada. (5)

Project management, in its present maturity, has demonstrated the value of using a temporary organizational focus to deal with the complexity, interdependence, and change occurring in contemporary organizations. Not only has a distinctive field of literature and a professional association emerged in project management, but a series of innovative organizational forms have arisen which emulate the multiple authority, responsibility, accountability patterns characteristic of project management.

ALTERNATIVE MATRIX ORGANIZATIONAL FORMS

In recent years the terms "matrix management" and "matrix organization" have come to be used to describe both project-driven two-dimensional organizations and organizations that have a "permanent" matrix form. An example from the banking industry illustrates what has happened in the use of permanent matrix organizational structures.

In the mid-1970s Chase Manhattan's corporate bank reshaped itself from a geographic form of organization into one that assembled officers into teams, each team organized to focus onto a single industry (such as drugs or electronics). Chase at present is steadily moving toward the matrix form of organization. According to Fortune: " A short time ago, an organization chart of the bank's international department would have shown it almost entirely divided along geographical lines, with only merchant banking roped off and functioning more or less worldwide. Today the bank has several other cross-border operations, to which it may add still more, that give its structure an unmistakable matrix look; international institutions (which primarily means correspondent banks), expert and trade financing, and private banking (for well-heeled individuals)." (6)

The temporary and permanent matrix organizational forms that have emerged in contemporary organizations are characterized by these properties:

- A shifting of management systems design to an horizontal, multidimensional model to complement the more traditional vertical organizational approach.
- Explicit dual/multiple authority, responsibility, accountability relationships influence the organizational culture.
- Predominance of a team culture at all organizational levels as the mechanism through which to accomplish results.
- Organizational interfaces which foster a cultural ambience where key managers and professionals share key decisions, results, and accountability.
- Widely practiced consensus decision making and participative management techniques in the organization.
- An organizational design which reflects some blend of project, product, functional, and geographic forms.
- Supporting systems (financial, information, accounting, etc.) are realigned to support the matrix management design.

An enumeration and brief description of these alternative matrix management organizational forms follow: (7)

Project Engineering:
Project engineers are usually responsible for directing and integrating all technical aspects of the design/development process. Typically a project engineer manages a product throughout the engineering process from initial design through the service life of a product. When a product design/development problem exists in a functional department, a project engineer is responsible for working with the functional department to correct the problem. In some companies the project engineering function is, in effect, the project management arm of the engineering department.

Product Management:
Product management in one of its earliest forms appeared in the early 1930s when Procter & Gamble inaugurated brand management. Thus this form of matrix management has been with us for some time. Briefly, it assigns responsibility for a given product or brand to an individual. When product managers are so appointed, a matrix organization is created with a resulting product-functional interface.

International Management:
Multinational companies are usually organized to do business globally on a matrix system of management. In these companies, responsibility for strategic and key operating activities is divided among organizational elements as follows:

Product - Responsibility concentrated in product or product line management with worldwide perspective.

Geography - Responsibility concentrated within a specific territory such as a country.

Function - Responsibility concentrated in an organization's functional specialty such as finance, production, marketing, or research and development.

In the international company there are usually two coordinated avenues of strategic planning: product, and geography. Since decisions are shared, accountability for results is also shared in terms of product and geographic profitability through profit centers.

Task Force Management:
Task forces are used by companies to deal with problems and opportunities that cannot be easily handled by the regular organization. Usually these problems or opportunities cut across organizational boundaries. A task force can be a powerful mechanism for bringing talent to focus on complex matters. When the objective for which the task force was organized is attained the group disbands.

Product Team Management:
Product team management is a generic phrase that describes a relatively permanent product-functional matrix in which business-results managers overlay a functional resource organization. A team of people is organized and charged with managing a product or product line serving specific market segments. Other names used to describe this form include "business boards," "business committees," and "business heads."

Production Team Management:
At the production level, teams of workers do their own work planning and control. In such a setting, the supervisor becomes a facilitator, who helps the teams work out the details of assuming responsibility for the manufacture of the entire product.

New Business Development Teams:
Sometimes teams are used to develop new business opportunities. Occasionally, they are organized on a permanent basis to conceptualize, develop, and provide an overview for new businesses.

Quality Circles:
A quality circle is a group of people (4-10) with a common interest who meet regularly to participate in the solution of job-related problems and opportunities. It is an ongoing group, operating in the work environment, that performs "opportunistic surveillance" for the organization: searching for opportunities, defining problems by applying formal data collection and

analysis, and arriving at solutions that are presented for acceptance and implementation by management.

The Plural Executive:

The size and complexity of many contemporary organizations have led to a new phenomenon termed the "plural executive" -- a permanent, formally established office composed of several individuals who as a team perform the functions of top management. The plural executive is a reasonable alternative to the single chief executive and performs as well as the traditional single single chief executive approach. This collective style of top management in the plural executive context has many designations: "Office of the President," "Corporate Executive Office," "Management Committee," and is used by such firms as: The Bounty Savings Bank, Sears, General Electric, IBM, Bendix, Westinghouse, Dow Corning, and Dupont.

Multiorganizational Enterprise Management:

The management of "super projects", such as the Space Shuttle Program or the Alaskan Oil Pipeline, requires the amalgamation of many organizations to support a common goal. Known as multiorganizational enterprises (MOEs), these ventures usually contain many participating organizations or groups that have different objectives and exhibit different cultures.

This diversity -- along with the size, complexity, and interdependence that characterize MOEs -- is best managed under a matrix system because of its emphasis on multiple authority and the sharing of key strategic and operational decisions, responsibility, and accountability.

The development and use of project management have not been without problems. A brief review of the experiences of some current companies illustrates the nature of some of these problems.

PROBLEMS WITH MATRIX MANAGEMENT

Anyone who has worked in matrix management will attest to its complexity, difficulties, and problems. Of all the approaches to structuring an organization, the matrix approach requires greatest caution in its design and patience in its implementation. Even in those situations where matrix must be used, as when doing business with the Defense Department, its effective use must be reinforced periodically by explanation and training to assure that people understand and accept the multiple organizational and system forces that operate.

Matrix, if properly designed and operated, can provide a way of synergizing organizational effort not possible under the more traditional organizational forms. Business Week magazine in a recent article described how Hewlett-Packard used matrix techniques to pull together widely scattered divisions into "lockstep" on a $100 million project. (8) But matrix does not work effectively if it is not properly introduced. Bausch & Lomb developed a strategic plan for the instruments group which was to be complemented by a matrix-based reorganization where manufacturing responsibility was divided among three new product divisions with a fourth division to manage sales and services. But according to Fortune magazine many of the managers remained "confused and demoralized." (9) They could not accept the matrix structure and this accounted, at least in part, for the failure of the strategic plan.

Texas Instruments, Incorporated (TI), recently went through an assessment of the strengths and weaknesses of the corporation. They examined their strategies, management systems, organizational structure, planning systems, and each of their businesses. The assessment was initiated by a failure on the corporation to adjust fully to the transition from a $3-billion to a 4-billion company. This failure to adjust affected both the operating and strategic structures of the corporation.

The Product-Customer Center (PCC) is Texas Instruments' basic operating unit with a focus on creating, making, and marketing products to satisfy customer needs. A PCC manager is expected to be an entrepreneur. However, over time two things happened to reduce the PCC manager's ability to act as an entrepreneur. Within the Texas Instruments matrix, resources were built up in large centralized support organizations, and as a result the decision making of these support units overshadowed that of the PCCs and compromised their control of their businesses. PCC managers were no longer managers of resources; they were negotiators between support organizations. On the strategic management side of TI, things were not going well: "Strategy management had drifted out of alignment with the PCC management. We had evolved into an almost complete matrix structure of product and technology strategies cutting across many organizations. The matrix approach fragmented both people and resources, and diffused authority to the point that managers could not carry out their program responsibilities effectively. With the increasing size and complexity of the matrix, and the accompanying separation of responsibility from resources, the system failed to support effective project teams and program executive suffered." (10)

TI reorganized to strengthen the PCC concept and to provide a new framework for executing key strategic programs. For example, within the semiconductor business operations, the organization has been restructured around seven major PCCs. Each manager of a PCC now controls the resources and operations for that product line from design through development, front-end processing, assembly and text, to product marketing. In addition, within its semiconductor division, TI has created a new advanced development activity where the mode of oeperation will be to put together project teams under responsible managers for specific periods with defined

objectives and adequate resources. These project teams along with the redefined PCCs will facilitate the execution of these strategies on a timely basis. (10)

In 1974, General Motors, as part of its strategy for downsizing their automobiles, adopted the "project center" concept as a way of organizing engineering resources to redesign automobile components. In GM, the project centers are composed of design teams that work on problems common to all divisions, and on standardization of equipment, such as frames, electrical systems, shock absorbers, steering gear, etc. By standardizing equipment common to all car models in the various GM divisions (Pontiac, Buick, Cadillac, Oldsmobile, and Chevrolet), the product costs of the manufacturing and assembly processes were reduced.

At the time that the "project center" strategy was announced by GM, the author speculated to his students about the possibility that this strategy might ultimately result in "look-alike" GM autos. It was postulated that as more and more equipment became standardized, customers might feel that any product differentiation was merely superficial. This may be what has happened. Fortune magazine in the February 21, 1983 issue reported that sales of the X cars have been falling, perhaps largely as a result of the usual decline in any model's sales over time. But, according to Fortune, ". . . the main reason for their coming demise, in the view of most industry experts, is that GM now has too many models too much alike." (11)

SUMMARY

In the last twenty-five years project management has emerged and holds a commanding position in the lexicon of management. The formation of professional organizations, the development of sophisticated literature, the design of graduate/undergraduate and continuing education criteria, and the widespread use of project techniques in contemporary organizations all attest to the rightful place that project management how holds in the management discipline.

Project management has been the leading edge of a new family of managerial approaches that is coming into prominence which promises to break with the rigidity and formality of the past. While it is difficult to put a single name on what is happening, "matrix management" has emerged as a strong candidate for such nomenclature. The end result of matrix management in contemporary organizations has been a greater use of temporary organizations at all levels to accomplish organizational purposes. Participative management, consensus decision making, team management, the systems approach, the development of specialized techniques, and a sharing of decisions, results, and rewards all work to change the culture in which contemporary matrix organizations operate.

Project management is not without its problems in its evolution. Some of the lessons that have been learned in such evolution include:

- The need for a careful prescription of the conditions under which project management should be used. Great care should be taken in its introduction and implementation.
- Recognize that it is not a panacea. If problems within the organization already exist, these problems will still exist, becoming more visible since the matrix culture "unclothes" the organization, allowing everything to be seen.
- It requires a total systems approach in its use. It only works through people, who must understand it and are committed to making it work.
- Control of the growth of centralized functional support organizations must be guarded. Avoid those situations where the decision making of the supporting functional groups overshadows the "profit-center" or "product-line" manager who has jurisdiction of the project management effort in the organization.
- Maximize the sharing of common resources across the project matrices in the organization, but within a product-related focus where the sharing of common resources is cost effective, and complements the strategic management of the project in the marketplace.
- Project management, if properly applied, can help organizations that must deal with interdependent, complex, and dynamic problems in their competitive environment.

Project management will continue to grow in its use and sophistication. It has paved the way for conceptualization and development of alternative matrix organizational forms. Finally, project management is an idea whose time has come. Contemporary organizations will not be managed in the traditional manner again!

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ADP002825

PROGRAM MANAGER'S SUPPORT SYSTEM (PMSS): AN UPDATE

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ABSTRACT

The Defense Systems Acquisition Process is a complicated process requiring the integration of many disciplines and functional areas. The Defense program manager (PM), in executing an assigned program within this environment, is faced with many non-routine and unstructured decisions. Although Management Information Systems (MIS) typically are available to the PM and provide information to aid in making these decisions, they predominately support only past and current project status, usually with an abundance, and many times perhaps, an over-abundance of data. A need exists, therefore, to support the PMs' decision-making process by looking at future courses of action, assisting in answering the "What if---?" and "Should I---?" questions, and distilling the available data into meaningful alternatives. This need is being addressed at the Defense Systems Management College (DSMC) through a research project aimed at applying Decision Support System (DSS) technology to the Defense weapons systems program management environment. This paper describes the resultant Program Manager's Support System (PMSS) effort. It is an update to the PMSS presentation given at the 1982 Federal Acqusition Research Symposium. As such, this paper presents a brief background review, the functional requirements for such a system, the project's current status and future plans, and issues which must be addressed.

INTRODUCTION

Defense program management is very complex. It involves controlling cost, schedule and performance program parameters; managing many diverse functional disciplines such as financial, planning, contracting, and configuration control; adjusting to the impact of outside influences such as economic conditions, political pressures, and changing threats; reconciling internal organizational and personnel matters; and providing responses to higher level requests or directions.

The program manager (PM), and appropriate staff personnel, in managing assigned programs within this environment, must make many decisions. Whether the decisions are effective or not depends to a large extent on whether the issue at hand is well understood, including alternatives and potential impacts. However, to understand the issue requires knowledge about it.

Having knowledge about an issue implies the availability of pertinent information and data. This has long been recognized, and with the advent of automation technology, many systems have been developed to collect, process, and report data in many ways. To date, however, these systems have keyed on "number crunching" processes, such as accounting, and data in fact, i.e., information about something that has happened or is currently taking place. Although these capabilities are important to decision-making, they do not provide a look into the future so critical to many decisions.

The advancement of automation technology has, in the past, fostered a divergence into "specialized" processing capabilities such as word processing, graphics, and artificial intelligence. Today, as the technology continues to advance and hardware costs continue their downward trend, we see a convergence, or melding of these specialized capabilities into integrated systems which can better aid the decision-making process (Figure 1).

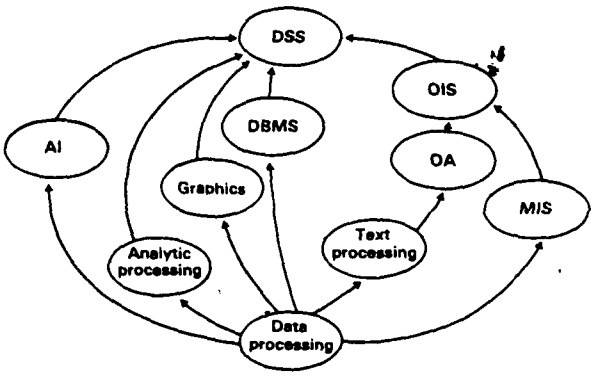

Figure 1. Automation Technology Convergence.

These new systems, conceptualized as early as the 1950's, are based on the modeling of more complex processes and interrelationships, the translation of these models into computer programs, and the operation of

the programs using current and historical data (usually from a MIS) in combination with that of expected environments. The result is a look into the future, i.e., the generation of future courses of action (answers to "Should I ...?" questions), and impacts of potential program changes (answers to "What if...?" questions).

These systems are designed around specific decision situations or processes and thus are called Decision Support Systems (DSS). The term "support" is important because these systems are not meant to actually make decisions for managers. Decision-making in the complex Defense program management environment must also take into account such factors as external influences and boundary values, and the PMs personal experience, management judgment, and intuition. Technology has not yet reached the point where these kinds of factors can be economically simulated.

This man-machine combination, a MIS, a DSS, and the PM (or the PMs staff), working together in a more harmonious manner, should result in more effective decision-making (Figure 2). Recognizing the potential benefits of applying DSS technology to the management of the weapon systems acquisition process, the Defense Systems Management College (DSMC) has initiated a research project to develop a DSS for the Defense PM. The resultant system, called the Program Manager's Support System (PMSS), was first addressed at the 1982 Federal Acquisition Research Symposium. (6).

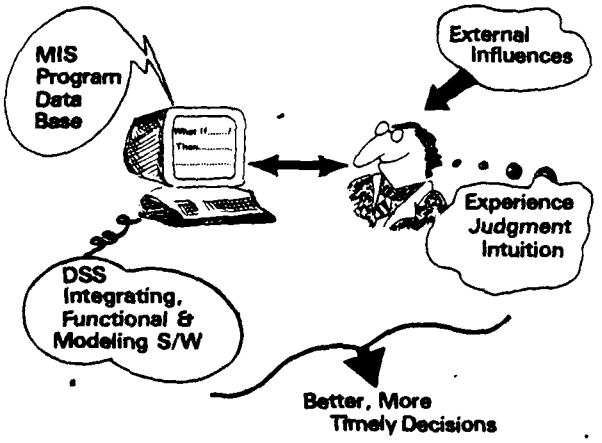

Figure 2. More Effective Decision Making

More detailed information concerning the PMSS was subsequently published in two additional papers. (2), (4) However, because of the limited distribution of the publication meduim, some of the information in those papers will be summarized here to provide a concise but comprehensive update of the PMSS project.

BACKGROUND

The PMSS concept was conceived at DSMC in December 1981 through a series of discussion and brainstorming sessions revolving around the problems of what data is available to the PM and how the PM handles that data. In early 1982, a number of academic, commercial, and DoD activities were visited to assess the status and use of DSS type systems. In addition, 21 Army, Air Force, and Navy PMs were interviewed to determine what information and information systems were being used. As a result of these efforts, a PMSS concept and program plan were developed.

During the past year, the PMs functional areas of responsibility and the functional requirements for the PMSS were refined, development of functional modules (bottom-up approach) begun, and system architecture (top-down approach) contracts awarded. These efforts will be further described in later paragraphs.

The approach being used for the PMSS development can be viewed as a combination of both top-down and bottom-up concepts. The top-down approach involves defining the bounds within which a PMSS can be developed, the overall system architecture, system software configurations and generic hardware configurations. The bottom-up approach includes the identification and development of specific functional module capabilities that can be integrated into the overall system as it matures.

The overall development process being used is based on the Staged Development Iterative Design Cycle being pursued by the Army Institute for Research in Management Information and Computer Sciences (AIRMICS). (3) Their research has shown that this design philosophy has a high success ratio in developing DSSs. One of the main reasons for using this iterative approach is the difficulty in defining the decision-making process and its data requirements. (1) This approach involves development of a basic capability, review of the design and requirements through operation of the basic capability, and further development of refined and/or expanded capabilities. This cycle, as depicted in Figure 3, is then repeated as necessary with concurrent top-down and bottom-up efforts.

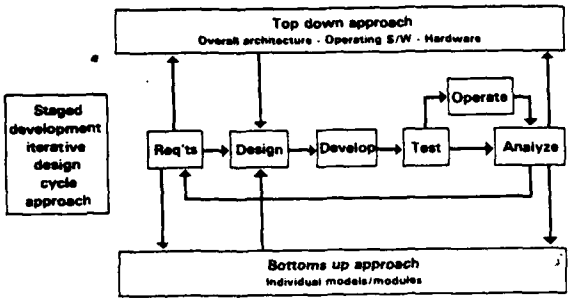

Figure 3. PMSS Design/Development Approaches

PMSS DESCRIPTION

Based on the review of PMs information systems, the twelve functional areas of responsibility of a PM, as previously reported in (6), were refined to the eleven functional areas of responsibility and three capabilities as shown in Figure 4. It is acknowledged that this is but one of the many possible ways of viewing the responsibilities of the Defense program manager. This approach, however, was selected because of the relative ease of collecting definitive data to support it.

- Functional Areas
  - Administrative Management
  - Program Overview/Status Management
  - Project Planning
  - POM Development and Budgeting
  - Financial Management
  - Contracting
  - Government Activity Tasking
  - Technical Management
  - Configuration Management
  - Integrated Logistics Support
  - Deployment and Operational Status
- Capabilities
  - Cost Estimating
  - Scheduling
  - Monitoring

Figure 4. Defense Program Manager's Responsibilities.

To support decision-making in these areas, five basic functions which the PMSS must perform were defined (Figure 5). The Acquisition Life Cycle Analysis function is perhaps the most important. It is the capability to rapidly assess the impact of program purturbations both across and within the eleven functional areas. Not only will this capability assist in responding to unplanned changes, it can also be used for program planning by testing various possible program conditions and analyzing the potential resultant impacts derived by this PMSS function. This function assists with the "What if---?" questions.

- **Acquisition Life Cycle Analysis**
- **Functional Analysis and Support**
- **Analytical Modeling**
- **Report Generation**
- **Ad Hoc Analysis Aid Generation**

Figure 5. PMSS Functions.

The Functional Analysis and Support function is a set of aids that will give the PM and the PMs staff additional capabilities related to specific functional areas. One type will assist in identifying and analyzing the implications of applying various acquisition management procedures (e.g., MYP, P^3I), give guidance for application, provide examples and "lessons learned", test the PM's program for applicability, and provide step by step procedures for implementation. This capability addresses the "Should I---?" questions. Another type will process functional data in specialized ways to provide better insight into program performance (e.g., CPR analysis). A final type of aid will assist in the generation of typical program documents (e.g., ILS Plans).

The Analytical Modeling function, useful primarily to the experienced user, will contain a set of general purpose operations research software which will allow the processing of program data using various standard analytical methods. Report Generation, of course, is the capability to present the results of any of the PMSS processing in a meaningful and useful way, either on a screen or hard copy.

The final PMSS function may not be feasible yet because it tests the limits of todays technology. It is the capability to construct, from parts of existing PMSS software, new analysis capabilities to assist with unique or ad hoc problems.

Despite these worthwhile functions, the PMSS will not be useful to the PM unless it can be easily operated and possess other general system characteristics conducive to operation in a PMO. Therefore the PMSS should meet the goals identified in Figure 6. The specifics of each item are currently being defined.

- Generic
- Service Adaptable
- Support Various Mgt Levels
- Growth Potential
- User Friendly
- Operate in Office Environment
- Relatively Inexpensive
- Common HOL
- Adequate Response Times
- Process Classified/Sensitive Data

Figure 6. PMSS System Characteristics Goals.

CURRENT STATUS

Architecture Development. As indicated above, the PMSS functional requirements were refined in early 1983, and three parallel contracts were awarded competitively on 1 July 1983. The purpose of these contracts is to define the bounds within which it will be feasible to develop a PMSS and it's most important function, Acquisition Life Cycle Analysis. In addition, overall system hardware and software architectures will be defined.

The winning proposals (and resultant contracts) provide a very wide range of approaches for the architecture development. In particular, these efforts represent quite different hardware architectures, software architectures, analysis methodologies, acquisition life cycle foci, and programming approaches. Of particular interest is the variety of system software concepts as shown in Figure 7. Such broad coverage of key systems factors is certainly fortunate and will provide a very good baseline from which to prototype the PMSS.

- Structured Programming
- Classical DSS
- Artificial Intelligence

Figure 7. PMSS Software Concepts.

Although the three contractors will address different approaches in developing the recommended architectures, the required products from each are identical. Within the contracted six-month study period each contract will provide the reports listed in Figure 8.

- Acquisition Life Cycle Analysis
- Trade-off Analysis
- Architecture
- Hardware/Software Analysis
- System Description
- Concept Demonstration Plan

Figure 8. Architecture Contract Reports.

These contract products will provide a wealth of information, and because of the diversity of approaches used, will require a significant review process by DSMC. This process will be aimed at finalizing the strategy for follow-on prototype acquisition and the selection of one or more concepts for demonstration.

Module Development. Concurrent with the activity related to the architecture development, the bottom-up approach, or module development effort, has also been progressing. There are presently two module development efforts underway. One will result in a module called the Procurement Strategy Model. The other will produce a prototype module to aid the analysis of data from contractor performance reports (CPR).

Under a DSMC contract in the 1980-81 timeframe, an experimental computer program was developed that demonstrated the feasibility of a model to aid the development of a program's acquisition strategy. The objective of a contract recently executed by DSMC is to modify and refine the existing model to produce a model and a program that can be used as a PMSS module - i.e., an operational program suitable for direct use in an interactive manner by program management personnel. Through this contract the existing model will be modified to provide more user-friendly features, a sensitivity analysis capability, and complete program documentation. The resulting model will be entitled the Procurement Strategy Model.

The purpose of this PMSS module is to assist acquisition management personnel in

developing the strategy to be pursued during each phase of a weapon system's life cycle through the process of eliminating less desirable strategies based on specified program criteria.

The Procurement Strategy Model will use a data base derived from real programs to identify the most attractive strategy selections. At the present time the data base consists of only two categories of weapon systems - tactical missiles and electronic subsystems. The opportunity to expand the data base for other types of systems, of course, exists. At the present time, the Naval Material Command is funding an effort to develop a more complete data base of Navy missiles and electronic subsystems. This additional data base should be operational prior to the end of calendar year 1983 and the Procurement Strategy Model is expected to be operational at DSMC in mid 1984.

The other PMSS module currently under development is called the CPR Analysis Module. The basic purpose of this module is to facilitate the use of CPR data for management decision-making. Numerous computer programs are available to assist the analyst in reviewing CPR data, calculating indices and plotting trends. However, there are no known automated aids that present this data in a manner that will be directly useful for managers (who likely are not expert in the details of CPR data analysis).

DSMC has recently executed a contract to develop a prototype CPR Module for use on the IBM-PC microcomputer. The focus of this effort will be on developing a "manager-useful" tool and plans call for making maximum use of color and graphical presentations. The prototype module is expected to be available for evaluation in DSMC courses and in acquisition management offices in late Fall, 1983.

Additional iterative design cycles are already being considered for the CPR module. One area of possible improvement is the addition of textual or graphical cues or alternative displays that indicate to the manager the significance of the CPR information being displayed. For example, in addition to simply displaying an increasing schedule variance, the improved module could increase the value of this information to the manager by indicating that usually a worsening schedule variance is followed in a few months by a similar cost variance trend. As another example, it is envisioned that the improved CPR module could assist the manager in understanding the importance of a sub-par cumulative cost performance index by highlighting the increased efficiency that would have to be achieved in the future to complete the contract within budget.

PLANS

Figure 9 presents the current PMSS project schedule. As indicated above, we are currently pursuing Phases 3 and 4. The Architecture Development will be completed after review and analysis of the contract results by DSMC. At that point, DSMC plans to build a small demonstration model using existing hardware and software, available modules, and some in-house integrating efforts. The purpose of this model is to obtain early feedback from potential users prior to developing system prototypes.

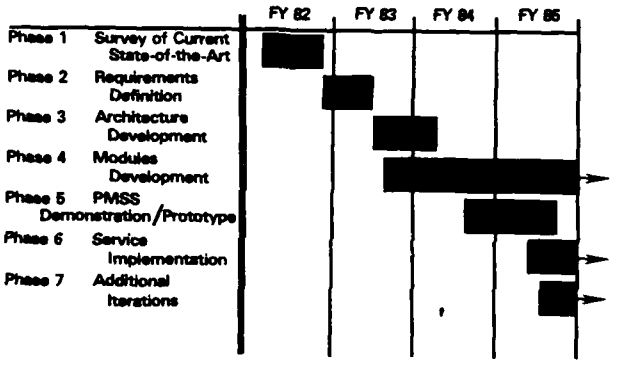

Figure 9. PMSS Project Schedule.

Plans are currently being formulated for the next modules to be developed. The most critical is the Acquisition Life Cycle Analysis Module which would perform the basic PMSS function described earlier in this paper. Other modules are being considered that will provide assistance in the areas of program scheduling, risk assessment, financial management, government tasking, decision-making and Selected Acquisition Report (SAR) generation.

Tentative plans call for initiating development efforts on all of these modules during FY 84 and having some of the less complex modules operational in FY 84 with the others following in early FY 85. Some of these modules will also be available as stand-alone software packages for early implementation by various PMs.

In late FY 84, as part of Phase 5, it is planned to contract for the development

of the first prototype system to be operated at DSMC in mid FY 85. This system will be installed in the PMSS Laboratory portion of the Program Managers Decision Support Center described below, and will be used initially as a baseline and test bed for further development.

The Program Manager's Decision Support Center (PMDSC) is envisioned as a three part facility which will provide program managers and their staffs a decision-making environment where they can receive orientation in program management decision-making from the DSMC faculty, and also conduct real problem solving exercises (Figure 10). The center will also be used for DSMC student training. One part consists of a PMSS laboratory where various hardware and software capabilities will be tested for applicability to the PMSS. The laboratory will also contain the operational PMSS, other data processing and word processing capabilities necessary to support the overall center, and access to the DSMC local area network.

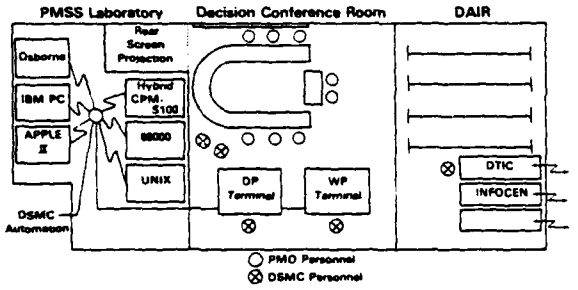

Figure 10. Program Manager's Decision Support Center

The second part of the center is a Defense Acquisition Information Repository (DAIR) which will contain programmatic data from various Defense acquisition programs, and also access to various information services such as DTIC and INFOCEN. The third part is a Decision Conference Room (DCR) where the actual decision exercises will take place supported by DSMC facilitators.

During the past year, initial efforts were started to collect acquisition information for the DAIR, and the PMSS laboratory was established with installation of the first two microcomputers.

Phase 7 represents additional iterative design and development cycles. As the prototypes and modules are tested and used operationally a more complete definition of the decision-making requirements will be possible. This will result in an orderly, evolutionary progression toward the final configuration of the PMSS.

ISSUES

There are many issues involved with developing DSSs, and therefore, are of concern to the PMSS project. Of these, several are considered as key issues. The first of these is the decision process itself. What is the process? How are decisions really made? How much of the process can be modeled? How do the interaction of the various decision-making disciplines result in better decisions? Obtaining the answers to these questions constitutes a major project unto itself. And although specific answers to all of them are not critical to the success of the initial PMSS, the long term results could be highly beneficial.

Several of thse questions are being addressed in the PMSS Architecture development contracts. Others may be addressed by research projects being considered at DSMC. In addition, DSMC and the Army Institute for Research in Management Information and Computer Sciences (AIRMICS) are jointly sponsoring a Decision Support System Research Institute (DSS RI). (5) This Institute was established to define and encourage research in appropriate decision-making disciplines, decision support systems, application of these systems in the public sector, and to provide a clearing house for the exchange of information about ongoing DSS activities.

Another key issue is whether PMs will actually use the PMSS. The answer to this has many facets, such as the operability, or user friendliness, of the PMSS itself, the propensity of the PM to the use of terminals, the need for specific capabilities available in the PMSS, whether the PMSS displays information conducive to the PMs management and decision-making styles, the need for, type, and availability of training, etc.

Recognizing these potential barriers, several actions have already been planned to help overcome some of them. For example, extensive human factors features, including training aspects, will be included in the PMSS design. A management style/decision-making module is being considered which would tailor the system to the manager. Also, extensive feedback from potential users will be obtained early in the develop-

ment cycle through the use of a demonstration model and the prototypes which will provide input to future iterative design cycles.

A final key issue being looked at closely is the development methodology that is evolving for DSSs, described above, and its relationship to current automated system development regulations. The Staged Development Iterative Design Cycle can be looked at as a series of development efforts, each defining the beginning of the next, whereas current regulations require complete definition of the end result or system. This apparent dichotomy is explored further in (1).

SUMMARY

DSMC has undertaken a research project, entitled the Program Manager's Support System (PMSS), with the objective of assisting the Defense program manager by applying information in a manner that supports his decision-making process. This project is well underway. Background surveys have been completed, the overall system concept formulated and the information requirements of program managers analyzed. Three architecture development contracts have been awarded which will result in the preparation of a number of study reports by the end of 1983. The analyses conducted under these contracts will form the basis for the prototype developments planned for the 1984-85 timeframe.

The development of specific functional modules has also been initiated. A Procurement Strategy Module and CPR Analysis Module are currently under development with plans to initiate efforts on program scheduling, risk assessment, financial management and other modules in the near future. The Program Managers Decision Support Center has been initiated, and several key program issues identified for further exploration.

The overall goal of the PMSS project is to provide the necessary tools to assist the program manager and his staff in the difficult task of managing a weapon system program and making the associated decisions in the complex defense acquisition management environment of today. The application of the decision support system philosophy through the two concurrent development approaches of top-down architectural design and bottom-up module development holds much promise for providing at least some of the required tools. Development efforts are underway and within the next year results should become available to begin assessing the development approach. In the same timeframe, useful products (the initial functional modules) for the program manager should also become available.

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MORTALITY AND SPAREPARTS: A CONCEPTUAL ANALYSIS

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AD P000 066

ABSTRACT

The MORTALITY CONCEPT describes how a 'population' deteriorates and what is needed to maintain a population. The populations considered are populations, or families, of spareparts needed to support military weapon systems.

The mortality concept is explained and used to delineate the necessary resulting behavior of families of spareparts. The 'necessary behavior' is defined as that particular behavior which follows, by necessity, from the selected MODE of acquisition (i.e., block-procurement) and from the selected QUALITY of the system.

A generic model is sketched and sample calculations are provided to allow the reader to arrive at firm conclusions about the necessary behavior.

INTRODUCTION

This paper deals with the problem of repairing or replacing worn out or defective parts of a machine. "Parts may be individual pieces, entire subsystems or even the entire system. "Machines" may be aircrafts, ships, radios, cars or other end products, composed of many subsystems and parts.

The problem is presumably as old as machines since the time of bow and arrows and the wooden plough. However, only with the railroad-age has the problem entered our consciousness and been found worthy to be analyzed. This happened because railroad engineers searched for a way to maintain tracks, cars and steam locomotives without peaks and valleys in the workload for the repair shops and the maintenance crews. Data collection on railroad maintenance started about 1880.

It wasn't until 50 years later, however, that the first systematic analysis of data was made by Kurtz. The results of his analyses have been published in 1937, in his book--"The Science of Valuation and Depreciation." He developed series of mortality curves for different equipment just by plotting data previously collected. He introduced a mortality analysis of population, borrowed from the "insurance-mathematics" of the life insurance industry. About 20 years later, accountants rediscovered the replacement problem as an interesting version of cash-flow calculations.

At about the same time when accountants rediscovered the replacement problem, engineers discovered quality statistics and "meantime between failures."

But regardless if we are talking about insurance, accounting, engineering or demography, the conceptual problem is the same. Only the nomenclature changes. Hence, it should be possible to deal with all these problems--including the versions in logistics--with a unified model of mortality.

The model is based on the generic mortality behavior of any population and investigates how a population can be built-up and how it can be maintained within the total systems life cycle. The model proves that all logistics actions depends upon (1) the quality bought, and (2) the mode of fielding a military system. In turn, it gives a new view toward the military decision process in systems acquisition.

FINDINGS

All findings are presented in abbreviated form and in such a way as to give insight into (1) the behavior of the systems population, and (2) the cost expectation to maintain the system. The findings are verbalized. Only the key findings are selected.

Finding #1: As soon as (1) the quality of a system and (2) the mode of fielding the system is determined, all logistic requirements are given.

Finding #2: Systems acquired in block-procurement will have fluctuating support requirements with peaks and valleys, prior to the time when the support requirements stabilize. The fluctuations will dictate warehousing demand, maintenance-work demand and distribution-demand.

Finding #3: The span of fluctuations in block-procured systems between peaks and valleys increases with increased quality of the system and decreased with decreased quality of the system.

Finding #4: The support requirements in block-procured systems for high quality

systems stabilize very slowly after many fluctuations and at a low steady state level. Low quality systems stabilize quickly but at a high level.

Finding #5: If block procurement is not required, then the possibility exists to build-up systems of any desired quality with a steady state support requirement right from the beginning of the first build-up period.

Finding #6: The support requirements for not block-procured systems decreased with a quality increase of a system.

Finding #7: Total systems life cycle cost can be only minimized by selecting the proper combination of (1) systems quality and (2) mode of fielding.

Finding #8: If either (1) the systems quality or (2) the mode of fielding is predetermined, no total systems optimization in form of cost minimization is possible; only suboptimization through proper selection of the non-predetermined part is possible.

Finding #9: If both (1) the systems quality and (2) the mode of fielding are predetermined, no total life cycle cost minimization is possible and any further search for logistic optimization is an exercise in futility. The logistic support requirements are cast in concrete and only the "how" of the response is open for localized improvements.

Finding #10: The logistic support demand for any system, block-procured or otherwise, can only and only be determined if the mortality of the systems elements is known. Without this knowledge of the mortality, all logistic cost predictions are purely speculation.

Finding #11: Mortality can only be determined through testing. The cost of testing can be balanced against savings in systems support cost and, hence, it will be possible to arrive at an optimal testing rate.

ELEMENTS

The concept of mortality is used to combine the two elements of quality and mode of fielding into a uniform model for logistis. Quality and mode are independent from each other and they are the only selective variables in any logistic operation. All other variables of logistics are dependent upon the selection of quality and mode.

Logistics is defined as the sum of all actions required to maintain the usefulness of a product for a specified time. All those actions follow with necessity from the selected quality of the product and from the selected mode of fielding such a product. The impact of the two elements of quality and mode of spareparts to the logistic management is the subject of this paper and I will start with the definition and description of those two elements.

QUALITY AND MORTALITY

Quality can be expressed in terms of mortality. Mortality is well defined in the statistics of populations of any kind. Quality, however, is a sometimes loose term and will be defined as used in this paper.

QUALITY

I define quality as the deterioration of performance over time, measured against the design performance of the new product. This makes quality dimensionless and implies that the design performance is normalized to "1"; it also underscores that quality and performance are NOT the same and that a comparison of different qualities has only meaning if the design performance of the compared products is identical.

The subject of quality is illustrated in Figure 1.

FIG. 1. QUALITY

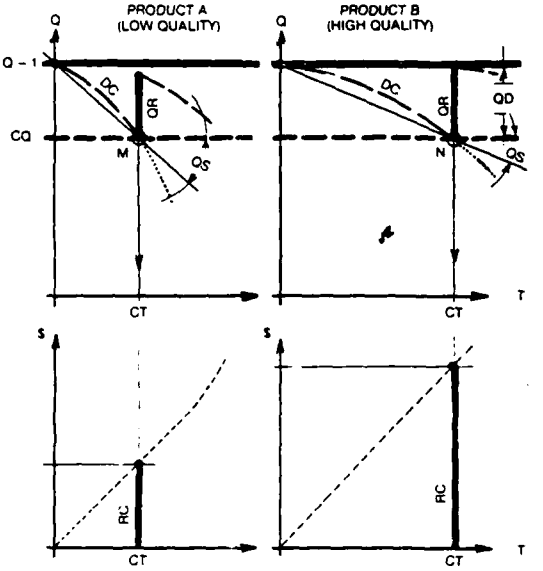


Figure 1 compares two different products--A and B. Both products shall have the same design performance but different deterioration curves (DC) over time (T). Only this part of the deterioration curve is of interest which is located between (a) the design performance "1" or the quality "1" (Q-1), and (b) the critical quality (CQ). The critical quality--smaller than

one--is defined as the limit to which the design performance can deteriorate before the produce loses its usefulness for the assigned mission. This means the critical quality is use-dependent and the CQ for the same product might be lower for commercial use than for military use. In consequence if the same product is used for commercial and military purposes, the military logistic requirement might be higher than if used for commercial purpose.

The deterioration curve (DC) intersects with the critical quality (CQ) for product A and B at the points M and N and determines the critical time (CT) for each product. The critical time is defined as this time when a product must be repaired or replaced in order to bring its quality above the critical quality and, if possible, back to the new quality (Q-1).

The deterioration from the new quality (Q-1) to the critical quality (CQ) is called the quality difference (QD). The quality difference (QD) and the quality time (QT) form the quality slope (QS). This, in time, permits to ignore the configuration of the deterioration curve (DC) for the purpose of quantitative logistics. The figure for product A shows that the quality slope does not have to be constant and, hence, the critical times may also vary accordingly to the quality restoration (QR) above point M.

The costs of quality are introduced in the lower part of Figure 1. We note that each quality restoration (QR) is associated with a restoration cost (RC) and that consecutive restoration costs do not have to be identical.

The addition of the consecutive restoration cost forms the quality cost curve (not shown) and I define the sum of all restoration costs over the lifetime of the product as the quality cost (QC) of the product. The form of the quality cost curve will depend upon the selected quality restorations and a crossover between the quality cost curves for different qualities is possible. It is also possible to construct different cash flow patterns for the quality cost by selecting the preferred quality restorations.

The shift from the non-dimensional quality (in the upper half of Figure 1) to the dimensionality of cost (in the lower part of Figure 1) points toward the separation of physical and economfc properties. The first lends itself to the development of a quality taxonomy, the second toward speculation on cost trends.

Much more could be said about quality but this must suffice for the moment.

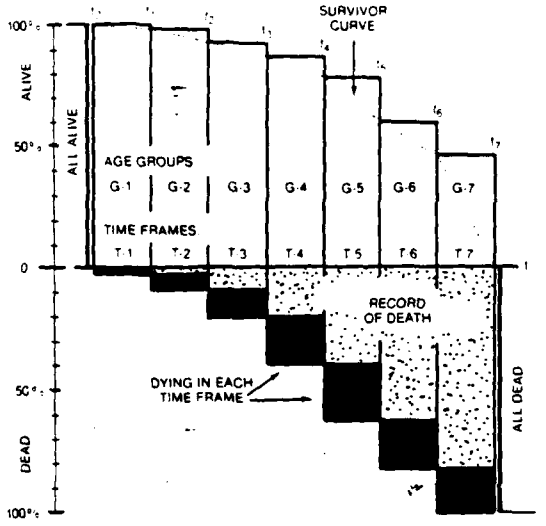
MORTALITY

The concept of mortality or the behavior of failures and death of individual members of large populations is the basis for the entire insurance business since ancient times (1). Its mathematical formulation started about 200 years ago and it was introduced to engineering about 100 years ago in studies about the maintenance of railroads (2) and systemized about 50 years ago. The concept is the basis for demographic work (3) and it seems to be ideal for handling logistic problems for spareparts.

The beauty of the mortality concept is its simple transparency and data economy: only one single type of data is required to make the concept operative.

The rudiments of the mortality concept are sketched in Figure 2.

FIG. 2. MORTALITY



ACCOUNTING SYSTEM

TIME FRAME		T-1	T-2	T-3	T-4	T-5	T-6	T-7
MEMBERS	IN	100	98	92	80	62	37	17
	OUT	98	92	80	62	37	17	0
MORT DISTR		2	6	12	18	25	20	17
SURV RATE		98%	94%	87%	78%	60%	46%	0%
MORT RATE		2%	6%	13%	22%	40%	54%	100%

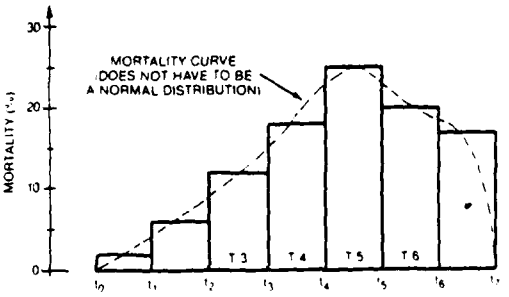


Figure 2 shows in the upper part the dynamic of a population of "100" formed at the time t_0 and observed over seven time frame T_1 to T_7. At the end of T_1, we observe that two units of the population have died. Accordingly, we speak about a mortality (also called the retirement rate) of 2 percent in the age group G-1; 98 percent of the population of 100 enters timeframe T_2; we call this the survival rate of 98 percent. The mortality rate and the survival rate are complimentary but the literature stresses mortality over survival as causal aspect and because of certain aspects in the calculation.

At time t_1, 98 members enter age group G-2 occupying the timeframe T_2 and in this time frame T_2 six members die and only 92 members enter at t_2 the timeframe T_3. Hence, the mortality rate from timeframe T_1 to T_2 is 6/98 = 6 percent and the survival rate from timeframe T_1 to T_2 is 92/98 = 94 percent.

The continuation of the dyanmic of the population "100" leads to the values shown in the accounting system of Figure 2. We observe that the mortality increases in this particular sample observation and that no element survives the timeframe T_7. Other population samples show that any mortality distribution is possible and de-facto exits. In engineering, the ideal mortality rate would be zero at the first timeframe and 100 percent in the last timeframe as it happens often with electronic products. For mechanical products the front mortality can be high because of excessive break in effects but thereafter the mortality stabilizes. High quality products have often a low front mortality but an excessive or progressive end mortality because of wear and tear. All these "quality behaviorisms" or forms of the deterioration curve as explained in this section can be expressed with mortality and, hence, the non-ambiguous relationship between quality and mortality is established.

In the lower part of Figure 2, we break out the mortality curve in normalized form, where the total amounts to "100". We can plot the mortality in steps according to selected age groups or in a continuous smooth form. Having established the mortality curve, we need (except the mode information) no further data to handle all and any logistic problem.

The mortality curve provides the entry into any logistic calculation. Starting with the mortality curve, we can calculate the survival curve, the probable life and the life expectancy for the entire population "100" for any moment of its life. Without the mortality curve, we can calculate nothing.

MODE AND FORMATION

The mode describes the form of fielding of a product. Mode and mortality together form over time a population and establish together the logistics requirements.

MODE

A product, for example, 1,000 new cars for a taxi company, can be introduced at the same time in block procurement. The 1,000 cars can be fielded-in over a period of time. This, I call the mode of fielding. The mode of fielding can be an operational requirement; the mode of fielding might depend upon the availability of funds and be, hence, erratic or it can be all pre-planned according to a set budget.

If we field, for example, 100 units in the first year, then this 100 units of a given product will be subject to mortality. If we field two years later 300 units and the next year 58 units, then this time block of 300 and 58 units will again follow the same mortality pattern and each stream of 100, 300 and 58 units will have a numerical mortality, proportional to the normalized distribution. The logistic problem emerges as soon as we decide to keep each of the three streams of 100, 300 and 58 units alive for a given time. In this case, we have to replace in each stream the members accordinly to mortality and the emergence of an erratic logistic requirement follows with necessity: erratic because of the mode and because of the requirements established by mortality.

The selection of the mode is of highest importance for a smooth industrial logistic support where the build-up of a product family operates with level production.

FORMATION

Regardless of the quality we select and regardless of the mode, any and every population will in the long run stabilize its logistic requirements, provided we decide to stabilize the size of the total population. It is not a question of "if" but only of time. And this time depends upon quality and mode. Ultimately, each population will appear in form of a population pyramid, regardless of how erratic the formulation process of the population might be.

Some of the intractions of quality and mode and its rammification to logistics are sketched in the next sections.

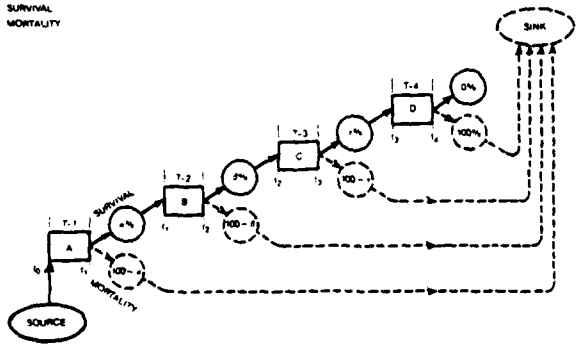
DEMONSTRATION MODEL

In order to explain the interaction between quality and mode, I have developed a DEMONSTRATION MODEL of utmost simplicity. The model is simple enough to be completely transparent and complete enough to make the point. For practical application, the model does not have to be changed but only expanded accordingly to need.

SINGLE STREAM MODEL

The single stream model is shown in Figure 3. The model is restricted to four time frames--T-1, T-2, T-3 and T-4. The four timeframes cover the time intervals from t_0 to t_1, from t_1 to t_2, etc. and it is assumed that no element will surve beyond t_4. Accordingly, four age groups--A, B, C and D--are defined.

FIG. 3. SINGLE STREAM MODEL

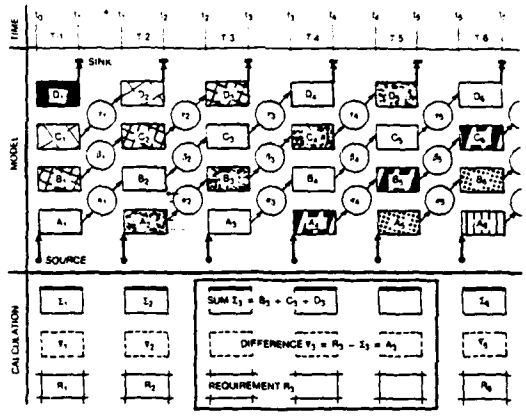


The initial population of "100" enters from a source the timeframe T_1 at the time t_0. At the end of the timeframe T_1 (at the time t_1) α percent of the population will survive and enter age group B while $(100-\alpha)$ percent of the elements will die and go to the sink. Next, β percent will survive age group B and so forth until all "100" elements have departed from the element stream A-B-C-D at the time t_4. In this stream, α, β, γ and δ are the survival rates in percent and $(100-\alpha)$, $(100-\beta)$, $(100-\gamma)$ and $(100-\delta)$ are mortality rates in percent. Each of these rates refers always to the foregoing age group and the total flow can be considered as a primitive form of Markov-chain.

MULTI-STREAM MODEL

The existance of a single stream (Figure 3) with one single chain A-B-C-D can happen in reality when a population of products is acquired at the time t_0 and thereafter used until depleted. Normally, however, one can expect that the dying elements will be replaced in each timeframe in order to maintain the population. Each group of replaced elements will again follow the same mortality pattern and be in itself independent from the prior or subsequent fielded streams. We can express this through a nested multiple stream model as shown in Figure 4. This figure represents at the same time the standard calculation form as used for the results shown in this paper.

FIG. 4. MULTI-STREAM MODEL



The multi-stream model works for demonstration purposes with four age groups G-1, G-2, G-3 and G-4 and can cover any number of timeframes T_i as necessary for our argument. Again, it is assumed that no element survives the fourth age group. For each timeframe the summation is given (SUM) and the Requirements (R_i) for the size of the population. The difference indicates the elements to be replaced in order to comply with the requirement.

Trial calculations have been made with more than four age groups in order to show that the type of model and the present conclusions are not restricted to the range of the demonstration model.

TRIAL CALCULATIONS

A total of 33 trial series have been calculated, representing a wide variety of combinations of motality rates, assumptions about fielding and requirements. Some of these series have been calculated up to 60 timeframes. The total set of the trial series covers the eight fundamental applications of the model:

1. The life of a single stream.
2. The build up of a population within given timeframes.
3. The behavior of a population with constant replacement.
4. The necessary replacement in order to keep a desired population at a constant systems level.
5. Replacement requirements in order to achieve a constant growth of a systems population.
6. Development of a population with constant growth in replacement.
7. Maintenance requirements in order to preserve a specific age group.
8. Change of quality (or mortality) during the maintenance of the systems population.

Practical questions related to the eight fundamental cases are:

to (1):
- o What happens to a population if no replacement for retired elements is provided?

to (2):
- o Does the acquisition process with constant inputs permit the development of a constant population?
- o What are the gains in acquisition cost, if a constant input rate can be secured?

to (3):
- o What happens if the replacement remains constant, however the mortality (or quality) in any of the individual streams changes?
- o What happens to the total system if the replacement level must be fixed according to budgetary constraints?

to (4):
- o What are the life cycle costs (on spare parts) for block procurement versus fade-in procurement--provided such change in the acquisition mode would be possible for operative and budgetary reasons?
- o What pre-procurement and what warehousing do I need in order to accommodate block procurement?
- o What are the production variations for spareparts as introduced by block procurement?

to (5):
- o What form of acquisition will result in the least cost spareparts?
- o What are possible industrial responses and warehouse requirements to uneven replacement pattern?
- o Is it possible to minimize cost for systems growth?

to (6):
- o How can a system population growth if the replacement increases in a preferred pattern?
- o Is it possible to select a level production in combination with short term warehousing--which results in cost reduction of the systems growth?

to (7):
- o It is possible to pre-determine the workload for maintenance for generically identical but operational different sets of equipment?
- o Is it possible to stabilize the workload for the maintenance of a specific technical system?
- o Can a training schedule for maintenance personnel be developed according to workload expectations?

to (8):
- o What criteria exist for keeping a total systems population alive?
- o What criteria exist for exchanging a single stream of equipment with other equipment?
- o Is block obsolescency avoidable?
- o What happens if military quality in spare parts is replaced by commercial quality or defense?

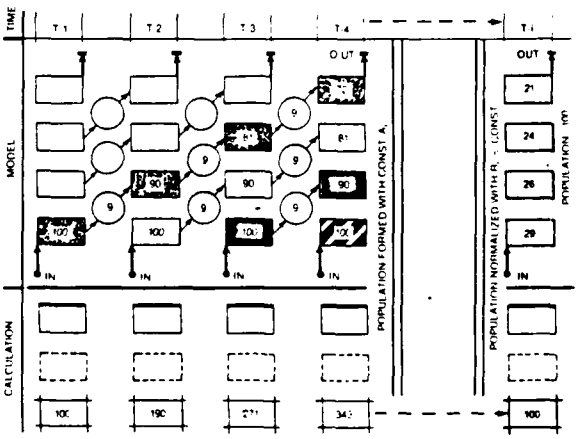
All of these questions--or combinations thereof--can be handled with to suggested type model.

Two trial calculations are outlined.

FORMING A POPULATION

A sample calculation for forming a population is shown in Figure 5.

FIG. 5. FORMING A POPULATION

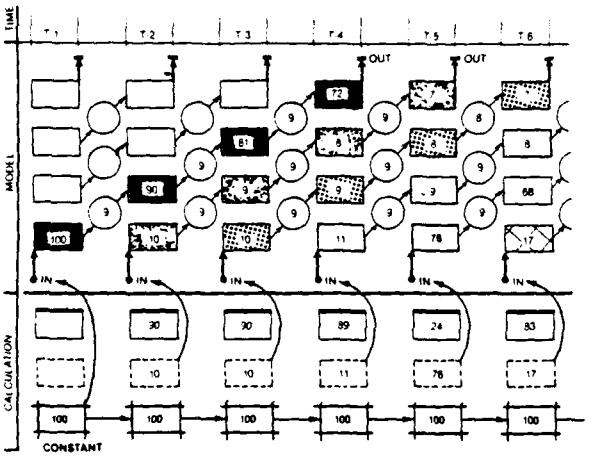


At the beginning of T_1, T_2, T_3 and T_4, a constant input of 100 units from a sink takes place and each of these 100 unit forms its single stream. A uniform survival rate of 90 percent is assumed and no element will survive the age group G-4. In time frame T_4, the population pyramid 100-90-81-72 has stabilized with a total population of 343 members. If we continue a further constant input of A_i = 100, the form of the pyramid will not change and the total number of members will also remain constant. We normalize the pyramid and the population of 343 to "100" and the normalized pyramid for a mortality rate of 10 percent and four age groups (mortality after G-4 is 100 percent) results in 28-26-24-21 normalized members.

MAINTAINING A POPULATION

The sample calculation for maintaining a population is shown in Figure 6.

FIG. 6. MAINTAINING A POPULATION



We assume that the total system of "100" is brought into being at the beginning of the first timeframe and we insist that this system of "100" remains constant over time. The "100" block procurement follows the single stream A_1-B_2-C_3-D_4 and none survives thereafter. This "100" initial stream has deteriorated in the timeframe T_2 to 90 units and in order to keep the "system" stable with 100, we have to add at the beginning of T_2 "10" units into the system. This new "10" units will again form a new stream of A_2-B_3-C_4-D_5 until all units of this stream are again a victim of mortality. We continue this process from timeframe to timeframe and notice that in the timeframe T_5, our first original "100"-unit stream is deceased and no survivors left. Only the replacement streams are carried forward with 7, 8 and 9 units in position D5, C5 and B5 and only 24 units remain in the system. In order to keep the system with "100" constant, we have to add A_5 units at the beginning of timeframe T_5 with a total of 76 new units. This represents a new peak in our acquisition cycle.

The next replacement cycle will start at A_6 with 17 units and so forth. If we call out the first 10 cycles, we get the following values for A_i altrnating between one peak (P) and three valleys(V):

T_i	1	2	3	4	5	6	7	8	9	10
A_i	100	10	10	11	76	17	17	18	60	21
	P	V	V	V	P	V	V	V	P	V

The peaks are getting lower and the valleys higher until they converge at a steady state value.

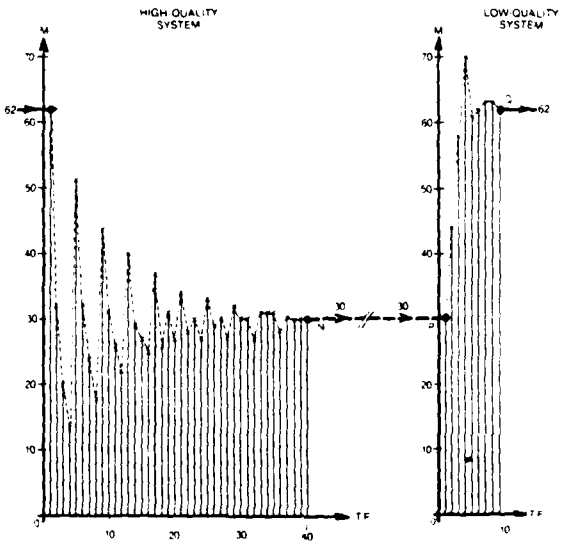
BEHAVIOR

The 33 sample calculations permitted to recognize the necessary behavior of logistic requirements. In different words: every selected combination of quality and mode resulted in a distinct behavior pattern for logistic requirements as needed to keep the system for a predetermined time alive.

QUALITY

Everything equal, quality has a fundamental impact on the behavior of logistics requirements. This is illustrated in Figure 7.

FIG. 7. CHANGE OF QUALITY



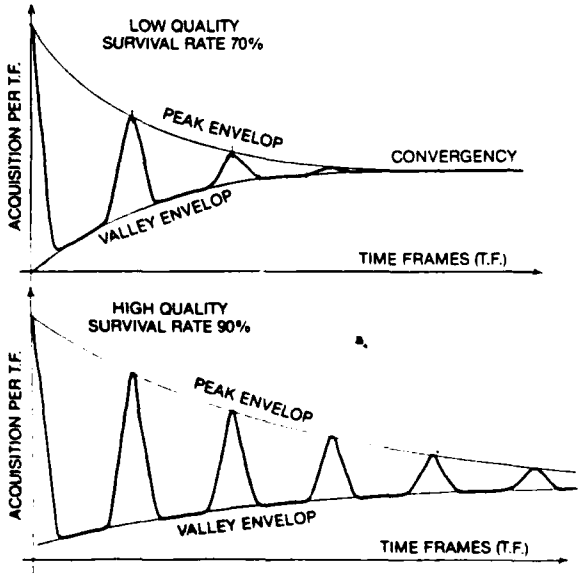
The problem illustrated is the shift from a low-quality population of "100" to a high-quality population of "100" and back to a low-quality population of "100" whereby "100" represents the normalized population in a population pyramid with a total population of 100 members. Accordingly with our demonstration model, we are dealing with four age groups. The low-quality is represented by a survival rate of 40 percent or a mortality rate of 60 percent at the first three age groups and a mortality of 100 percent after the fourth age group. The high-quality deals with a 90 percent, a 10 percent and a 100 percent rate respectively.

The calculation shows that the low-quality population needs 62 constant replacements per timeframe in stable condition-point M. At this point, we replace the low-quality with high-quality, however, keeping the total population of "100" constant. The constant replacement demand will drop to 30 units per timeframe. However, we need 40 timeframes until this new stable station is reached in point-N. Now return to the low-quality at point-P and need only 9 timeframes until the system stabilizes again at the 62 units replacement level in point-P.

TRENDS

For Figure 8, we compare two 4-age group systems, both acquired in block procurement.

FIG. 8. TRENDS



In the upper figure we have a system with a constant mortality of 30 percent and in the lowe one with a 10 percent mortality. The high-mortality system has few peaks and levels out relatively fast at a high level, while the high-quality system levels out very late, but low.

UNCERTAINTY AND TESTING

It is axiomatic that any decision deals with the future. We make judgments about the past and postulate expectations about the future. In particular, we are formulating our expectations for logistics needs in war and peace by assuming a certain mortality for all logistics goods from spareparts to ammunition.

The point at present is that it does [illegible] matter if we are talking about wa[illegible] or peace; it does not matter if we are ta[illegible] about a specific product, a spe[illegible] sparepart or ammunition or fuel--any [illegible] these related logistic demands is bas[illegible] he mortality behavior of the pr[illegible] involved. Ammunition expenditure or [illegible] consumption are just specific terms for mortality. Whenever we do not know or cannot know the mortality behavior, all logistic plannings must remain a dealing with uncertainty.

Fortunately, within the waste plethora of logistics obligations in the commercial and the military domain, we have a large group of products, where we either know or can acquire the knowledge of the products mortality at least down to a "knowable range". Hence, in part, we can deal with the future as it were the past. In mature products we might know the mortality behavior from our experiences in the past and with new products we can acquire this knowledge by testing. Testing brings the uncertainty of the future down, equal to "knowing the past" and the practical question is: "How much testing should I do and how much can I afford if measured against the possible savings in the future?"

UNCERTAINTY

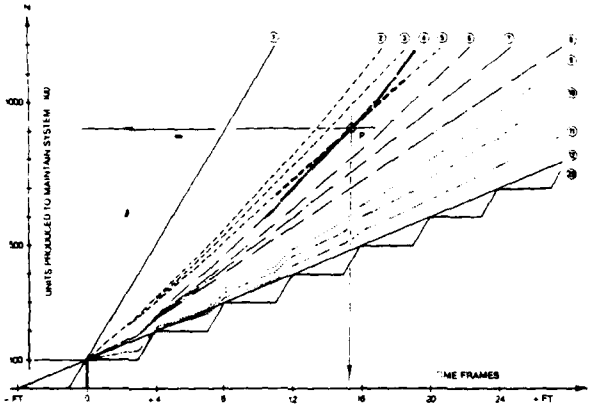
In order to investigate the impact of uncertainty toward logistic requirement, two approaches have been selected. The first approach is to assume that uncertainties will increase in each single stream of the multi-stream model as shown in Figure 4. The uncertainty is expressed in a change of the mortality or survival rate between the timeframes. The second

approach is much broader; it assumes that the total replacements requirement at each timeframe are selected and the uncertainty is superimposed by assuming a constant increase of uncertainty for each progressive timeframe. For example, we assume absolute certainty for the first timeframe T_1 and a 1 percent uncertainty for the second timeframe T_2; thereafter, a 2 percent, 3 percent, 4 percent, etc., uncertainty for the timeframes T_3, T_4, T_5, etc.

Both approaches are a simplification of reality. However, the lessons learned from both are the same and, therefore, can be considered as of conceptual validity and sufficient because we concern outself at this time with "concepts only."

The second approach is illustrated in Figure 9.

FIG. 9. UNCERTAINTY



CURVES:

(1) Absolute limit for zero-quality production rate (No element survives the first age group (G-1).
(2) Survival rate 0.5 plus 2 percent uncertainty increase in each timeframe.
(3) Survival rate 0.5 plus 1 percent uncertainty increase in each timeframe.
(4) Survival rate 0.7 plus 4 percent uncertainty increase in each timeframe.
(5) Survival rate 0.5 without uncertainty increase in each timeframe.
(6) Survival rate 0.7 plus 2 percent uncertainty increase in each timeframe.
(7) Survival rate 0.7 plus 1 percent uncertainty increase in each timeframe.
(8) Survival rate 0.7 without uncertainty increase in each timeframe.
(9) Survival rate 0.9 plus 2 percent uncertainty increase in each timeframe.
(10) Survival rate 0.9 plus 1 percent uncertainty increase in each timeframe.
(11) Survival rate 0.9 without uncertainty.
(12) Absolute limit for perfect-quality production rate (All elements survive all four timeframes and now enters the fifth timeframe).
(13) Survival rate 1.0 without uncertainty.

The curves in Figure 9 are the summary curves for fielding plus replacements for four-age-group families of 100 members with constant survival rates.

The point-P in this figure shows the same numerical need to field and maintain the system with two different qualities and different knowledge about the product behavior toward the future. As example, the curve (5) might be a low-quality car which has been produced since many years in the millions and, hence, I know the repair requirements; the curve (4) might represents a new model of a better car where I know very little about its repair expectancy. If we attach cost to this example and a decision over how many timeframes (or miles) I desire to operate the car, then we are able to evaluate the trade-off between low-quality plus certainty against high-quality plus uncertainty. In short, we can establish the TRADE-OFF BETWEEN QUALITY AND UNCERTAINTY.

TESTING

The next logical step is to translate the trade-off consideration (from Figure 9) into the trade-off between testing and uncertainty. This is shown in Figure 10.

FIG. 10. TESTING

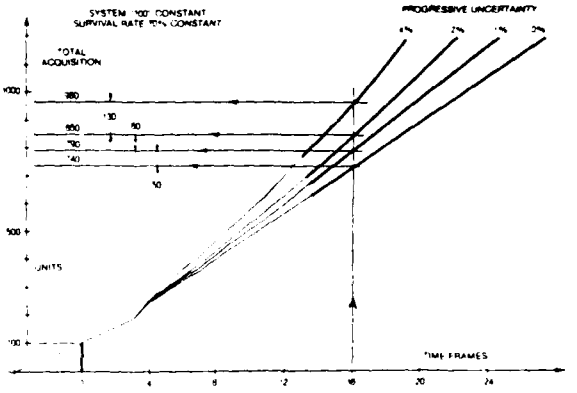


Figure 10 shows the number of units to be produced for a systems quality with a survival rate of 0.7 and with certainty

about the systems future in curve (8) and with progressive uncertainties of 1 percent, 2 percent and 4 percent in the curves (7), (6) and (4). If we have absolute certainty about the systems future, we have to acquire a total of 740 units in order to keep the systm for 16 timeframes at the operative systems level of "100". A 1 percent progressive uncertainty brings this requirement to 790 units; 2 percent to 850 units and 4 percent to 980 units. Now, if we know how much our testing costs to reduce the uncertainty, then we are able to predict the savings in total acquisition and, hence, the TRADE-OFF BETWEEN TESTING AND UNCERTAINTY is established.

PRODUCTION RATE AND MORTALITY

If one fields a system of "100" units, one has first to produce the 100 units and second all spareparts which the system needs for its lifetime. Let's simplify the case and assume we know what the lifetime of the system is supposed to be and let's also be a little bit optimistic and assume we know with certainty that we need another "900" units to maintain the system for the predetermined liftime of 9 timeframes. Now we know we have to produce "1,000" units altogether: 100 for the fielding and 900 for its maintenance. Now we have quite a few options of how to do it. For example, we start the production with 100 units per timeframe (which is our production rate) one timeframe before fielding and continue thereafter with the same production rate for the next 9 years. In this case, we can deliver the "spareparts" with minimum or no warehousing at all direct to the system. Or--in the other extreme, we might produce all 1,000 units right in a single timeframe before the fielding; thereafter, we field the system of "100" units and put the other 900 units in a warehouse and stop production. The optimal production rate and reality will be somewhere between those two extremes.

I will sketch this in two (out of 7) figures.

CONSTANT PRODUCTION

The problem of constant production is sketched in Figure 11.

FIG. 11. CONSTANT PRODUCTION

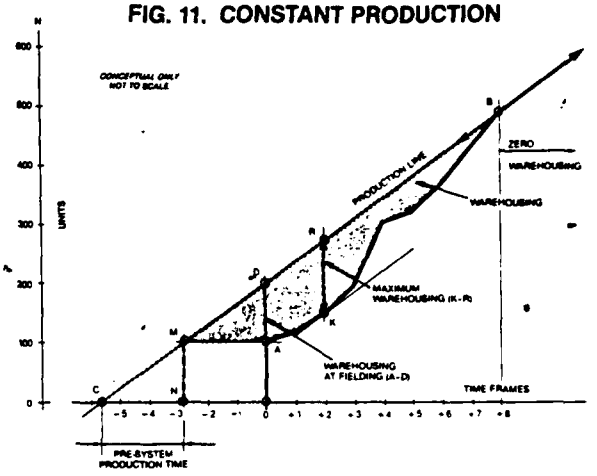


Figure 11 shows a summation curve for a system. At the time zero at point 0, the system of 100 units is fielded. This 100 units brings us in our curve from point 0 to point A. Now the system operates over many timeframes (T.F.) and in each timeframe some elements of the system break down and must be replaced. We add one replacement to the other and the curve goes up (through the crosses) in an uneven fashion until at point B the system has stabilized and the replacement per timeframe remain constant; this means the erratic curve will change into a straight line for all timeframes larger than 8.

We are using the summation curve through the points 0-A-B and extended the constant part (on the right side of B) toward the left until the line intersects with the T.F. axis at point C. The line C-B represents this particular CONSTANT PRODUCTION RATE which is able to build and maintain the system as portrayed by the 0-A-B line, provided the production tarts abt. 5.7 timeframes before the fielding as shown by the distance from point 0 to point C.

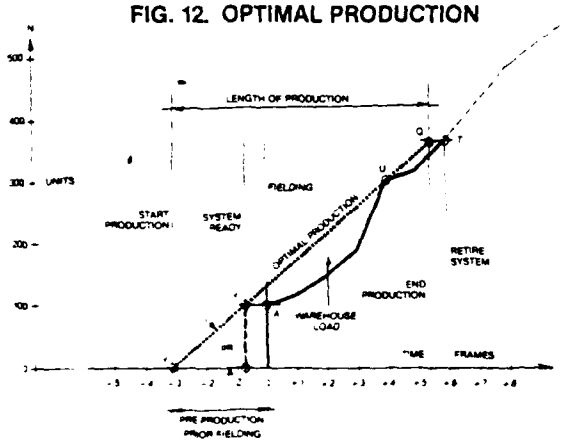
We have assembled the "100" units of our system already at point M at the timeframe point N. The distance N-C is the PRE-SYSTEMS PRODUCTION TIME. Now please consider (1) the system of "100" is already completed at the point N and the size of the system is given by the distance M-N; (2) however, the system will only be fielded at the timeframe point 0 (and of course the distance M-N is the same as the distance A-0; (3) the build-up of the inventory continues constantly from point C to point M to point B; (4) this means that our initial WAREHOUSE INVENTORY between point A and D is already established at the timeframe at point 0, the time when the fielding is made; (5) the maximum warehouse capacity can be obtained by drawing a parallel to the C-B as tangent to the summation curve--which happens in our case

at point K and hence the distance from point K to point R represents the maximum warehousing need for our system; (6) this warehousing need will be reduced unevenly toward point B, where no further warehousing need exists because production and replacement need is identical.

OPTIMAL PRODUCTION RATE

Let's assume we have determined (a) the summary curve for a - logistic operation including fielding given by the curve O-A-U-T; (b) the optimal production rate given by the elevation PR and (c) a predetermined lifetime of six timeframes. In reversed order: the lifetime is a decision, the optimal production rate is a function of facilities and the summary curve is the result of fielding or mode and quality with uncertainty. The result of brining these three elements (a), (b) and (c) together is sketched in Figure 12.

FIG. 12. OPTIMAL PRODUCTION



The production curve must be tangential to the summary curve at point U and we get the solution of the problem. We learn that the production must start at point V. At the time point Z the system of "100" is ready, however will be fielded only at time point O. The distance Z-Y is of course the same as O-A. At Y the warehouse will be stocked and the production continues from V to Q. At this time the production ceases and the warehouse surplus will be exhausted in the time Q to T.

The sketch illustrates:

- o The optimal production rate is independent -from all other systems considerations.
- o The length of the production run and the warehousing load will depend upon the systems quality, the estimate of the uncertainties toward the systems future, and upon the predetermined length of the systems life.
- o Any system can be produced and maintained with an optimal production rate.

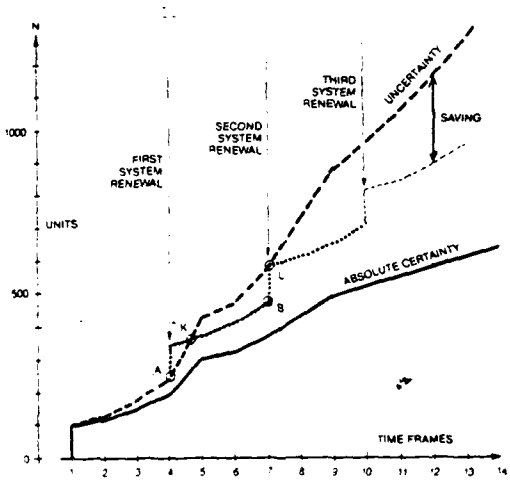
REPAIR OR REPLACE

Some hints to the question of repairing or replacing worn out parts are already given in the discussion of Figure 1. Now the considerations are extended to the inclusion of uncertainty and early repair or replacement for constant performance is considered.

SAMPLE CALCULATION

The result of one of many sample calculations is shown in Figure 13.

FIG. 13. SAVING THROUGH RENEWAL



The full curve in Figure 13 shows a summary curve (as in Figure 11) without uncertainty on the dotted line with progressive uncertainty. We are searching now for a way to avoid progressive uncertainty as much as possible and start at A with a new summary curve instead of continuing along the dotted line. At point A, the next summary curve will jump above the old curve but re-cross at point K below the original curve. This process is repeated at point B, recrossing at point L. With this method we will be able to keep the cash flow more favorable for the replacement of systems than for the continuation of the old system. Tacitly, I translated replacement acquisition into cash flow.

REPLACEMENT CRITERIA

The replacement criteria are summarized in Figure 14.

FIG. 14. REPLACEMENT CRITERIA

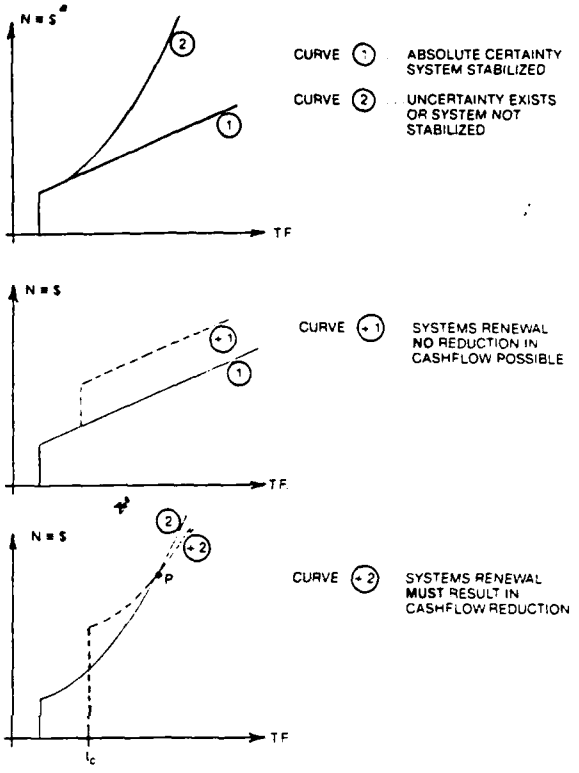


Figure 14 shows three graphs. In the upper graph, we assume that the curve (1) represents a summary curve with complete certainty about the future for a stabilized system. This integral curve, of course, must be a straight line. Curve (2) is assumed to represent either a non-stabilized system with extreme variations or more probably a system with progressive uncertainty toward the future. The integral curve for this behavior must have a quasi-exponential form.

In the curve in the middle of Figure 14, we shift a replacement curve (+1) on top of the original curve and, of course--if complete certainty about the future of a system exists, no reduction in cash flow is possible through systems replacement and the system should be maintained as long as it is justifiable by its performance.

In the lower part of Figure 14, we have sketched a system with uncertainty and shifted curve (+2) along curve (2). In this case, the system replacement at a critical time t_c must result in a cash flow reduction beyond the cross over point (P) of both "old" and "new" systems.

Now we can translate these findings into most pedestrian observations: First of all we can assume that certainty about the future is a criteria for simple systems like a stone building whose construction is (a) testable at any time, and (b) whose construction soundness has been tested since generations. Second we can assume that complicated or complex systems are only testable in full during its actual use and, hence, the certainty about the future is most elusive. Hence, it might be eminently logical to replace (a never used) missile system of enormous complexity with a new one, while a 200-year-old building might be renovated and still be useful for another 200 years. It all depends upon the subjective evaluation of the future of a system.

FROM CONCEPT TO REALITY

All "necessary" behaviors of a logistic system have been explained and defined as this systems behavior which follows by necessity from the quality of the system and from the mode of fielding such systems.

The necessary behavior is a purely physical phenomena, measurable in mortality and operating with physical dimensions. Unfortunately we are neither selecting the quality of a system nor its mode of fielding in a vacuum where we are free to select quality and mode solely on scientific principles. In reality we have to live with numerous constraints such as budget cycles, subjective priorities, variable allocations of funds, changing requirements in response to changing threats and whatever you have there on subtile and often no at all so subtile extrinsic determinants.

The logistic decision maker has to count for those determinants and has to maneuver like between cliffs toward his goal of providing logistic support. Hence, one can assume that he will be interested in a decision tool and I suggest that a "Model for Logistic Decision" might be such a tool.

TOWARD A DECISION MODEL

A logistic decision model should be able to satisfy the following two requirements:

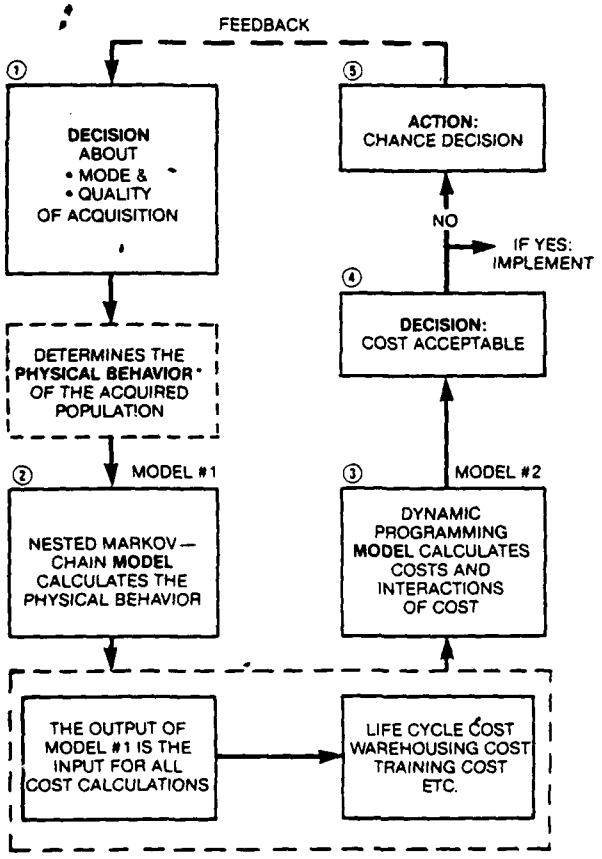
- First, the model should be useful at all levels of the logistic decision process. It should be useful for the top policy decision maker (for whom logis-

tics might be only one of his many concerns) and it should also be useful to the practitioner of logistics at the program managers level.

- o Second, the model MUST be able (a) to accommodate the physical properties and the non-physical or constraint properties of the logistic decision process, and (b) to handle the interactions between the two property groups.

The first requirement describes the wide range of expected users; the second requirement implies the needed decision rules to be built into the model. A rudimentary structure which satisfies the two design requirements for the model is sketched in Figure 15.

FIG. 15. MODEL LOOP



We enter the model at the time t_0 with our initial decision about the quality and about the mode of fielding for our prospective system or product. This input, which of course includes quantitative information, can be made at any detail level of the work breakdown structure of the system. Each individual selected detail input will be associated with its individual Markov chain.

The sum of all Markov chains will result in statements of the necessary behaviors at times t_x, t_y, t_z. . . until the system stabilizes at the time t_i and/or for the planned lifetime of the system. This part of the model follows the physical decision rules or decision calculations for the physical behavior of the system.

Now we have all information at hand that must be translated (ultimately) into cost and cash or cash flow. The result of the Markov chain calculation will determine our maintenance requirements, warehousing, manning level, etc. But all these are cost and we can check, for example, if the calculated cash flow is compatible with the budget flow. If we find contradictions, we have to change the assumptions (as indicated by the feedback loop) until the result is satisfying.

A model designed to the rudimentary structure as described should be useful throughout the entire development and design process for a new system in order to check the possible impact of design changes on total systems life cycle cost. This would amount to a continuous sensitivity analysis for possible impacts, even though we may have only a logical quantification or order of magnitude estimates at hand.

The anticipated model (or program) has two distinct parts or subsets. The first subset is the Markov chain calculation. The second subset deals with the translation of the output of the first set into cost or "constraint" and we can expect that all those constraints are interdependent. This would point toward the use of dynamic programming for this, the second subset. I see no conceptual problem to develop both subsets in tandem and to join both systems thereafter.

The suggested model has NO optimization mode per se. The model is only designed to play "IF-GAMES"; this means the model can answer the decision makers question of what will happen (i.e., in cost terms) if he makes or changes such and such decisions. However, sufficient runs of if-games will point toward a subjective optimal region for a solution and I expect a flat-laxity over a wide range of solutions. In plain English, I expect that each logistic problem will have a wide range of "acceptable solutions" where all optima are within a narrow band as given by the vague ness of the needed assumption for the calculations (i.e., inflation rates in the distant future).

For the model part based on dynamic programming, one can expect the existence

of many detail models able to establish the links among the nodes of the logic chart which is the beginning of dynamic programming.

DATA

The Markov part of the model will determine the needed data and as explained, defacto the only data needed are mortality information.

If we do not have mortality data, the entire exercise of building a logistic decision model must be in vain and we better abandon any illusion that any logistic study can ever make any sense without such information. And I need this mortality data BEFORE I put the system into existence. This, in turn, means that only this is of value to me, what I have properly tested BEFORE the fielding of the system. Specific test data might be substituted by data from "similar" means. This may be problematic in the absence of a developed taxonomy of spare parts. Only such a taxonomy could inform us with statistical credibility about the transferability of existing data to a specific new system.

The model works only with one type of data and modern computer technology permits to go down to any distinct detail level in the work breakdown structure.

EPILOGUE

Unavoidably, but much got lost in the condensation. However, I hope I was able to bring the main points in a coherent form.

I tried to develop the INTERNAL LOGIC of logistic operations. I called this internal logic the "physical necessities" of logistics. This at least was my intent. Now, in retrospect I am somewhat perplexed because I have to confess that all I did was give an exposition of the logical truisms of logistic and all truisms are obvious once they have been pointed out. This obvious truism is the fact that mortality and the mode of fielding drives any logistic operation.

I expect three different reactions to this report. Some will say I over-complicated trivialities, others will say I only scratched the surface of the problem, and a third group will accuse me for not bringing statistical data. The first two reactions have some truth in it; it just depends upon the reader's professional point of departure. However, I would like to deal with the third reaction--that I left statistical data untouched. This is correct and I did it on purpose, because statistics can mostly only point toward possible causalities but statistics rarely can establish causalities of logical necessity. And my interest concentrated on causal connections. In reverse, statistics, if placed into a logical framework, can prove or disprove the logic. So much about the epistomological aspects of research.

Finally--and this was sometimes hard for me--I tried to constrain all discussions of and about mortality to the specific subject of logistics, although the mortality concept has some unexpected applications in economics, industrial planning and similar subject. At the proper time, I will return to this.

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NOTE:

This paper is a condensed version of a 150 page report with 60 illustrations written by the author for NAVELEX in the search for answers to conceptual problems related to sparepart logistics. Some of the ideas have been taken up by NAVFAC and NAVSUP and coordinated research is in progress.

I wish to acknowledge many members of the Center for Naval Analyses (CNA), of the Defense Systems Management College (DSMC), and of the Logistic Management Institute (LMI) for the peer review of different draft versions of the report.

ADP002827

IMPROVING THE EFFECTIVENESS OF AWARD FEE CONTRACTS FOR PROGRAM MANAGEMENT SUPPORT SERVICES

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ABSTRACT

This article reports on a method to improve the effectiveness of Cost Plus Award Fee contracts used for program management support services. The approach involves allowing employee participation in the receipt of award fee dollars thru a concept called Cost Plus Award Fee, Employee Participation, CPAF (EP). An example of an unsuccessful attempt to use CPAF (EP) is presented and a possible solution to problems associated with the use of EP on support service contracts is introduced. The recommended solution is centered around the use of a "criteria oriented" EP system, similar to criteria developed for C/SCS. A major element in the EP system presented is simplicity, in that any EP system must be easy for a contractor to administer. The article concludes with a structured recommendation that CPAF (EP) criteria be developed and tested.

COST/SCHEDULE CRITERIA SYSTEM

INTRODUCTION

This paper introduces a new approach for achieving better Contractor Support Services (CSS) for support of DOD weapon system acquisition programs. In background, Cost Plus Award Fee (CPAF) contracts have been used since the early 1960's for different types of program management support. CPAF was used in early 1960's for support at the Navy Pacific Missile Test Range, and in 1964, a large CPAF Contract was used for the design of the Navy Command Ship USS Blue Ridge AGC 19. More recently, Navy Project Managers have been using CPAF contracts to encourage superior support services, the most notable being the large three-year CSS Contract for support of the Navy's Amphibious Ship Acquisition Program.

The advantages of using CPAF contracts for services are numerous. For the contractor, CPAF provides the ability to earn larger fees/profits. While most CPFF services contracts earn 7% or 8% fee, a well structured CPAF contract can provide from 10% to 12% fee to the contractor for his superior performance. Since top management of professional service companies normally compare negotiated fee against earned fee on contracts on a monthly basis, heavy pressure would be exerted in the company to perform well and earn high available fee. Because CPAF service contracts usually measure cost, technical, schedule, and management performance, company interest would exist to do well in each of these measured performance areas. Assets, especially in the form of talented personnel, could be directed to a CPAF support contract, rather than a CPFF support contract, since a negotiated fee will be earned on the CPFF contract regardless of the level of performance on the CPFF contract. There is also a distinct advantage to a contractor since each quarter is graded on its own merits. If a contractor falls down one quarter, they can recover the next quarter by superior performance, which is sometimes very difficult to do with a CPIF service contract.

There are many benefits that also accrue to the government by using a CPAF support service contract for PM support. Because of incorporated incentive features, CPAF contracts historically produce superior performance by the support contractor. The fact that the contractor is measured quarterly and given a "report card" usually means that the government will have a better handle on the contractor's performance, rather than awarding a support service contract and forgetting it or not "requiring" good performance. By using a CPAF support service contract, the government program office also gets to review, once a quarter, their own effort in working with the support contractor. Is GFI being delivered on time? Are draft deliverables reviewed and returned to the contractor in a timely manner? In a CPAF contract, problems of that nature surface at least quarterly.

There are, of course, disadvantages in the use of CPAF service contracts for PM support services. Contractors sometimes feel that the government is trying to meddle in their internal operations, which may be the case. For the government, CPAF service contracts are difficult to administer. Monitors from the government program office and other participating government organizations must meet periodically (usually once a quarter) to formally grade the contractor's performance. These government individuals must monitor the contractor's performance during the quarter, in order to develop the grade, which relates directly to contractor award fee dollars. The contractor is also usually allowed the opportunity to make a presentation to the government contract monitors concerning his position on his performance during the quarter.

Although the government's decision on periodic award fee dollars is not subject to appeal, animosity can develop between a contractor who believes that he is performing well and the government program office which believes otherwise. From a technical viewpoint, one serious disadvantage of CPAF support service contracts is that the reward

generally accrues only to the company or to a few senior managers, who may be part of a company's bonus program. Rewards for superior performance are not passed down to the professionals who are performing the superior support services for the government program office.

A NEW APPROACH

A new approach has been developed for CPAF support service contracts whereby support service employees are allowed to share in award fee dollars. The approach is sometimes called Cost Plus Award Fee, Employee Participation, CPAF (EP). The objective of this new approach is to improve employee interest and productivity, which should result in overall better support service contract performance.

The approach sounds complicate, but it is not. The contractor would propose EP in his initial proposal, with a brief description of his plan. During negotiations, the exact contractor/employee AF dollar split would be agreed to. After award, the contractor submits a CPAF (EP) plan for government approval. The employees could receive their AF dollars right after the contractor receives his AF dollars from the government (quarterly or whenever). Participation by employees would be based on performance and would cover all levels of contractor employees working directly on or supporting the contract. The easiest way to describe this approach is by use of an example. The government awards a $2 million CPAF (EP) contract for program support services. The base fee could be 3% and the contractor could receive all award fee from 4% thru 7% and share equally award fee over 7% (possibly to 12%) with participating employees. The reason for the contractor receiving all award fee between 4% and 7% and 50% of award fee over 7% is that there has to be some real incentive for the contractor. While he would receive 7% to 8% in a normal CPFF professional service contract, the contractor could receive up to 9.5% in this CPAF (EP) example. From the employees' point of view, if they perform well, they can receive between 5% and 7.5% (using the above example) of their salary as a bonus (ratio of 2 or 3 to 1 because AF dollars are based on contract cost rather than direct labor/salary).

The problems with the use of a CPAF (EP) type of contract, from the contractor's viewpoint are; (1) they are difficult to administer and (2) employees working on other contracts may be unhappy because they do not receive AF bonus dollars.

PROBLEMS ENCOUNTERED

CPAF (EP) contracts have been tried experimentally, and in some cases, have been proven to be a disaster. In 1980, the Navy awarded a three year (one year with 2 one-year options) CPAF (EP) contract, valued at $2 million a year, for support of a large Navy acquisition program.[1] The contract provided for a 0% base fee and for a 0-15% award fee, with contractor receiving all award fee dollars up to 8%, and with half of the award fee dollars between 8% and 12% going to participating employees and all award dollars between 12% and 15% going to those employees. A contractor Advisory Council was suppose to have developed an employee participation plan and distributed applicable award fee dollars to participating employees at the end of each year. The employees were to have been selected for participation by the Advisory Council and the company program manager was to rate participating employees in accordance with pre-determined criteria. As it turned out, in this contract, the proposed Advisory Council never functioned and was abolished, with the agreement of the government, during the first year of the contract. No EP plan was developed and all award fee dollars went to corporate profits. Some of the otherwise eligible managers and senior employees working on the CPAF (EP) contract did share in the contractor's regular bonus program, but with no relationship to their performance on the CPAF (EP) contract. Although the employees were told that they would participate, there were no AF rewards given. As a result, employees working on the contract demonstrated poor morale and overall contract performance was below average. It appears that the EP elements of this 1980 CPAF (EP) contract were too difficult for the contractor to activate, resulting in poor employee morale and below average contract performance.

A POSSIBLE SOLUTION

Cost Plus Award Fee support service contracts, with employee participation, can work if the administration is kept simple. It is important that the government does not get in a position of telling the contractor how to reward his employees. The solution rests in the government developing a CPAF (EP) criteria, similar to the DODI 7000.2 criteria for contractor cost/schedule control systems. The contractor could use his own individual compensation/bonus system to meet the government's criteria. An acceptable EP approach could work as follows. The contractor would propose use of EP and provide a summary of his plan with his proposal. The AF company/employee dollar split will be fixed during negotiations prior to award. The contractor would be required to submit his EP plan for approval within 60 days following contract award. No award fee allocations would be made to the contractor until his EP plan was approved. The participating employees would be paid their AF bonus following the payment of award fee dollars to the contractor (quarterly or whenever). The Administrative Contracting Officer (ACO) or the Contracting

Officer's Technical Representative (COTR) could check to see if employee EP bonuses are being paid.

In order to reduce the common problem of favoritism and in order to keep the system simple, the criteria could specify that an employee is either participating in the plan or not, and if the employee was participating, AF bonus would be based on the employee's salary. For example, if a 2% employee participation award fee were earned in a quarter or a year, the participating employee could earn as much as 4% to 6% of his/her salary, depending on the overhead rate of the company, since AF is paid on contract cost rather than direct labor/salary costs.

The advantages of a "criteria oriented" CPAF (EP) system are; (1) the contractor can use his existing system and meet the criteria, (2) it is easy for the contractor to administer since an employee is either in or out of the plan, (3) the allocation amount for participating employees is based solely on salary, (4) the contractor allocates AF bonus money to the employees after he receives his AF dollars from the government (quarterly or whenever), and (5) this system should lead to high employee motivation leading to superior contract performance. The major disadvantages of such an EP system are that; (1) it takes additional contractor effort to administer and (2) employees not working on a successful CPAF (EP) contract will not be sharing in AF bonus money and may feel deprived.

CONCLUSION

In conclusion, this paper has presented a new approach to structuring Cost Plus Award Fee contracts for program management support services to improve their effectiveness. The approach attempts to drive superior contract performance by providing AF dollar incentives to those contractor employees who are performing work on the service contract. The concept is called CPAF with employee participation, CPAF (EP). The paper highlighted problems that have been experienced in using a CPAF (EP) type contract, and offered solutions to the problems that were experienced. The solution proposed requires the development of a "criteria oriented" CPAF (EP) system, whereby the individual contractor is allowed to utilize his existing compensation/bonus system, not unlike the cost/schedule criteria established for DODI 7000.2. Another quality of the suggest CPAF (EP) system would be the ease of administration, in that; (1) an employee is either participating or not, (2). bonus dollars relate to an employee's salary, and (3) bonus is paid following receipt of AF dollars by the contractor from the government. It was concluded that viable employee participation should generate superior contract performance. The shortfalls of the suggested CPAF (EP) system are: (1) it requires more effort by the contractor to administer and (2) employees not working on a successful CPAF (EP) contract may resent not being eligible AF bonus dollars. The paper concluded with the thought that further research is required on this idea, particularly in developing a government criteria to be used for measuring the acceptability of contractor proposed CPAF employee participation plans. Such research could easily be conducted by DOD acquisition research organizations or be graduate-level students at universities offering programs in acquisition/contracting. Once acceptable government employee participation criteria is developed, that criteria should be tested in a large multi-year DOD program support service contract to determine the full potential of employee participation in AF support service contracts.

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RELATED ASPECTS OF PRODUCTIVITY IMPROVEMENT

Panel Moderator: Dr. Richard Stimson
Director, Standardization and
Acquisition Support and
Acting Director, Industrial Productivity
Office of Secretary of Defense, Research
and Engineering

Papers:

Contract Requirements - A Key to Controlling DOD Acquisition Costs
by Frank E. Doherty

Material Handling - A Target for Productivity Improvement
by Richard T. Gibbons

The Impact of Factory Automation and Robotics on the Contracting and Acquisition Processes
by M. Dean Martin and Robert D. Guyton

A Survey of Contractor Productivity Measurement Practices
by Monte G. Norton and Wayne V. Zabel

CONTRACT REQUIREMENTS - A KEY TO CONTROLLING DOD ACQUISITION COSTS

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ABSTRACT

This paper suggests that controlling contract requirements can hold the key to lowering DoD systems acquisition costs. This paper describes a proposed DoD initiative designed to help control imposition of non-cost-effective contract requirements in DoD contracts. The proposed initiative is based on recommendations from a Defense Systems Management College (DSMC) report developed in conjunction with the Joint Logistics Commanders (JLC), The Boeing Company, and the Council of Defense Industry Assocations (CODSIA) in support of Acquisition Improvement Program (AIP) Initiative #14. Major recommendations from this report call for: a. Specifing in request for proposals (RFPs) and contracts what is needed, not how to accomplish it; b. requiring contractors to tailor during one phase for application to the next; c. not requiring referenced documents to be contractual unless specifically identified as such; d. ensuring that production specifications are not contractually applied to production; and e. providing incentives to program managers to encourage accomplishment of the recommendations cited above. This paper concludes that the key problem to be solved is bridging the gap between current DoD policy and practice. A DoD initiative has been proposed to identify candidate programs for applications of these concepts. The fundamental objective of the proposed approaches is to save dollars. The fundamental approach is utilization of cost/benefit analysis and incentives. The desired impact is greater focus on the real goals of the acquisition, increased freedom to make design trade-offs, and eliminating unnecessary paperwork and procedures.

INTRODUCTION

The current acquisition environment is one of growing public concern as to how well the Department of Defense (DoD) is spending its tax dollars. Overhead costs for most of our major defense contracts have grown dramatically over the past 10 years to the point when direct labor has become a relatively small percentage of overall weapon system cost. At the same time, within private industry, there is an increased drive to become more efficient through emphasis on productivity through improving quality and reducing direct and indirect costs. The Chrysler Corporation recovery is one example where reducing costs through elimination of unessential functions and indirect staff has been a key to company survival. With the defense budget being emphasized as the "big ticket" spending item in the federal budget, the efficiency of defense spending has come under close scrutiny. Public and Congressional pressures demand cost awareness and efficiency in defense spending. The Nunn-McCurdy Amendment will require full justification for cost overruns in excess of 15 percent of unit cost, or 25 percent of program target cost. DoD acquisition managers must take whatever cost reduction actions that are needed to minimize cost growth in defense acquisition. Controlling contract requirements can hold the key to reducing costs and increasing the effectiveness of contractor performance.

BACKGROUND

DoD Acquisition Improvement Program (AIP) Initiative #14 initially focused on reducing the numbers of DoD acquisition directives. The initial (Phase I) effort, accomplished by a DoD/industry Directives Reduction Group, recommended 31 DoD acquisition related directives for deletion. As this initiative evolved it became evident that excessive data may be a symptom of a deeper problem, that of excessive or non-cost-effective technical requirements. Phase II of this initiative involved focusing on requirements in major DoD contracts. In January 1983, the Under Secretary of Defense for Research and Engineering (USDRE) tasked the JLCs and a major defense contractor to assess representative DoD contracts to identify non-cost-effective requirements. The DSMC was tasked to consolidate results and provide recommendations to the Deputy Under Secretary of Defense (Acquisition Management). DSMC's recommendations were as follows:

- Specify in request for proposals (RFPs) and contracts what is needed, not how to accomplish it.
- Require contractors to tailor during one phase for application to the next.
- Do not require reference documents to be contractual unless specifically indentified as such in the contracts.
- Ensure that production specifications are not contractually applied to development phases.

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- Provide incentives to program managers to encourage tailoring.

Implementation actions recommended by the DSMC were (1) a DoD wide test of the proposed concepts be undertaken; (2) strengthening of current Defense Acquisition Regulation (DAR) guidance relating to contract requirements; and (3) inclusion of polices in key DoD acquisition directives such as DoDD 5000.1, "Major Systems Acquisition".

PROBLEMS TO OVERCOME

Unnecessary Requirements. Many of the troublesome specifications leave a wide latitude for interpretation. A 1977 Defense Science Board (DSB) Task Force observed that specs and standards most often indicated as contributing to excessive costs contained levels of lower cost options which were rarely used.[27] A preliminary list of approximately 120 potential cost driver specifications were identified by the task force. The cost driver specifications in general were:

- General Design Requirement Specifications.
- Environmental Requirements and Test Methods.
- Reliability and Maintainability.
- Quality Control.
- Human Factors and Safety.
- Documentation.
- Configuration Control.
- Integrated Logistics Support.
- Packing, Packaging, Preservation, Transportation.

Uncontrolled Incorporation By Reference. The Defense Science Board also indicated that, in the absence of positive management control, the process of contractual incorporation-by-reference can result in the number of contractually binding referenced documents proliferating dra ically. It has been established that each spec or standard can reference an average of eight other specs and standards which in turn will reference another eight, the process being repeated - ad infinitum. The following chart depicts five specifications and the associated references at the 2nd and 3rd tier levels:

EXAMPLE: THE SPEC SNOWBALL

1st TIER	2nd Tier	3rd Tier
MIL-P-9024 (PKG/HANDLING/TRANSP)	50	1,009
MIL-S-8512 (GENERAL S.E. SPEC)	75	3,111
MIL-STD-490 (SPEC PRACTICES)	10	112
MIL-STD-891 (PARTS CONTROL)	18	899
MIL-STD-1561 (PROVISIONING)	8	38
	161	5,169

Premature Application of Specifications. Another source of unnecessary costs is requiring application of detailed production related specifications in full scale development contracts. Describing premature "how to" requirements for objects that have not been designed, nor proven feasible, is not only unwise but thwarts Design-To-Cost trade off efforts. Unduly massive contractual baselines inhibit design changes when they are most needed and when it is least costly to make them. They can generate significant unnecessary cost and time delays as deviations or contract changes are needed to deviate from prematurely described detail requirements. The true goals of the acquisition can easily be obscured as these premature detail requirements become ends in and of themselves.

DoD Policy Implementation. Current DoD policy requires tailoring and utilization of minimum requirements, however, implementation has been a major problem. Although a small number of major programs have employed these concepts, the real challenge has been achieving broader application of these principles. Some of the key problems in this regard have been: (1) a lack of time during RFP preparation to adequately tailor requirements; (2) lack of incentives for program managers and program office personnel to take on the task; (3) lack of experienced personnel to accomplish tailoring, and (4) lack of information upon which to base application and tailoring decisions. At the heart of the problem is often a lack of understanding of what is in the specification and a lack of appreciation of the magnitude of the tailoring task. Experience has shown that tailoring on a major system often takes close to one year and involves extensive interations of specifications between the program office and contractors involved.

PROPOSED IMPLEMENTATION EFFORTS

A proposal is being made to select a small number of existing and new major system aquisition programs in each Military Department to utilize these concepts. Program managers and key program office personnel would be endoctrinated in proposed approaches in a training session to be held shortly after program approval. Recommendations were also made to assign a focal point (SES or Flag Officer) within each Military Department to ensure implementation of the proposed concepts. The OSD Directorate of Productivity, OUSDRE(AM)IP would be designated as the focal point responsible for strengthening current DoD policy and providng the status on program implementation to the DEPSECDEF. Each Military Department would be required to develop plans for implementation of those concepts to be presented to the DEPSECDEF within six months from program go ahead.

Objectives. The principal objective of the proposed initiative is to seek broad implementation of the proposed concepts. The underlying goal is to save DoD acquisition dollars. The application of specs and standards can have a significant impact in increasing defense contractor direct and indirect costs, as systems and manpower have to be added and maintained to satisfy contract requirements. Individually, any given added requirement may produce little identifiable incremental costs. However, the sum total of thousands of these actions, interacting with each other, can significantly increase the cost of DoD products.

A second objective of the proposed initiative is to provide impetus and momentum to facilitate implementation of existing policies and needed reforms. Most of the recommendations included in

A third objective of the proposed initiative is to implement those concepts in pilot programs which can be used as models for subsequent acquisition programs. An underlying benefit associated with this approach is immediate implementation of the proposed concepts on selected systems.

A forth and last objective of the proposed initiative is to strengthen DoD policy and guidance. Additionally progress can be made in defining new incentives and techniques to facilitate the tailoring task.

Cost Benefit Analysis. An underlying principle of the approaches to be evaluated is cost benefit analysis and the application of judgement. Tailoring has been defined as using common sense in the application of specification and standards. Close coordination and communication between the program office and defense contractors can facilitate identification of costly requirements. Contractors are often in a better position than DoD to recognize unnecessary and costly requirements arising out of specification misapplication. Typically, tailoring can include, but is not limited to:

- Selection of the appropriate level of requirements.
- Utilization of the specification as a guide.
- Elimination of the specifications not applicable to the specific program at hand.
- Selection of only a limited number of requirements within a specification.
- Substitution of commercial or industrial specifications.
- Limiting referenced documents to only those specifically needed.
- Rewriting paragraphs.
- Modification of quantitative requirements (such as a temperature range or vibration level).

Obviously it takes time and an extensive effort to review the 200-300 detailed specs and related reference documents that are normally called out in major defense programs. Recognition of the magnitude of the tailoring task and the need of close program manager involvement are essential if tailoring is to be effectively accomplished. It can take almost a year to effectively complete a tailoring effort on a major system.

Use of System Level Functional Requirements and Goals. One of the key factors contributing to a cost-effective application of requirements is the development of definitive performance-oriented requirements which can be used for contractual control. These requirements must reflect a thorough understanding of the employment, maintenance and support concepts planned by the using, supporting and training commands. Use of functional requirement during the early phases of the acquisition allows design trade-offs and necessary engineering changes

to be effected quickly, unencumbered by inappropriate procedures, unnecessary paperwork, and premature or unduly detailed requirements.

Tailoring In One Phase for the Next. The selective application of appropriate requirements based on adequate knowledge avoids many expensive time delays and enables design flexibility. In requiring contracts to tailor in one phase for the next, recognition is given to the fact that design is an iterative process. Effective tailoring requires extensive time and skills. Often the contractor is in the best position to accomplish this task and make tailoring recommendations to the program manager. In employing this concept initial program office focus would be on the development of functional requirements and goals. Although the program office could identify specs and standards, known from past experience to be essential (or candidates for consideration), the identification and tailoring of the list of "how to" specs would primarily be a responsibility of the contractor. A complete system of specifications would be provided for customer review at Preliminary Design Review (PDR). Final Government approval would be provided at Critical Design Review (CDR).

Post Award Contract Evaluations. Since the bulk of DoD acquisition expenditures are involved in current on-going DoD programs, techniques are needed to eliminate non-cost-effective requirements on a past award basis. A proposed approach is to formulate a contract or program office assessment team that would seek a dramatic reduction non-cost-effective requirements contained in selected on-going acquisition contracts. Identification of non-cost-effective would be incentivized up-front based on an added contract incentive which would allow for appropriate sharing with the contractor involved. Program office personnel assigned to this effort and would facilitate advance coordination of proposed changes to contract requirements.

PROGRAM MANAGER INVOLVEMENT

An essential ingredient to the success of this type of effort is program manager leadership in the decision making regarding the requirements to be added or deleted. The rapid growth of engineering desciplines in recent years has meant an increasing number of functional requirements needing to be satisfied. Quite often decisions regarding contract requirements are not decisions between good and bad specifications, but rather between good and better. Program managers are in the best position to make tough decisions to optimize program requirements to ensure the overall goals of the aquisition are met at the lowest cost.

Ensuring Contract Performance. While the proposed initiative is designed to eliminate non-cost-effective contract requirements, the necessity and value of specifications should be recognized. Specifications are essential to technical procurement and can improve quality by defining proven components, fabrication techniques, test procedures, and management disciplines, while at the same time, reducing development risk. There are good specifications which merit full application, even when they dictate design solutions. The key is to identify only these requirements which are essential. There are some risks in utilization of these approaches that contract requirements may not be adequately specified. Experience in a number of programs that have tried these concepts have indicated that the benefits far out weigh the risks. The approaches proposed provide for a firm technical cost and schedule baseline. Management reporting and testing are still required. Given the flexibility to utilize ingenuity, contractors can be freed-up to focus on the more important aspects of DoD programs and reduce today's trends in escalating costs.

CONCLUSIONS

Detail specifications and standards have a very definite and beneficial role in technical procurement. The goals of the proposed approaches are to ensure that the appropriate specifications and standards are applied, to the right degree and at the appropriate time. When applied in this manner specifications can facilitate, guide and document the design rather than hamper design trade-offs and drive cost. These proposed concepts however need to be applied with judgement and flexibility. Application of these principle will also require closer working relationship between program manager, engineering functional organizations and contracting personnel. Hard program manager decisions will most likely be required.

Prior experience with the proposed approaches has indicated the risks in the application of these concepts are far outweighted by the potential benefits in improved cost, schedule and technical performance. The outcome should result in reduced costs, more effective definition of the real requirements of the acquisition and improved design flexibility.

The challange that lies ahead is implementation. Determining the most cost-effective definition of our contract requirements must become an integral part of our system acquisition strategies and ingrained as a key responsibility of our program managers.

If successful this initiative has the potential for reorienting the ulitization of defense contractor resources to where they can be most effectively applied. Implementation of these concepts will allow for a more streamlined acquisition programs, characterized by improved communication, more effective incentives, incentives and freedom to make trade-offs, not encumbered by unnecessary paperwork and premature detail. In total this can result in a significant reduction in cost to the DoD and the acquisition of better defense systems.

FOOTNOTES

1/ DSMS memorandum dated 9 September 1983, Subject Non-Cost Effective Contract Requirements

2/ Defense Science Board "Report Of The Task Force On Specifications and Standards", April 1977

3/ Proceedings, American Defense Preparedness Conference on Tailoring Of Specfications and Standards Oct-Nov 1977

NOTE:

MUCH OF THE INFORMATION IN THIS PAPER ARE THE AUTHOR'S VIEWS AND SHOULD NOT BE CONSIDERED A STATEMENT OF DOD POLICY.

ADP002829

MATERIAL HANDLING - A TARGET FOR PRODUCTIVITY IMPROVEMENT

Richard T. Gibbons, HQ Air Force Contract Management Division

ABSTRACT

Material Handling, as it applies to manufacturing and related operations, is generally accepted as a major cost driver for any contractor. Inasmuch as it does not directly add to the value of a manufactured part or assembly, material handling in most cases has not been given the attention it deserves until the last decade or so. During the 70s, most contractors became more aware of an idea called "productivity", or the ratio of output to input. Any increase in productivity, it is surmised, would mean an increase in return on investment.

As the decade wore on, it was seen that in order to fight against inflation, productivity improvement was not only desirable, but required, and the area of material handling was a prime target for productivity improvement. Productivity in the materials handling area has begun to take its rightful place as one of the key points for management concern. With competition as keen as it is for resources, and with the numerous opportunities for productivity improvements in the material handling area, continued cooperation between Government, Industry and Academe will produce significant productivity improvements.

OVERVIEW

Productivity Measures - In order to improve productivity effectively and on an increasing scale, management has to develop methods of measurement that will not only give current position but also reflect on past performance and highlight significant trends.

Productivity should be used as tracking signals to monitor material handling performance over time for an individual operating unit such as inbound material, individual work station storage or interdepartmental movement. In any comparisons between the performance of distinctly separate individual units such as between a machine shop and a fabrication shop we must insure that we are comparing the same things, e.g., apples to apples. Because of this, these types of comparisons are only used on a limited scale. Productivity charts are one of the best methods for tracking these individual units. Used constantly, periodically and as yardsticks, productivity measures will help gauge the movement of material handling costs, either increasing or decreasing, depending upon the particular performance measure. Daily, weekly, monthly, or quarterly observations should be made. Inefficiencies and/or declines in productivity generally do not suddenly occur. Rather, creeping inefficiencies or gradual deteriorations in productivity tend to be more common. Hence, it is essential that periodic monitoring of the productivity pulse of an operation is established and conformed with. The systems approach has to be a key driver in developing a productivity improvement program. Since productivity measures tend to focus attention on an individual department or worker, there is a natural tendency to suboptimize. Suboptimization occurs when you optimize a component of the system, at the expense of the overall system. As an example, if one productivity measures is pallets delivered per operator, then it could be maximized by providing only one operator and letting material pile up awaiting delivery.

To avoid suboptimization, a comprehensive productivity improvement program is needed. If the measurement program is comprehensive then the effect on the total system can be measured when a change is made in one part of the system.

In addition to the systems approach, it is also important "to do first." The 80-20 rule indicates that 80 percent of the productivity improvement will come from 20 percent of the operations. It is important to focus first on the 20 percent of the operations. [1]

Air Force Concern - The Air Force Contract Management Division (AFCMD) of the Air Force Systems Command has been aware of a need for an increased emphasis on materials handling productivity for many years. AFCMD is responsible for contract surveillance and administration of twenty-six major Department of Defense contractors' facilities producing weapon systems from small rockets to the largest cargo aircraft in existence. AFCMD has defined their materials handling effort to encompass all areas of manufacturing including shipping, receiving, warehousing and stores as well as the work-in-process areas. The analysis of contractor facilities takes into consideration plant layout and material flow, parts protection, work standards and methods as well as production control.

AFCMD has been working with industry and with many educational facilities to develop means to increase productivity in the materials handling area. This involves areas such as working smarter, improved management control and increasing the efficiency of movement operations. As a result of several studies conducted in concert with industry and various universities,

AFCMD has been able to outline various problem indicators which seem to exist regardless of product produced.

THE STUDIES

In order for AFCMD to obtain a firm grasp on the state-of-the-art in material handling, it was decided that in-depth studies should be conducted at selected contractors facilities. Five contractors were chosen. They included (1) A major airframer, (2) an engine manufacturer, (3) a missle and rocket motor manufacturer, (4) an electronics and radar facility, and (5) a research and development operation. The study of each facility was designed to take four weeks with all studies to be completed within one year. That schedule was strictly adhered to.

The make-up of each team was apporoximately the same. The team chief had 10-12 technicians, full time, to evaluate various segments of the contractors facility. The team consisted of industrial engineers and specialists, packaging managers and safety managers, Quality Specialist, and Industrial Property Management Specialists. Each area of expertise had a charter and guidelines of areas to look into. Material handling operations were observed on all available shifts and on weekends. In most cases, the contractor provided a counterpart to facilitate the review. The data output was in the form of findings that revealed inadequate formal procedures of work (handling) practices. The findings were then compiled into lessons learned from each study, which were in turn used to develop lessons learned for the entire study effort. Management tools used to develop this data and also provide a baseline for future evaluation, were the material handling ratios and the list of major problem indicators.

Ratios - The best way to measure the effectiveness of material handling is with detailed cost reports similar to those generated for production costs. But while this is the best way, it also requires facts and figures that are extremely difficult to obtain. Or it involves quantities impossible to measure on an accounting form. For example, how does one acccount for the handling done by production personnel in the course of their jobs, handling that is done over and over again during the production process?

Another acceptable method of effectiveness measuring is to use trend indcators or ratios that have been developed for use in materials handling analysis. They have been used by private industry with a good deal of success and are now being used by government contract administrators as valid checkpoints of a contractor's material handling system. These ratios are used as management tools to develop trends in the contractor's systems and are tailored to specific applications and used on set frequency to substantiate trend validity. They help to control cost influenced by material handling operations. Use of these ratios can help spotlight and control the direct costs of handling material; find and understand hidden operating costs that can be reduced by better material handling practices; and explore opportunities to improve profits through utilization of newer techniques and equipment.

The ratios represent a way of establishing a quantitative measure of the present state of material handling productivity. To use these "quantitative figures" effectively, calculations can be made for systems used in the past which, in turn, permit comparisons to be made. If figures are available, comparisons should be made with facilities having similiar handling problems. Used correctly, the ratios will enable a manager to see which way handling costs are going - and by how much.

1. Material Handling Labor Ratio. This represents the number of personnel assigned to material handling duties in proportion to the total operating force. It determines the proportion of an establishment's labor force that is directly chargeable to material handling needs.

2. Direct Labor Handling-Loss Ratio. This is the ratio of material handling time lost by direct labor to total direct labor time. It measures the relative amount of direct labor effort lost because the workers are required to handle materials when they could be producing.

3. Movement/Operation Ratio. This is the ratio of the number of "moves" inherent in a process to the number of productive operations in the process. The movement/operation ratio measures the relative efficiency of the material handling plan. It shows how well the handling system works, but not necessarily the degree of mechanization of the handling plan.

4. Manufacturing Cycle Efficiency. This is the ratio of actual productive time spent in making a product, to total time. In other words, it is a gauge of the time required to handle a product under ideal circumstances and under actual circumstances. This ratio measures the efficiency of a system for putting materials "through the mill" to make a product.

5. Space Utilization Efficiency ratio is the cubic feet of space usefully occupied to net usable storage. It measures the effectiveness of space utilization. This ratio should be applied regularly to warehouse and storage operations - production operations can be scrutinized less frequently because they don't change that rapidly.

6. Equipment Utilization Ratio. This is actual output of a product facility compared to the theoretical capacity. It measures the extent to which production facilities are utilized.

7. Aisle Space Potential Ratio. This is the ratio of current aisle floor space - minus theoretical optimum aisle floor space - to current aisle floor space. [2]

Major Problem Indicators - There are several areas that can be observed to see if a potential problem exists. Some get glossed over in everyday operations but could stand a closer look. Some of the more fruitful indications are as follows:

1. Crowded Conditions. This becomes an indicator when queueing problems such as backtracking become apparent. Crowded conditions are also apparent when there are aisles blocked by work in-process or when operators or material handlers have excessive moves. Reconstructed plant layout by problem area and by system is required to alleviate this condition.

2. Questionable Storage Practices. This includes temporary storage and workplace storage of work in-process as well as all short and long term storage of finished parts. Indicators in this area include: items placed in temporary storage for over six months, using workplace storage as a holding area for parts that won't be used or worked within the next few shifts, storing tools or items that will be used sometime in the future in high traffic areas of a warehouse, and improper application of preservation and control of tools in finished stores.

3. Equipment in Repair. There is going to be downtime for all materials handling equipment. When preventative maintenance and repair begin to interfere with or cause a slow down of the movement of material, an analysis of types, numbers, and age of the materials handling fleet has to be accomplished. Materials handling equipment also includes protective containers used to transport parts and assemblies throughout production areas. Damaged tote pans and wooden containers that are still in use do not offer the intended protection.

4. Excessive scrap or Increased Scrap Rate. This is an indicator that has a direct cost tie-in and should be tracked by all contractors. The first part of this concern has to be inspection of individual areas or departments. A norm has to be established for how much scrap can be tolerated, what is the cost to reduce this scrap, and what is the cause. Defining the cause correctly is the major factor in using this indicator. The second part of this concern is that even if the amount of scrap is below the established amount, yet the rate per area, machine or department is increasing, it should be seen as a possible problem area. The total scrap function has to be analyzed, segment by segment, to arrive at the disposition of the health of an organization. The amount of rework should be analyzed along with scrap to make a valid determination in this area.

5. Improper Personnel Usage. Like equipment utilization, you need the right skills and number for each job. Using a person to perform a task under his skill level amounts of overpaying. Using a person for a task that is beyond his skill risks having an unqualified operator handling your livelihood, and increases the likelihood of an incident. Training is a branch of this indicator that should not be overlooked. Formal training plus on-the-job training is essential to maintain high skill levels and operator efficiency. There is obviously vast differences in the type and amount of training needed for various materials handling areas, and even the simplest of operations have a right and wrong method of doing it. It is the wrong method that we hope to avoid by proper training.

Another area to be included in improper personnel usage is the indirect labor charges. A lot of cost centers can charge hours to indirect labor under the materials handling heading. Unless hours charged under materials handling are reviewed periodically, they can become runaway charges. When used correctly, these charges should paint an accurate picture of the actual cost of materils handling.

These indicators, of themselves, are not solutions but merely means to find and isolate causes of breakdown in materials handling. Corrective actions has to be the logical next step.

LESSONS LEARNED

The findings and observations taken from all Material Handling Studies can be categorized into one of five discrepancy trends. A description of these trends is as follows:

1. Poor Planning. By far, the leading cause of discrepancies was poor planning on the part of the contractor through ineffective interface with areas affecting materials handling. This resulted from the low priority and lack of emphasis placed on materials handling by most contractors. Subcategories of poor planning highlighted by the studies include:

a. Inadequate Space Utilization. This condition results in a congested layout and material flow that is bottlenecked or causes backtracking. All of these slow down part movement and increase production time. This condition will also lead to operators having to handle parts

(either mechanically or by hand) more than should be necessary.

b. Ineffective Staging. This could be too much or too little stock on hand to perform the next manufacturing operation. Workplace storage and work-in-process staging has to receive serious consideration in material flow planning in order to develop a smooth running operation that has enough stock on hand for production needs but, not so much that manufacturing floor space is used as short to mid term storage.

c. Inadequate Training. In most instances, the emphasis placed on material handling training is low with much of it coming as on-the-job type. There have been contractors that have a conscientious plan for classroom as well as hands-on training for new employees. They also have mandatory refresher courses for material handlers. In some cases, this information is computerized along with medical checks to inform management when an employee is scheduled for what.

d. Low Equipment Utilization. To effectively use the material handling equipment available, a contractor must have measurements or ratios ofthe state of being of all equipment. This includes every piece of material handling equipment from forklift trucks and overhead crane systems to tote pans and storage racks. To maintain the proper usage of powered equipment, a contractor must develop a workable dispatch system. An effective container control system will insure the most efficient use of nonpowered material handling equipment.

e. Excessive Transportation Costs. For a contractor to rent a piece of equipment for a special move and let that equipment sit idle for hours or days because the move was poorly planned adds to a contractor's overhead and contract costs. Planning for moves of this type should be exact enough to have the equipment rented for a minimum amount of time. Excessive transportation costs are also incurred when items are placed in storage at some distance from the manufacturing area and then retrieved, while on-site storage would have been more practical. The third type of excess transportation cost is incurred when vehicles not designed to handle a specific move are used. When an over-sized pickup is used to haul one container that could better have been moved by a small van or pickup, exces transportation costs are involved.

2. Procedural Breakdown. The second leading cause of material handling deficiencies observed at a contractor's facility is the lack of procedures or the enforcement of them. Basically, procedural breakdown will fall into one of the following subcategories.

a. Poor Housekeeping. Most contractors have sufficient procedures that should produce a reasonable clutter-free work area that is organized well enough to allow machine operators to accomplish their work. Receiving and shipping areas should also be well organized and allow the stock handlers to move material into and out of an area in a systematic manner. Storage and warehouse space should be clear of clutter to make access to aisles and locations unhampered. In most of the contractors reviewed, the procedures were fairly well written but not emphasized. The statements to the effect that this is "only temporary" or "awaiting more space" do nothing to alleviate the situation nor enforce the procedures.

b. Lack of Inspection Objectivity. For most operations, the inspectors have checklists or procedures that have been layed out by product engineering. These procedures, if followed correctly, will produce the required part or operation. In many instances, these checklists were "rubber-stamped" or the procedures circumvented in order to maintain a schedule or avoid production delays. In some observations, the inspectors rely on the word of the operator that a critical task was completed and stamp off on an inspection point without having actually observed the operation or result. They have taken the attitude that the operation has been accomplished many times in the past and the operator would not make a mistake.

c. Excessive Handling Operations. In many handling observations, it was noted that items were moved unnecessarily. Procedures had been established to outline proper move sequences but were disregarded by operators and material handlers. Most held the opinion that procedures were for general guidance, but at each work area the handling of material was a judgment call by the operator. For common reoccurring type moves, most contractors have developed pamphlets similiar to an in-plant material handling guide that is convenient for equipment operators to carry and refer to. These guides are usually forgotten and rarely ever consulted.

d. Conflicting Tool Inspection Criteria. For complex moves or moves involving specialized equipment, most contractors require operators to insure that the equipment to be used has a current safety inspection buy-off, and usually the procedures call for an operator sign-off to that effect. Several observations indicate that this is not always the case. Operators have been observed using out-of-inspection equipment and post signing inspection check-offs.

3. Insufficient Parts Protection. This results in potential or actual damage to material moving through production lines; material awaiting disposition in shipping or receiving, or material in storage. One of the major elements contributing to discrepancies in this area is lack of knowledge of the actual pro-

tection parameters required for the item. The second major element is the disregard for these requirements. Evidence of these two elements was that material was improperly preserved or packaged for storage. Material was improperly stacked or protected on the manufacturing floor, and improper tie down procedures were used for intra-plant transfer as well as inter-plant movement.

4. Safety Violations. Although material handling and safety are two different segments in a company, they do have many interactions. Safety, as it concerns materials handling, encompasses not only the protection of workers from material, but also protection of material from material. Instances of no protection over sharp protrusions, to improper storage and handling of hazardous materials in-plant involve both segments. For this reason, any investigation into materials handling must also involve safety.

5. Poor Material Control. This discrepancy trend manifests itself in several ways. An area of the manufacturing facility with excessive stock on hand or in storage at the workplace, is one indication that material control is not being properly maintained. Items frustrated in shipping or receiving for extended periods of time is another indicator. These conditions all lead to item and material backlog as well as excessive storage and warehousing costs.

As can be seen by examination of these five discrepancy trends, poor material handling can have quite an impact on a company's manufacturing effort. It can also be stated that the Quality Assurance and Safety functions along with Industrial Equipment and Contracts, play an important part in establishing an effective and efficient materials handling program. The level of success obtained from the execution of the material handling studies could not have been attained without the cooperation and insight of these elements.

SUMMARY

On a national basis, productivity improvement is needed to prevent inflation. Without improvements in productivity to counteract increases in wages, cost and prices, such increases lead to inflationary conditions, As William F. May, Chairman of American Can Co., stated, "Productivity gains remain this nation's best defense against inflation." [1]

AFCMD, in a constant effort to protect the taxpayer dollar has initiated many programs such as "Project Cost Initiatives" which increases the depth of contractor surveillance. One of these initiatives, Material Handling Productivity improvement, has a basis in industry and has caught the interest of the academic community. With the help of these two functions, AFCMD has mounted a campaign to not only increase the awareness of the contractor's material handling function, but also to apply productivity improvement principals for the benefit of both Department of Defense contractors and the tax paying public at large.

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AIR FORCE CONTRACT MANAGEMENT DIVISION

AD P002830

THE IMPACT OF FACTORY AUTOMATION AND ROBOTICS ON THE CONTRACTING AND ACQUISITION PROCESSES

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ABSTRACT

A report issued by the United States (U.S.) Comptroller General in 1976 noted that virtually every item produced by the U.S. industry is procured by the Federal Government. Products and services are procured by the Department of Defense (DoD) from over 25,000 industrial firms. The basic mechanism is through the contracting and acquisition processes. The key question raised by these circumstances is how will the increasing use of automation and robotics impact the contracting and acquisition processes in the 1980s and 1990s. A study was conducted to identify and classify the changes which will result from this trend to factory automation. The items considered include: reclassification and structure of contract costs; contracting and acquisition planning; contract types and their use; cost visibility; labor and other direct costs; cost and price analysis; cost control; bidding and solicitation procedures; and, clause structure and selection.

INTRODUCTION

Since its founding, the U.S. has been a strong industrial nation characterized by an extensive and growing industrial base. Through an extensive marketing and distribution system, this industrial base placed the U.S. in a position of world leadership. The U.S. enjoyed this leadership position until 1971, when, for the first time since 1888, the U.S. experienced a trade deficit. [1] Subsequent years have found this leadership increasingly challenged by other countries, notably Germany and Japan. A significant sector which has contributed to this U.S. industrial strength is the defense industrial base. Research has disclosed that the industrial base of defense has become economically inefficient and unresponsive to a potential, strategic emergency. [2] There are several pertinent factors contributing to this decline and need to be briefly reviewed.

A significant factor in this scenario is the decline in U.S. industrial productivity as compared with other nations. [3] Part of the decline in productivity has its genesis in the aging of the U.S. industrial capability. The reasons for this condition (such as inflation, high energy costs, lack of investment motivation, high interest rates, costly and restrictive government regulation and other factors) are beyond the scope of this paper; however, the need for plant modernization is not. Extensive research and development in the area of industrial processes and methods have been accomplished. A large amount of this effort has been undertaken by U.S. companies. These R&D assessments indicate a gap exists between the new technologies and their application to manufacturing and production operations by the U.S. defense industrial sector. For example, about 35,000 industrial robots are in use on a worldwide basis. Japan has about 30,000 in operation, as compared to the 2,000 in use in the U.S. [4] The term manufacturing technology has generally been used to describe the development of new production methods which tend to reduce the cost of defense and weapons systems. [5]

Thus, it is the defense industrial base which provides the context of this paper. The general conditions described earlier have impacted the defense acquisition and contracting processes. The results are evidenced by increasing weapon system costs, delayed deliveries and inadequate system performance. [6] The condition of the industrial base, the decline in competitive position, the decline in worker productivity, the increasing costs of weapon systems and other symptoms are variables which have been observed and noted by many DoD policy makers and other government leaders. An increased awareness of these problems have led to many initiatives, by both government and industry, to correct the deficiencies and, in time, to return the U.S. to its preeminent world leadership position. Most of these actions involve the increasing use and application of automation, computers and robots to the defense industrial base.

In recognition of this automation movement, the authors in 1982 asked the question, "How will these changes impact the acquisition and contracting processes which form the nexus between the U.S. defense community and industry?" This question forms the basis for the research study which was conducted to

provide a priori what the consequences of these changes will be, so that policy guidelines can be developed to bring these two processes into line with the environment which is likely to exist in the 1990s. In subsequent sections, a brief background of the automation area and the acquisition and contracting processes will be provided. Then the impact of the automation revolution will be assessed and the paper will close with significant conclusions as to the changes required to maintain the effectiveness of the interface between the defense industrial base and the DoD acquisition and contracting processes.

BACKGROUND

The defense industrial base and the DoD exist as components of an overall system whose purpose is to provide a strong viable defense for the U.S. It has been referred to as the military-industrial complex. The interactions between the two components reflect the characteristics of a system. [7] In this interaction, the health of one influences the other. Changes in one influence can affect the structure of the other. It is a system of actions and reactions, depending on the origin of the initial stimulus. This relationship is illustrated in Figure 1.

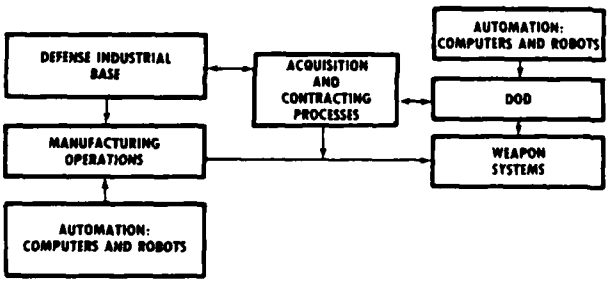

Figure 1. DoD and Defense Industry Interactive System

Thus, as computers and robots are increasingly applied in manufacturing operations, the resultant changes will spread throughout the system requiring changes in the structure of the acquisition and contracting processes.

The need for plant modernization has long been recognized by the U.S. Air Force, who, by virtue of the scope and quality of its manufacturing technology program, has become a leader in the application of computers and robotics to manufacturing operations. The origin of this Air Force program has been traced back to 1947, when numerical controlled machines began their entry into the manufacturing process. However, funding and DoD managerial emphasis for manufacturing technology have been sporadic. The awareness of the problems facing the U.S. as a world economic and military power has given the matter a higher priority in recent years, as evidenced by a concept paper developed by the Air Force Materials Laboratory at Wright-Patterson AFB, Ohio, which states:

> "By the mid-1970s a realization of the potential impact of automation and the use of the computer in achieving (or preventing) manufacturing productivity became evident. An initial study called AFCAM, attempted to develop a master program plan to determine the nature and magnitude of manufacturing technology involvement in the CAD/CAM area. Refinement of this plan became the basis, in 1976, for the evolution of the Air Force ICAM Program, which represents the Nation's only systematic attack on this problem of major national proportion." [8]

Thus, the objectives of the Integrated Computer Aided Manufacturing (ICAM) program are specifically oriented to the establishment of manufacturing technology which will: (a) reduce defense systems costs by developing and applying computer-aided manufacturing technology to the fabrication of defense material; (b) establish a model for the integrated application of computer technology to all phases of production/manufacturing; (c) improve the long-term competence, efficiency and responsiveness of American aerospace and related industries to defense needs; (d) provide a mechanism for Integrated Computer Aided Manufacturing technology transfer to-and-within American industry; and (e) validate and demonstrate the cost-saving benefits and flexibility of ICAM for representative elements of Air Force systems production. [9]

In 1982 a series of conferences, whose proceedings are entitled, Factory of the Future, were sponsored by The Technology Transfer Society and The American Society for Quality Control to assess the current state-of-the-art in terms of what technology exists in the areas of computer and robotic automation applicable to manufacturing and logistics operations. [10] In terms of computer and robotic technology, U.S. industry leads the world. However, in terms of current industrial applications, as compared to other countries (Germany and Japan), there is much that needs

to be accomplished. Basically, robotics are extensions of the computer and, as such, will continue to replace industrial workers on the plant floor. Currently, the use of robots can be summarized as follows:

> "...At the present time, it is clear that numerical controls and programmable robots are established with human workers only in a fairly small number of simple, repetitive jobs that can be done by a single arm with two fingers. Now that the capabilities of industrial robots are becoming better known, it is evident that the mainstream of manufacturing jobs is just beginning to become subject to programmable automation. What the commercial robot of 1980 still lacks (at least, in adequate degree) is a high-quality feedback-control system: an ability to sense its own position and motion in relation to the working environment and to utilize this information to modify its actions in real time - as humans do - so as to compensate for variations and irregularities in that environment..." [11]

However, research continues and there is no question that in the future computers and robots will operate factories and their support systems. [12]

These trends in automation of industrial processes, and eventually industrial plants, will impact and cause changes in the weapons acquisition and contracting processes. The weapons acquisition process is outlined in Figure 2. [13]

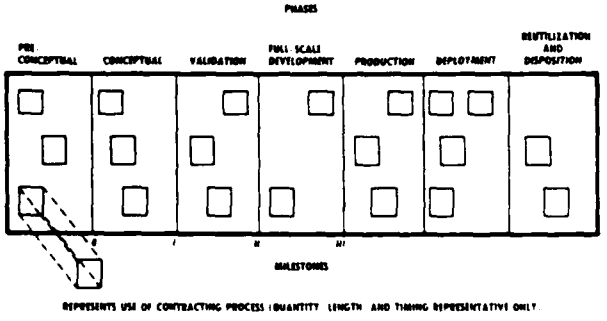

Figure 2. The Weapons Acquisition Process

The basic operation of the process is through program management concepts known to most readers and will not be reproduced here. The contracting process is illustrated in Figure 3. [14]

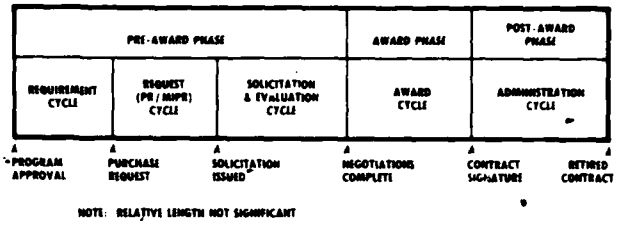

Figure 3. Contracting Process

Again space limitations preclude a discussion. Interested readers are referred to the Proceedings of the Ninth Annual DOD/FAI Acquisition Research Symposium for details. [15] As mentioned earlier a study was conducted to determine the impact of factory automation on these two processes. The results of this study will be considered next.

IMPACT OF AUTOMATION ON PROGRAM MANAGEMENT

Program management is ideally suited to deal with change. It places the responsibility for the development and production of a weapon system on a program manager and his team of selected individuals. As a variant of project management, it provides top DoD management personnel with visibility and accountability in terms of program success and failure as related to cost, schedule and performance goals. [16] The flexibility of the management concept permits adaptation to uncertainty and the complexity that permeates the weapon acquisition process. The changes which have been identified as the results of increasing computer and robotic automation include the following:

- Enhanced planning and control
- More effective organization and staffing decisions
- Improved communication, coordination, integration and direction
- Reduced overall system cost
- Improved system quality control
- Improved schedule implementation and control
- Easier identification of program team members
- Better delineation of team member assignments
- Improved program documentation
- Enhanced technical specifications
- Better reporting systems

- Improved identification of equipment needs
- Enhanced technical diffusion
- Simpler and more accurate inspection procedures
- Valid and more accurate spare parts identification
- Enhanced systems reliability and maintainability
- Improved test procedures
- Improved program budgets and reviews
- Better change administration and control
- Improved cost control
- Better visibility of indirect costs
- Enhanced production scheduling
- Improved materials, fabricated parts acquisition and routing with commensurate quality
- Reduced scrap and waste
- Better plant layout and production flows
- Reduced personnel costs with improved productivity
- Improved program evaluation
- Simplified configuration management
- Enhanced environmental assessments: political, legal, economic, social, technological and ecological
- More rapid reaction to threats and opportunities
- Enhanced tooling response
- Reduction in organizational conflict
- More efficient use of managerial time
- Overall improved integration of the manufacturing process
- Improved and shortened acquisition leadtimes
- Enhanced spare parts provisioning
- Better identification of inventory scheduling considerations
- Improved technology and management interaction [17]

These changes derive from the nature of the automated manufacturing operations as visualized by the ICAM Program. [18] A key consideration is that the production line will shift from processes which are currently labor intensive to those that are capital intensive. Labor as a factor will become more oriented to control, monitoring and maintaining the automated system. Obviously, the change to a fully automated factory will not occur overnight, but will be evolutionary in nature. The conversion to the automated manufacturing system will place a high level of emphasis on ROI decisions and the commensurate cost-of-capital issue. Benefit tracking systems of a quality structure will become an important consideration. The reduction in what are now termed direct costs will require significant changes in cost accounting systems with accompanying redefinition of costs, as more costs assume an indirect focus. Interestingly, this cost structure change as identified by the authors was independently surfaced by researchers at Price Waterhouse. [19] The more accurate collection and reporting of costs for specific manufacturing operations will permeate the entire DoD and defense industry interactive system. A reduction in cost uncertainty will result in more accurate cost estimates for planners to use in the early phases of the acquisition process. The slope of the uncertainty envelope as set forth by Drake will be decreased considerably. [20] Manufacturing dependence on computers and robots will provide better precision work and a concomitant increase in quality output. Fewer in-process inspection centers will be required. This factor, among others, will necessitate that program management personnel be assigned to programs on a long-term basis. Lengthened and stabilized tours will assist in alleviating the succession problem that often contributes to cost overruns, schedule slippages and poor system performance. Many of these changes will also impinge on the contracting process.

IMPACT OF AUTOMATION ON THE CONTRACTING PROCESS

As reflected in Figure 3, the contracting process provides the legal and economic interface between the DoD and defense industrial community. In Figure 2, the pervasive nature of the contracting process is demonstrated as related to the weapons acquisition process. Consequently, multiple changes may be expected which will affect the contracting process. If these changes are not anticipated and planned for, then conflict is inevitable. Admittedly, some conflict is healthy, however common sense dictates that it be managed and thereby minimized for the common good of involved parties. [21] The anticipated changes are enumerated below:

- More technically-oriented contracting managers
- Enhanced contract management
- Reduced contracting cost and leadtimes
- Simplified solicitation procedures
- Better input specifications to the contracting process
- Improved utilization of experienced and trained contracting personnel
- Improved contract and acquisition planning
- Enhanced contract clause selection
- Reduction in contract size and length
- Streamlined patent management

- Improved contract types
- Better cost visibility
- Cost accounting classifications tailored to functional operations
- Enhanced linkage between cost expenditures and program cost management reserves
- Accurate and useful work breakdown structures
- Better make or buy decisions
- Less premium labor costs
- Faster contract payments with enhanced contractor liquidity
- Enhanced negotiation process
- Price and cost analysis will be facilitated
- Improved utility of the life-cycle-cost concept
- Decreased need for indirect cost renegotiation
- Better use of competition and firm-fixed price contracts
- Better feedback on processing and fabricating operations - production surveillance
- Simplified contract support of R&D
- Viable technical and cost proposals
- Improved inventory control
- More useful warranty conditions

Customized and refined specifications as an input to the contracting process will assist contractors in responding to DoD solicitations. This condition follows from the use of functional cost accounting systems which will provide improved cost and program documentation. Changes in evaluation of contractor technical and cost proposals will be mandatory. In a study of the Best and Final Offer (BAFO) process, the majority of participating contractors voiced the sentiment that the process should either be modified or eliminated. [22] With clearly delineated specifications and better cost estimates, changes to the process will be required. [23] In like manner, many of the changes imposed by the automation revolution will dictate revisions in DoD policy and regulations. With increased investment in plant capacity and automated capital equipment, the policy of not allowing interest charges as contract costs will have to be reexamined and modified. The current policy is not realistic and past efforts to remedy the situation have been costly and ineffective. The use of computers within the DoD will facilitate the development and writing of contracts. This has been the case for several years with standard supply items which are amenable to procurement using the Customer Integrated Automated Procurement System (CIAPS). Currently, the Contracting Division, 2750th Air Base Wing, Wright-Patterson AFB, uses the computer to generate contracts for the procurement of more complex items, such as medical supplies, library resources and other more unique and heterogeneous items. [24] These computer applications are useful and will eventually lead to more widespread use, and ultimately to a totally integrated system. In the future, organizations in the system outlined in Figure 1 will be communicating through telecommunication systems. [25] Negotiations between parties geopraphically separated by many miles will be conducted electronically. Contracts will be automatically generated by the system. These documents will be simple, incorporating many clauses and provisions by reference. The products will be produced, inspected and accepted with payment being electronically transferred to the contractor's bank account, without "being touched" by human hands. Futuristic as it sounds, these changes are inevitable. The cost of industrial operations and government must be brought under control if the U.S is to survive in the emerging competitive and complex world community. In most cases, this is more rapid than most people are willing to accept.

CONCLUSION

The defense industrial base must be modernized to cope with the demands of an increasingly complex and uncertain environment characterized by high levels of international competition. This modernization will be effected through greater use of computers and robots in manufacturing and logistics operations. The trend in the factory of the future is toward total automation with workers being displaced and/or retrained. Future employment and retraining of these workers are social problems which must be coordinated at the national level. The changes in the defense industrial base will impact and lead to changes in the weapons acquisition and contracting processes. DoD policies and regulations will have to be revised and modified to meet the requirements of the future business environment. It is not a question of whether the DoD can afford to anticipate and plan for the nascent computer and robotic revolution and its impact on the weapons acquisition and contracting processes. The only question is how soon will the DoD, from a national perspective, accept this reality, and aggressively plan and implement on a coordinated basis to meet the challenges of these inevitable changes.

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A SURVEY OF CONTRACTOR PRODUCTIVITY MEASUREMENT PRACTICES

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ABSTRACT

This paper is extracted from an interim APRO report describing the results of a survey of contractor productivity measurement practices. Respondents ranking organizational performance evaluation factors listed productivity fifth in importance behind profitability, effectiveness, quality, and efficiency. Problems encountered in measuring productivity were usually due to the complexities of quantifying and relating various input and output factors involved. Although no evidence was found from the survey that an integrated total factor productivity measurement system has been implemented, production cost and productivity information is available and currently being tracked with varying success by defense contractors. The most popular indices used are value added/employee and a comparison of standard hours to actual hours.

INTRODUCTION

The cost of producing weapon systems with the current defense industrial base continues to escalate. In addition, the deteriorated condition of the base has prompted increased concern over its capability to respond to mobilization requirements. The recognition of these problems led to the initiation of a DOD Industrial Modernization Incentives Program (IMIP) which targets industry through incentives to substantially increase its capital investments with its own financing in modern technology, plant and equipment for defense work. A requisite for productivity rewards from these incentives is the ability to accurately measure and track a contractor's productivity gains.

The objective of the study from which this paper is generated is to develop and test measurement systems which are (1) designed to complement IMIP by providing a productivity measurement and tracking system and, (2) may provide a basis for contract incentives to motivate contractors to improve their productivity through methods changes, management improvements and other means in addition to capital investment.

All military services are participating in this DOD study. Defense contractors are also involved in system development through a survey of contractor productivity measurement practices. The general study approach is to conduct a literature search and thorough investigation of productivity measurement theory. The theory investigation is then complemented with a survey of contractor productivity measurement practices. From an analysis of the literature and survey responses, productivity measurement methodologies will be synthesized. The proposed methodologies will be tested, and if warranted, an implementation guide supporting the IMIP will be prepared.

To be useful to the IMIP, a measurement methodology must not only be based on sound theory but also be implementable. Since defense contractors have always been measuring their productivity, directly or indirectly, they are an important source of information for this study. Their experiences are useful in understanding both what is currently being practiced and what has been tried with little success. A written survey was used to contact a large sample of defense contractors. The survey not only helped identify current practices but also allowed defense contractors an opportunity to participate in an effort that could eventually affect them. This was considered important to a successful implementation of any proposed methodologies. The National Security Industrial Association (NSIA) was solicited and agreed to participate in a survey of some of its member companies.

SURVEY DESCRIPTION

The primary purpose of the survey was to obtain information about productivity measurement methodologies currently employed by defense contractors. It also opened doors for follow-up discussions by asking for points-of-contact for such. The survey was not intended to provide an elaborate description or classification of current practices.

The survey was sent to 92 different contractor locations. Figure 1 lists the 21 responses to the survey. Follow-up discussions were then held with 14 of those that responded. The number responding was less than desired but adequate to gain an understanding of current practices. The relatively low response rate can be attributed to a general reluctance to participate in any survey and, perhaps, inattention to productivity measurement concepts per se in the defense community prior to the IMIP. Even for those contractors responding, pro-

1. Remington Arms - Bridgeport, CT
2. AVCO - Bridgeport, CT
3. Sperry - Waterbury, CT
4. United Technologies - Hartford, CT
5. EG&G Sealog - Warwick, RI
6. Hazeltine - Greenlawn, NY
7. Westinghouse - Columbia, MD
8. Western Electric - Burlington, NC
9. Martin Orlando - Orlando, FL
10. Sparton Corp - Deleon Springs, FL
11. Harris Corp. - Melbourne, FL
12. Northrop Corp. - Los Angeles, CA
13. Rockwell Int'l - Canoga Park, CA
14. McDonald-Douglas - Huntington Beach, CA
15. Ford Aerospace - Newport Beach, CA
16. Ball Aerospace - Boulder, CO
17. Ingalls Shipbuilding - Pascagola, MS
18. Magnavox - Ft. Wayne, IN
19. Goodyear Aerospace - Akron, OH
20. Honeywell - Edina, MN
21. Anonymous

FIGURE 1. CONTRACTORS RESPONDING TO SURVEY

ductivity factors were ranked low (usually fifth) relative to other measures of organizational performance asked for in the survey (see figure 2).

SURVEY RESPONSES

There were four major sections in the survey: (1) general information, (2) performance evaluation, (3) productivity measurement, and (4) general comments.

General Information. All commodity markets were represented by the responding contractors with electronics and communications equipment being the dominant market. The contractors involvement as prime, subcontractor or both was roughly balanced among those three choices. The dollar value of their defense contracts during their latest accounting year ranged from $.6M to $4.3B and averaged roughly $500.M. The contractors worked predominantly for the Navy, but all services were represented by the respondents.

Performance Evaluation. Question B.1 (shown below) of the survey asked contractors to rank their measures of organizational performance.

"B.1. Which of the following factors do you use to measure organizational performance within your company? (Indicate order of relative importance to your company, e.g., 1, 2, 3...)

____ (a) Effectiveness (i.e., accomplishing the right goals or objectives considering timeliness, quantity, and quality)

____ (b) Efficiency (i.e., ratio of resources expected to be consumed on goal achievement to resources actually consumed)

____ (c) Quality (i.e., conformance to specifications)

____ (d) Profitability (i.e., comparison of revenues to costs)

____ (e) Productivity (i.e., ratio of output to input)

____ (f) Quality of Working Life (i.e., personnel response to living and working in organization)

____ (g) Innovation (i.e., introducing new ideas, processes, or products)

____ (h) Other - (Please specify)"

Figure 2 shows the contractor rankings of these performance evaluation factors. Profitability was consistently ranked most important by the respondents. Effectiveness and quality were ranked second and third in importance. Productivity, when used, was usually ranked fifth after efficiency which was fourth.

The only problems identified by the respondents using the above performance factors were:

a. performance measures did not connect with productivity
b. short term was wrong emphasis
c. comparisons between two time periods can be influenced by extraneous factors foreign to what is being measured.

Productivity Measurement. The productivity measures used by defense contractors varied according to the organizational level being measured. For example, a value added type of index such as value added/employee was frequently used at the firm level. Efficiency measures such as the ratio of standard time/actual time were also used by some to judge productivity at the firm level. Other firm level indicators used included value added/capital, sales/assets, profit/employees, and direct employees/indirect employees.

PERFORMANCE FACTOR	CONTRACTOR																	
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
a. Effectiveness	2	3	1	1	3	3	4	1	2	7	1	3	2	4	2	2	1		2
b. Efficiency			3	2		2	5		3	4	4	5	5	5	7	3	3	2	1
c. Quality	4	2	2	2	2		3	3	4	2	3	6	4	2	4	4	2	3	3
d. Profitability	1	1	4	2	1	1	1	2	1	1	2	1	1	1	1	1	5	1	4
e. Productivity	5		5	2		5	6	4	5	3	5	7	3	3	3	5	6		
f. QOWL	6		6	2		6		5		6		4	6	7	5	7	7		6
g. Innovation	3	5	7	2		4	2			5		2	7	6	6	6	4		5
h. Other		4		1	4										8				

FIGURE 2. CONTRACTOR RANKINGS OF PERFORMANCE EVALUATION FACTORS

(Note: The contractor order has no relationship to the Figure 1 list)

Although the efficiency ratio of standard time/actual time was used on occasion to judge firm or factor productivity, it was more frequently used at the department or shop level. Generally at this level performance ratios such as inspectors/production workers or units scheduled/units produced were used to measure productivity. Physical units of production were also compared to various labor and capital inputs at this level for true productivity measurement. These include, for example, purchase orders/buyer and engineering change orders/engineer.

Subordinate activities or work centers frequently compared some specific output to labor input. Examples at this level include cables/labor hour or printed circuit boards produced/labor hour. Comparison of standard hours to actual hours for work performed was also popular at the work center level.

Data sources for productivity measures also varied widely depending on the specific indices used. Accounting, personnel, production and labor hour data were used as appropriate. Adjustments for inflation and learning curve effects were often made to productivity information, but discounting and quality changes were usually not incorporated.

Validation efforts ranged from virtually no effort to implementing changes in production standards. Usually validation was minimal since internal review mechanisms were not as rigid or strict as would be required for an external audit.

Those with productivity measurement experience encountered problems of varying degrees in attempting this measurement. Some of the problems reported include:

a. difficulty in isolating cause of improvement above plant level because of many variables

b. qualitative factors influencing productivity difficult to measure

c. difficulty in aggregating data for government accounting on a job-by-job basis while productivity measures require an overall accounting

d. difficulty in quantifying output because of large number and complexity of projects

e. present methods not applicable to white collar area which is 75% of work force

f. difficulty in measuring productivity impacts in other organizational areas

g. timeliness, accuracy, insufficient detail and difficulty in analyzing the data

h. costly to apply, requires computer support, has limited coverage (production operations only)

i. many measurements deal with symptoms, not causes

General Comments. Question D.1 of the survey asked:

"D.1. If the Government were to offer your company a productivity incentive in a new contract, how would you prefer to have your productivity improvements measured?"

Responses included the following:

a. value added/employee

b. cost savings

c. no change in present method being used by company

d. cost reduction relative to a baseline, adjusted for inflation

e. track measurable changes in safety, quality and productivity output in finished good per man-hour of input

f. simple comparison of target cost to actual cost

g. unit production labor hours

h. simple profit rate increases

i. compare new systems to existing systems

j. estimate savings prior to change then increase profit accordingly

k. traditional measures of cost, schedule and performance

l. quality measurement should be used

m. in terms of total factory cost by product.

In summary, the responses indicated a desire to keep the productivity measurement system simple and to base the award on the cost difference between a baseline and achieved cost, adjusted for inflation.

DISCUSSION FINDINGS

Production Cost Visibility.

Production cost visibility and related productivity measurement varied widely among those contractors visited. Some contractors relied primarily upon standard cost accounting systems to yield general profitability information only. Others had sophisticated management information systems (MIS) to capture costs and productivity information in detail at work centers throughout their plants. This allowed tracking a large number and variety of productivity related indices in functional areas in addition to production such as engineering, procurement, and accounting.

Direct Costs.

All contractors visited could provide direct labor and material costs through work center tracking. Indirect costs were also available, and overhead rates were usually applied to get their total cost figures. Unfortunately, direct costs constitute a small and decreasing percentage of total cost, and therefore are becoming less useful as a productivity measurement base. For example, direct labor typically amounted to less than 10% of the total and is decreasing regularly with the advent of automation and robotics.

Productivity and Other Indices.

Productivity information is readily available to all contractors, but some are just beginning to track specific productivity indices. Value added per employee was frequently used as an overall indicator of plant or company productivity, however no single index is adequate for all contractor purposes. The value added per employee index is useful for contractor purposes in comparisons among plants or companies within an industry.

There was no evidence of a total factor productivity measurement system implemented by the survey respondents, although some attempts were being made to development such. Multiple indices were often used; however they were not integrated as required in a total factor approach. Frequently, other productivity related indices were used for particular purposes in different departments such as rework hours/direct labor hours, cost of quality/cost of sales, and indirect employees/direct employees. These ratios are not productivity indices per se (using the standard output/input definition) but were useful in measuring and analyzing performance.

Tracking Impacts.

Defense contractors know the costs of operating current capital equipment, and they can give a reasonable cost estimate for an investment in new capital equipment. The impact of this new equipment on direct labor and materials is also usually apparent. However tracking the impact of an investment for productivity improvement in the indirect and overhead areas gets obscured, and these costs usually increase with a decrease in direct costs. For example, programming support costs for a new NC milling machine may get buried in the ADP department, or maintenance increases for new robots may get lost since its impact appears negligible. Also, a new automated MIS provides a degree of cost control not previously possible, but it is also used for inventory control, financial accounting, and personnel management. Proper proportioning among functions is difficult but may be necessary for DOD productivity measurement purposes.

The multiple product, plant and customer environment found at most contractors visited further inhibits accurate cost tracking for productivity measurement. A single plant, single product environment provided relatively easy assessment of productivity improvements for DOD purposes.

Follow-up Verifications.

Partly because of the difficulty in tracking the impact of investments in productivity enhancing equipment, the follow-up verification of productivity gains savings appeared somewhat lax. Although some companies did review an investment at a later date (e.g., one year), the evidence of savings was frequently soft and judgmental. Improvements were accepted intuitively because it was obvious that more goods were produced faster and cheaper at the work center level. The impact on other areas within the company was not readily identifiable.

Investment Purposes.

It appeared that investments were mostly for competitive and technological reasons rather than simply for cost reduction. Contractors tended to plan ahead to other contracts and products and make investments accordingly to improve their long term situation. Contractors also replaced older equipment that could not keep tolerances or required quality levels. Immediate cost improvement was secondary. Sometimes both immediate and long term benefits were realized in an investment, but the long term payoff was primary.

SUMMARY

Contractors responding to a survey of productivity measurement practices ranked profitability most important in a list of performance evaluation factors. If used at all, productivity was usually ranked fifth, after effectiveness, quality, and efficiency. Problems encountered in measuring productivity were usually due to the complexities of quantifying and relating various input and output factors involved. The respondents indicated a desire to keep any productivity measurement system simple and to base the award on the cost difference between a baseline and achieved cost, adjusted for inflation.

There was no evidence of a total factor productivity measurement system implemented by the survey respondents; although some attempts were being made to develop such. Production cost visibility varied widely among the contractors visited, but all could provide direct labor and material costs through work center tracking. Unfortunately, direct costs constitute a small and decreasing percentage of total cost, and therefore are becoming less useful as a total productivity measurement base. Many productivity related indices were being tracked by most contractors, the most popular indices being value added/employee and a comparison of standard hours to actual hours. It appeared that investments were mostly for competitive and technological reasons rather than simply for cost reduction on a current contract.

NOTE: This paper is an extract from an Army Procurement Research Office (APRO) Report 83-01 (Interim), by M.G. Norton and W.V. Zabel, titled "Contractor Productivity Measurement Practices" and dated Oct 1983.

The information in this paper is the result the authors' research at APRO and should not be considered a statement of Army policy.

SOCIO-ECONOMIC CONSIDERATIONS

Panel Moderator: Ms. Margaret A. Olsen
Assistant General Counsel (Acquisition)
Department of the Navy

Papers:

Strengthening Small Business Participation in Department of Defense Extramural Research and Development
by Bernard K. Dennis

Contractor Fraud: Government Response
by James O. Mahoy

Employment Changes Resulting from the Award of Contracts in Labor Surplus Areas
by Dennis Robinson and Daniel Gill

ADP002832

STRENGTHENING SMALL BUSINESS PARTICIPATION IN DEPARTMENT OF DEFENSE EXTRAMURAL RESEARCH AND DEVELOPMENT

Bernard K. Dennis, Defense Technical Information Center

ABSTRACT

This paper discusses steps taken by the Defense Technical Information Center (DTIC) to strengthen small business participation in DoD extramural R&D, indicates a need for explicit attention to information transfer requirements by R&D contract administrators and concludes with a suggestion to the DoD contract administration community. Many factors impede small business efforts to do R&D business with the federal government. These run the gamut from federal procurement policies, regulations, and procedures; beliefs, biases, and practices of federal R&D people and their management systems; and the formidable advantages of bigness in the federal marketplace. Information transfer issues exacerbate the impacts of all the above and further reduce small business capabilities to compete for and to perform federal agency--particularly DoD--R&D projects. The studies and testimony leading to the Small Business Innovation Development Act of 1982 indicated a need for change in federal agency approaches to R&D contracting. DTIC's approach has been to mitigate the impacts of information transfer barriers on small R&D firm efforts to do business with DoD.

INTRODUCTION

The concept of helping small and disadvantaged firms obtain a fair share of federal government business has been around for about a half century and institutionalized through various legislative, regulatory, procedural, and organizational infrastructures in federal agencies. Only within the past few years has particular attention to the capabilities of small research and development (R&D) business begun to emerge. The most recent and widely publicized attempt to strengthen small business participation in the federal contract R&D arena is the Small Business Development Act of 1982 (1) and the resulting Small Business Innovation Research (SBIR) programs now in progress in 11 federal agencies.

Much has been written about the declining rate of productivity increase in the United States over the past decade. Our rate has been well below that of all leading industrial nations, particularly Germany and Japan. Although this relative decline in our productivity is attributed to many factors, a major one certainly is the slowdown experienced in technological innovation. Recognizing that small R&D firms historically have excelled at technological innovation, Congress perceived that R&D work should be encouraged within the small business community and passed the Small Business Innovation Development Act of 1982 by overwhelming majorities. In April 1981, Senators Rudman and Weicker introduced S.881, which later passed the Senate by a vote of 90 to 0. The House's companion bill passed by a vote of 353 to 57. President Reagan signed the Act as Public Law 97-219 on July 22, 1982, and it became effective on the first of the following October.

It is well known that technological innovation creates new jobs, increases productivity, enhances the competitiveness of products in foreign markets and stimulates economic growth. Studies identified in the legislative history of the 1982 Act (2) indicate that small R&D firms produce 24 times as many innovations per R&D dollar as large firms and four times as many as medium-sized companies. Further, small firms accounted for 87 percent of new jobs in the U.S. between 1969 and 1976. Also, the cost of an R&D scientist or engineer in small businesses is one-half that in large companies. Yet, as pointed out in the Act's history, small firms get four percent of the federal R&D dollars while large companies receive the lion's share. Of $15 billion in contract research, 70 large firms got 80 percent, 20 percent of which went to only four large companies. These figures helped Congress and the President see the need for change. Since the federal government funds about half of the nation's R&D, it can have a significant impact on the efficiency and effectiveness of the country's R&D output and hence its technological innovation. The Defense Department accounts for over half of the federal government's R&D. It is essential that its R&D dollars be used optimally.

Although numerous studies have shown small businesses to be the country's most efficient and productive source of innovations, of the $12.96 billion in DoD R&D contract awards to U.S. businesses in FY 1982, only $733 million, or 5.7 percent, went to small R&D firms. In overall DoD awards of $102.5 billion to U.S. business firms that year, however, $20.1 billion was awarded in prime contracts to small firms and another $13.4 billion in subcontracts. In other words, one of every three dollars in total awards went to small businesses, but in R&D contracts only one dollar out of 20 went to small R&D firms. (3)

The purposes of the 1982 Act are to: (1) stimulate technological innovation; (2) use small business to meet federal R&D needs; (3) increase private sector commercialization of innovations derived from federal R&D; and (4) foster and encourage minority and disadvantaged participation in technological innovation.

The Act requires all federal agencies to establish Small Business Innovation Research (SBIR) programs (as they are commonly called) if their FY 1982 extramural R&D budgets exceeded $100 million. There are 11 agencies meeting this requirement. The law specifies a percentage of the budget that must be allocated to the SBIR program in each agency beginning with 0.1 percent for FY 1983 and growing to 1.25 percent in FY 1987. Based on budget projections, which may change in accordance with actual appropriations each year, DoD's SBIR program projections start at around $16.7 million in FY 1983 and grow to about $204 million in FY 1987. (3)

As required by the 1982 Act, the DoD SBIR program provides for three phases of R&D work. Phase I contracts typically require 6 months and from one-half to one manyear of effort. Their purpose is to contribute to proving the feasibility of innovative approaches or concepts. Phase II contracts will provide for from one to two years of R&D to develop the approach or concept fully. Phase III development or production is intended to proceed on private funding in the commercial sector. At that point, DoD may become a customer.

Clearly, there is a strong potential for significant sociopolitical and economic as well as defense benefits to the nation from strengthening small business contributions to DoD's technological base. All feasible steps toward that end should be taken. In the course of their efforts in this area, DoD SBIR program management in the Office of the Under Secretary of Defense for Research and Engineering and the Office of Small and Disadvantaged Business Utilization (SADBU) in the Office of the Secretary of Defense recognized that small R&D firms unaccustomed to doing business with DoD would probably be hindered by knowing little about R&D already done or in progress by DoD laboratories, research centers, and contractors. Also, small business people would not likely know where to turn for such information. Yet, these people would need to know about and have access to such available information if they were to respond successfully to DoD SBIR solicitations and perform the awarded work. The Defense Technical Information Center (DTIC) was asked to do something about it.

DTIC'S INFORMATION TRANSFER SUPPORT PROGRAM FOR SMALL R&D BUSINESS

As the central repository of technical reports that result from DoD-funded R&D, DTIC maintains some 1.5 million such documents in its files. Also, DTIC handles summaries of DoD R&D projects recently completed or still in progress. There are about 162,000 of these on hand. Several services inform the defense R&D community that this information is available and provide access to it. An on-line retrieval system with over 600 terminals at sites throughout the country provides access for thousands of DTIC users. In addition, DTIC has a number of information transfer and computer system specialists doing R&D in applied information science and technology to develop a fuller understanding of the DoD information transfer process. They identify needs and develop advances in the state-of-the-art to facilitate more efficient and effective information transfer in DoD and its defense community.

Prior to its involvement with the DoD SBIR program, DTIC had initiated technical information transfer support to the DoD SADBU program and had been studying small R&D firm information transfer issues. A key problem area confronting small businesses attempting to compete for federal R&D business involves identifying R&D needs of federal programs and determining if, how, by whom, and when contractual assistance will be sought to address which needs. An integral part of this information transfer problem is knowing about, locating, and getting access to available scientific and technical information and contacts required to develop the understanding, concepts, and approaches needed to prepare and market proposals to address identified needs. The requirement for information transfer assistance continues throughout the performance of R&D contracts.

Through their large technical staffs and internal technical information services, larger companies have a tremendous scientific and technical information acquisition advantage. Size also provides significant advantages in making and cultivating contacts essential to a firm's efforts to market its capabilities in the federal marketplace.

DTIC's fundamental mission is to advocate and facilitate better informed decisions throughout the total process of planning, developing, disseminating, using, and evaluating the use of technical information to address DoD programmatic objectives. Contract R&D is a primary part of this process. Considering the potential sociopolitical and economic benefits

to the nation, as well as needed innovative contributions to our defense capabilities, and recognizing the special needs of small R&D firms for information transfer support, DTIC is giving particular attention to the needs and priorities of DoD's SADBU and SBIR programs and their small business constituents.

INFORMATION TRANSFER SUPPORT TO DoD SADBU PROGRAM

A DTIC survey of SADBU specialists located in Defense Logistics Agency (DLA) Defense Contract Administration Service Regions (DCASRs) around the country indicated that these people have need for information transfer support in their R&D-related outreach, referral, and procurement functions. They also need a system to facilitate rapid communication among themselves as specific issues arise. They can then benefit from each other's knowledge, experience, and contacts. In addition, they need training in the information transfer process and related techniques. Although not generally understood, the basic role of SADBU specialists is to function as information transfer agents. Their job is to advocate small business interests in the DoD acquisition process. They are supposed to help link small firms to specific DoD contract opportunities. The SADBU program has turned in a credible performance regarding the share of DoD overall contracting going to small business. However, there seems to be considerable opportunity for improvement regarding DoD R&D contracting done with small firms.

In working with the SADBU people, it became clear that their primary emphasis has been on the legal, regulatory, and procedural issues connected with the acquisition of physical commodities and services with considerably less attention paid to the structure and needs of DoD's R&D programs and the small R&D business sector. For example, procurement conferences generally seem to be less useful to small R&D firms than to others. Identifying small R&D businesses for mailings presents a problem. Referring representatives from small R&D companies to appropriate DoD R&D people to discuss technical concepts, needs, and issues poses yet another information transfer problem.

To help resolve such information transfer problems, DTIC has worked with the DLA Headquarters SADBU Office to set up a two-way communication linkage between the SADBU program and the Federal Laboratory Consortium for Technology Transfer (FLC). FLC has representatives concerned with identifying technologies available or under development in 300 federal laboratories, 60 of which are in DoD. FLC's objective is to transfer technology developed with federal funds to state and local governments and to the private sector for use in meeting other societal needs. FLC representatives know what is going on in the laboratories they represent; they also conduct outreach efforts to identify targets for available technology. Therefore, they are excellent sources for SADBU specialists to contact in their outreach and referral functions related to the interests of small R&D firms. On the other hand, FLC sees their SADBU connection as a means for focusing their efforts on small business needs for technology.

Other steps to strengthen DoD SADBU support to small R&D firms through increased attention to information transfer issues are in progress or planned. For example, a DoD Washington, DC, area small R&D business technical assistance center is currently being considered. This center would provide [illegible]ng and guidance related to marketing and other business activities as well as technical information transfer assistance.

INFORMATION TRANSFER SUPPORT TO DoD SBIR PROGRAM

By the time this paper is presented, the second DoD SBIR program Phase I solicitation will be in progress. Distribution of the solicitation brochure is planned for 14 Oct 83. The solicitation is scheduled to close 12 Jan 84. It is expected that small business interest in the forthcoming solicitation will exceed that experienced during the first which was held from 15 Mar to 31 May 83.

The first DoD SBIR program solicitation, number 83.1, was sent to 14,000 firms who had registered with the Small Business Administration (SBA) to receive SBIR solicitations from participating federal agencies. In addition, and resulting from announcements in the Commerce Business Daily and an SBA pre-solicitation brochure, DTIC provided another 7,000 copies to small business requesters. The SBA mailing list now includes over 30,000 firms and continues to grow. Further, the DoD SBIR set-aside of 0.1 percent of the extramural R&D budget in FY 1983 becomes 0.3 percent in FY 1984. SBIR funds grow from approximately $1b million to over $40 million.

To provide assistance to small R&D firms preparing proposals in response to the DoD SBIR program solicitation, DTIC obtained appropriate clearance to provide unclassified and unlimited distribution information on the

solicitation research topics. An offer to provide technical information assistance to SBIR proposers was presented in the DoD solicitation. To focus attention on the offer, a reminder note was attached to each of the 7,000 copies of the solicitation brochure requested from DTIC. As a result of these outreach steps, 910 small businesses contacted DTIC for assistance. A technical information proposal package containing a technical report bibliography, summaries of DoD-funded research projects in progress, and other relevant information sources (including DoD Information Analysis Centers) was prepared for each of the 400 DoD solicitation research topics. Nearly 3,800 of these packages were provided in response to requests from the SBIR proposers during the solicitation period. In addition, nearly 3,000 technical reports identified by the bibliographies were provided.

Beyond technical information assistance to support SBIR proposal preparation, DTIC also referred numerous small business requesters to SADBU specialists in DLA DCASRs around the country on various proposal preparation issues. As a further step, DTIC provided DoD Potential Contractor Program (PCP) information and contacts to all requesters. PCPs, which have been set up in the Army, Navy, Air Force and the Defense Advanced Research Projects Agency (DARPA), provide a means for qualified firms currently without DoD contracts to obtain access to planning and technical information on the sponsoring service or agency R&D requirements and to DTIC services. This type of information is key to a firm's efforts to market its R&D capabilities to DoD.

Over 2,900 proposals were received by the Army, Navy, Air Force, DARPA, and the Defense Nuclear Agency in response to DoD's first SBIR program Phase I solicitation. Although the number of resulting awards is not yet known, DTIC is already identifying how best to provide long-range SBIR program support.

CONTINUING DTIC SUPPORT TO DoD'S SBIR PROGRAM

DTIC is now studying its first SBIR Phase I solicitation support experience and preparing for the next. Concurrently, planning is in progress to identify the firms that receive contracts and ensure that they are promptly registered as DTIC full-service users. This will require the cooperation of appropriate contract administration officials, SBIR program management, and principal investigators of the SBIR contractors. Phase I contracts typically require only 6 months to complete; therefore, registration procedures and coordination must be implemented as quickly as feasible.

DTIC is also having the FY 83 solicitation topic authors identify technical information sources which would be particularly useful to new SBIR contractors in getting off to sound starts on their Phase I projects. Such sources may include technical reports, journal articles, names of experts, centers of expertise, etc. DTIC will organize this material and provide it to appropriate SBIR contractors immediately following awards.

DTIC services to SBIR contractors will continue through Phase I and Phase II R&D work and, in some cases, may be needed to support Phase III efforts. Concurrently, new Phase I solicitations and projects will be supported each year throughout the life of the Act.

INFORMATION TRANSFER RESPONSIBILITIES OF CONTRACT ADMINISTRATORS

Historically, contract administration people have given little explicit and consistent attention to information transfer issues inherent in the R&D work called for by the contracts they administer. Yet these issues impact significantly on the cost-effectiveness of the contract information deliverables. One such issue area involves contractor access to and use of R&D results already paid for by DoD and available from DTIC. DoD R&D contracts should require the contractors to register with DTIC and use its services. Further, contract administrators can take steps to ensure that a work unit summary (DD 1498) is prepared promptly for each R&D contract and input to the DTIC Work Unit Information System. R&D contract administrators also can ensure that technical reports and other technical information deliverables are specified appropriately and consistently in the contracts they administer and can facilitate systematic input of such R&D outputs into DTIC collections for wide dissemination and use.

History also shows that R&D people address their information transfer responsibilities inconsistently and with varying degrees of effectiveness. Appropriate provisions regarding information transfer requirements in the contract administration phase of R&D can add a degree of consistency needed to increase the availability and use of R&D results and thus their cost-effectiveness.

There are additional ways in which contract administration people can impact beneficially on the planning, development, dissemination, and use of technical information needed to support better informed DoD technical decisions. Perhaps a DoD-wide program is needed to support R&D contract administration people in meeting their information transfer-related responsibilities. DTIC would welcome the opportunity to advise and otherwise assist such an effort.

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ADP002833

CONTRACTOR FRAUD: GOVERNMENT RESPONSE

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ABSTRACT

Air Force Logistics support is adversely affected by the presence of fraud in Government contracts. Fraud occurs in the award of contracts, in the technical aspect of performance, and in the submission of false claims. Dishonest contractors, a small minority, must be found out and brought to justice. The response of the Government is channeled along several lines. Fraud is both a civil and a criminal matter. The Government may sue for financial recompense and may also invoke criminal penalties, and may debar bidders. The Contracting Officer and eventually the whole contracting team may be needed to detect fraud. The using activity, the Office of Special Investigation, the FBI and ultimately the Justice Department attorney and Federal Court are involved.

INTRODUCTION

If the Air Force is to support its forces in the field, it must contend with those procurement problems which would delay or diminish logistics support. One such procurement problem now emerging is that of fraud on the Government practiced by contractors at the inception or in performance of defense contracts. Fraud leeches away the moneys appropriated by Congress for defense work and may even cause defective work to enter the logistics pipeline and pose a direct threat to military success. Though not all fraud on the Government comes from outside the Government, this paper will discuss fraud by bidders and contractors.

YEARS OF CHANGE

The willingness of people to try to defraud the Government is, I believe, traceable to slow but profound changes in our perceptions of the role of Government with the people. Turn back to World War II. Millions of men were put under arms. Millions of women entered the work force for the first time. Most Americans entered into a personal relationship with their Government for the first time. After the war (and the G. I. Bill) peoples' expectations of direct Government benefit in their lives increased. By 1960, President-elect Kennedy was saying: "Ask not what your country can do for you....". Still higher taxes followed bigger programs until, under the grants programs, redistribution of wealth was a fact. It became routine for citizens to expect the Federal Government to solve their problems and meet their needs. Unrealistic expectations brought disappointment-and to some, disillusionment. Higher taxes spawned a disturbing phenomenon called the "underground" economy where no records were kept and no income reported to the Government--a wide-spread and calculated conspiracy to defraud the Government of tax moneys. Thus it was, in my opinion, that the stage was set for contract fraud to emerge as a procurement problem.

FRAUD IDENTIFIED

Government contract fraud must be identified to be addressed, and to be identified it must be defined. Turning to the dictionary[1] we find fraud defined as: "deceit, trickery, or breach of confidence, used to gain some unfair or dishonest advantage". Accurate, perhaps, but unsatisfying. We need a definition that will respond to the world of work--one tried in the marketplace, so to speak. In the law dictionary[2] we find:

> FRAUD. An intentional perversion of truth for the purpose of inducing another in reliance upon it to part with some valuable thing belonging to him or to surrender a legal right; a false representation of a matter of fact, whether by words or by conduct, by false or misleading allegations, or by concealment of that which should have been disclosed, which deceives or is intended to deceive another so that he shall act upon it to his legal injury.
> ....Any kind of artifice employed by one person to deceive another....A generic term, embracing all multifarious means which human ingenuity can devise, and which are resorted to by one individual to get advantage over another by false suggestions or by suppression of truth, and includes all surprise, trick, cunning, disembling, and any unfair way by which another is cheated....Bad faith and fraud are synonymous, and also synonyms of dishonesty, infidelity, faithlessness, perfidy, unfairness, etc.
>
> This recital does not exhaust our source, but should provide a legal framework within which to discuss our subject.

FRAUD INDICATORS

Experienced contracting personnel and investigators eventually construct a list of fraud indicators--i.e., work situations and experiences where fraud is apt to be perpetrated. Experience, it seems, is the best teacher. Since fraud is by its nature secretive, a careful attention to detail and a willingness to report fraud are necessary prerequisites for success in fraud prosecution. Justice Department sources[3] list several indications of contractor fraud:

- Alteration of records to get a contract.

-Use of a "holding account" to enable the contractor to perform an "after the fact" reconstruction of costs.

-Failure to disclose material facts before bidding.

-Failure to disclose all material facts to outside auditors.

-A deliberate attempt to remain ignorant about the facts surrounding a contract or claim.

-Deceptive or unresponsive answers to questions posed by outside auditors.

-Substitution of used for new products.

-Bribing Government personnel.

The Air Force Office of Special Investigation (AFOSI) is the investigative arm of the Air Force when fraud is suspected. Turning to its listing of contract fraud indicators[4], I note but a few of the more obvious:

-Substitution of materials, components or items controlled by specification.

-Defective pricing data.

-Frequent user complaints concerning supplies or services.

-Abuse of Government furnished property.

-Falsified records (contractor or Government).

Of the twenty-six contract fraud indicators listed, most require the cooperation of, or mis-management by Government personnel for the fraud to succeed! Clearly, the Air Force must clean its own house as well as pursue contractor fraud. Since most procurements take place at base level, most fraud opportunities occur there. The OSI is not unaware of this!

CIRCLING THE WAGONS

The escalating pressure to attack fraud and other white collar crime has led all three branches of Government into this endeavor: The list of agencies is formidable: The Office of Management and Budget (OMB), the General Accounting Office (GAO), some sixteen civilian agencies and DOD through their In - spectors General (IG), the Air Force Office of Special Investigation (OSI), the Army Criminal Investigation Command (CID), the Naval Investigative Service (NIS) the Defense Criminal Investigation Service (DIS), the Defense Contract Audit Agency (DCAA), the Federal Bureau of Investigation (FBI), the Justice Department Task Forces of auditors, investigators and U.S. Attorneys, and lastly, the federal court judges. This list is not exhaustive by any means. Clearly, a circling of the wagons is taking place.

APPLYING THE REMEDIES

Although fraud has been recognized in the common law, the Government has relied on statutes, both civil and criminal, in pursuing contractor fraud. In addition, administrative remedies can be applied to redress fraudulent conduct. Though the Contracting Officer is the initial victim of contractor fraud, he makes no formal determination of such, but refers it to OSI, who on investigation may refer the case to the Justice Department, if warranted. Let us look at the remedies available.

CRIMINAL REMEDIES

There are many Federal statutory crimes. A few statutes stand out as tools to punish the guilty in contractor fraud:

False, Fictitious, or Fraudulent Claims.

This so-called criminal False Claims Act says:

> Whoever makes or presents....any claim... knowing such claim to be false, fictitious or fraudulent, shall be fined not more than $10,000 or imprisoned not more than five years or both.

This Act directly punishes the false claim and acts as a deterrent to blatant cheating. It has been used where claim was made for a higher grade of meat than was actually delivered to the Government[6], and where fast-pay procedures were deliberately misused[7], and where a contractor fraudulently altered computer job cards to transfer costs from his fixed-price contract to a cost-type contract[8], and where a contractor repeatedly and deliberately included rejects for shipment to the Government[9]. Conviction may be had on circumstantial evidence, as it is rarely possible to uncover positive evidence of fraud[10]. Also, a corporate contractor may be liable for its employees' actions defrauding the Government when they are acting within the scope of their employment[11]. However, falsification by an employee of his work hours was found to be fraud only on the employer, not the Government [12]. Another criminal statute[13] states:

Conspiracy to Commit Offense or to Defraud United States.

> If two or more persons conspire either to commit any offense against the United States, or to defraud the United States.....and one or more of such persons do any act to effect the object of the conspiracy, each shall be fined not more than $10,000 or imprisoned not more than five years, or both.

Thus, an employee acting for his contractor in entering fraudulent amounts of work on tally sheets was properly charged with conspiracy and could not defend on the ground there was no contract between the employee and the Government[14]. So also with fraud by a subcontractor [15]. Finally, it should be noted that a criminal conviction does not preclude the Government from pursuing civil remedies for the same actions. This has been held not to be double jeopardy[16].

Compounding the problems of those who defraud the United States is another statute, Frauds and Swindles[17], which punishes with a $1,000

fine and five-year imprisonment the use of the U.S. Mails to defraud. Thus, a fraudulent bid or claim sent through the mails would violate this statute also. Particularly offensive is the bribery of contracting personnel. This violates the statute entitled: Bribery of Public Officials[18], and a fine of not more than $20,000 or three times the monetary value of the thing of value, whichever is greater, or fifteen years imprisonment, or both may result. Since fraud on the Government may involve someone inside the Government, this is a particularly important statute. Of course, it is also illegal to take a bribe[19].

Fraud and False Statements [20].
This criminal statute addresses not claims, but false statements. It is therefor of broad applicability, and states:

> Whoever, in any matter within the jurisdiction of any department or agency of the United States knowingly and willfully falsifies, conceals or covers up by trick, scheme, or device a material fact, or makes any false, fictitious or fraudulent statements or misrepresentations, or makes or uses any false writing or document knowing the same to contain any false, fictitious or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than five years, or both....

Such statements may be oral or in writing and are meaningful to procurement people in bidding and negotiation of contracts, where the Government may rely on false statements and thereby award a contract mistakenly. It has also been used where Government approval stamps and serial numbers were switched from previously approved items to those later delivered to the Government [21]. It is not necessary under this statute that the Government suffer monetary loss to justify conviction. A contractor who was being paid on gross receipts (theater concessionaire) submitted false profit and loss statements, correctly reporting gross receipts. Still, a conviction was had, as the false statements would influence Government personnel as to the terms of a renewal of the contract, and therefor influenced the exercise of a Governmental function[22]. This statute permits cancellation of contracts obtained by false statements[23]. Although this does not exhaust the range of criminal statutes applicable to Government contracting, it does review those most often employed and indicates the "state-of-the-art".

CIVIL REMEDIES

The Government response to fraud via its civil remedies is at least as vigorous as on the criminal side. Again, the same agencies, including the Justice Department, are involved, but with statutes which recompense the Government more than they punish the wrongdoer. Perhaps the foremost statute involved is:

The False Claims Act[24].
This Act is the civil counterpart of the criminal false claims act already reviewed, and was enacted in 1863 to combat contract fraud during the Civil War. It states:

> Any person...who shall make or cause to be made, or present or cause to be presented, for payment or approval....any claim upon or against the Government of the United States, knowing such claim to be false, fictitious, or fraudulent....shall forfeit and pay to the United States the sum of $2,000 and, in addition, double the amount of damages which the United States may have sustained by reason of the doing or committing....such act, together with the costs of suit....

This statute does not bar the Government's right to cancel fraudulent contracts, but provides remedies in addition to that right[25]. Each invoice is a separate claim and carries a $2,000 forfeiture[26]. But where the subcontractor is the perpetrator of the fraud, it's three invoices to the prime, rather than the prime's fifteen invoices to the Government shall govern the number of forfeitures[27]. This statute applies to fraudulent submissions of cost or pricing data, where such submissions result in a higher contract price[28]. It has also been applied where the contractor deliberately mislabeled aircraft bearings delivered under the contract. The bearings did not meet contract specifications and the statutory forfeitures applied. Consequential damages were denied, however, on the ground that the False Claims Act recovery was limited to the express provisions of the Act. An express warranty was present in the contract and the court allowed recovery of the lost value based on warranty rights. Thus, recovery was had on two different bases. In addition, the vice-president of the contractor's division which did the work was held liable[29]. This case demonstrates that the False Claims Act, though useful, is not an all-purpose remedy. It has been applied, however, even where no monetary loss was suffered by the Government, when the Government was exposed to dual liability by the false claim[30].

Another civil remedy is provided through the Forfeiture Statute[31] which provides for forfeiture of claims that are fraudulent. This appears to be a defensive provision as it simply fends off fraudulent claims. The Court of Claims in yet another approach went beyond this, and found an illegal arrangement whereby a contracting officer's representative was bribed by a contractor. Invoking the Conflict of Interest Statute[33], the court ordered forfeiture not only of the contractor's claim on which suit was based, but also of all monies already paid on the contract and also all monies already paid under two previous contracts tainted by the same fraudulent arrangement. The court observed there was no precedent for this in Federal cases, but noted such forfeitures were ordered by state courts and utilized

these decisions as the basis for his decision. Such is the attitude of the Court of Claims (now U.S. Claims Court) where Government agents are subverted.

ADMINISTRATIVE REMEDIES

In addition to the many criminal and civil remedies available through the courts, administrative actions may be taken to combat fraud.

Inspection Clause[34]. The clause used in supply contracts provides in part:

> Unless otherwise provided in this contract, acceptance shall be conclusive except as regards (1) latent defects, (2) fraud, or (3) such gross mistakes as amount to fraud.

Thus, the Contracting Officer may treat supplies foisted off on the Government by fraud as though they had not been accepted and require their replacement or correction under other language of the Inspection Clause.

Disputes Clause. Contractor claims under or relating to contracts must be brought under the procedures provided in the Disputes clause of the contract[35]. The clause implements the will of Congress as provided in the Contract Disputes Act of 1978[36]. Section 5 of the Act provides:

> If a contractor is unable to support any part of his claim and it is determined that such inability is attributable to misrepresentation of fact or fraud on the part of the contractor, he shall be liable to the Government for an amount equal to such unsupported part of his claim in addition to all costs to the Government attributable to the cost of reviewing said part of his claim...

This provision affects all claims arising under or relating to the contract. In addition, the Act and Clause provide that contractor claims exceeding $50,000 must contain a certification that the claim is made in good faith, that the supporting data are accurate and complete to the best of the contractor's knowledge and belief, and that the amount requested accurately reflects the contract adjustment for which the contractor believes the Government is liable. A false certification is deemed fraudulent, and would subject the contractor and its officers to the penalties already discussed in this paper. The Contracting Officer does not make formal fraud determinations under the Disputes procedure, but refers the matter for investigation.

Debarment. This administrative action bars contractors from award of future contracts, thereby protecting the Government. Instructions for handling Air Force debarment actions is contained in Air Force Defense Acquisition Regulation Supplement 1-650, Part 6. "Debarment, Ineligibility, Suspension" and provides for initiation of debarment recommendations by the purchasing activity, coordination by major command legal and contracting offices, and submission to the Air Force Deputy Chief of Staff for Research, Development and Acquisition[37].

Historically, not many debarment actions have been taken--if taken, other agencies did not know of it, or if they knew, elected not to follow suit with their own debarment actions. The Office of Federal Procurement Policy (OFPP), in an effort to broaden the effect of debarment actions, issued OFPP Policy Letter 82-1, effective August 24, 1982. As a result, all Air Force debarments are effective DOD-wide, and, as other agencies conform to the policy letter, they will be effective Government-wide. The subject of debarment is a delicate one for industry and a court challenge of the Government's debarment policies and procedures is likely. The expected argument: lack of due process in debarment proceedings.

IDENTIFYING A TREND

The Government has responded to fraud by substantially increasing the staffs of investigative and prosecutorial agencies. Substantial increases have occurred in money recovery[38]. The recent push given debarments just discussed is through the initiative of OFPP and the General Accounting Office. The Congress in 1978 passed the Inspectors General Act[39] putting enforcement teeth in the civilian agencies. Inter-agency cooperation is on the increase, particularly as to anti-trust, tax evasion, and debarment. Fraud "hotlines" have been established to aid fraud reporting. The statutes now on the books reinforce administration and the Congress looks at the fraud problem in each session. Clearly, the tempo has increased.

CONCLUSIONS

This paper is presented to acquaint those interested in an effective Air Force with the threat posed by contract fraud and the forces at work to combat it. The reader should be cautious in generalizing from the case examples cited. With so many different statutes involved and so many different fact situations presented to the courts, the author recommends advice of counsel before taking specific action in fraud situations. Use of fraud "hot lines" is encouraged, nonetheless.

Contract fraud is taking shape both as a legal topic and as a matter of management. It is being examined with more precision, and fraud reporting and prosecution is on the rise. Air Force managers may expect more definitive help in the future, as the shape of fraud, and the Government's response are better perceived.

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NOTE:

UNLESS SPECIFICALLY ATTRIBUTED TO OTHERS THE OPINIONS CONTAINED HEREIN ARE THOSE OF THE AUTHOR.

ADP002834

EMPLOYMENT CHANGES RESULTING FROM THE AWARD OF CONTRACTS IN LABOR SURPLUS AREAS

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ADP002834

ABSTRACT

Until 1981, the Department of Defense (DoD), as a result of amendments to their annual Appropriations Acts (known as the Maybank Amendment), had been prohibited from setting aside procurement contracts for award in labor surplus areas (LSAs) in order to relieve economic dislocations. In 1981 a coalition of Northeast and Midwest Congressmen succeeded in having the Defense Logistics Agency (DLA) test a modification to the Maybank Amendment and measure the local employment effects of increasing DLA contract awards in LSAs. In order to assure reasonably accurate predictions of employment impacts due to the DLA Maybank Test, the U.S. Army Corps of Engineers Construction Engineering Research Laboratory developed a computer-assisted regional economic impact model (called the DLA Employment Impact System) to assist DLA with their Congressional requirement.

INTRODUCTION

How much affect do Defense Contract awards have on employment in areas where they are performed? This question has been the subject of much discussion for many decades and both sides of the issue have been supported with convincing evidence. On the one hand, the Northeast and Midwest Coalition, a strong political interest group made up of Congressional representatives from eighteen states, argues that over the past thirty years dramatic changes in national and regional economic conditions have led to an out-migration of population, industry, and jobs from the Northeast and the Midwest to other areas of the country, principally the South and the West. The Coalition argues that defense contracts, especially in peace-time, can be used as instruments to stimulate economic recovery for suffering regions. On the other hand, the Department of Defense (DoD) disagrees with this concept and argues that more important issues are involved, such as competition, productive efficiency, and national security. Regardless of the position one takes, there are many unanswered questions about the effects that DoD contracts have on the local economies. Certainly, there has been much interest in the local employment effects that DoD contracts have in areas suffering significant and persistent unemployment.

This paper discusses a Congressionally authorized test program. The program requires that the Defense Logistics Agency (DLA) permit price differentials to set-aside contracts for firms operating in labor surplus areas (LSAs). This paper also describes a computer-aided regional economic model designed to measure the employment effects of DLA contract awards that fall under this test program. The "DLA Employment Impact System" correlates relevant information influencing local employment levels, such as geographic location, type of product, technological processes, and the existing sales levels, to arrive at a range of possible employment levels for a particular contract award. Finally, recommendations are made regarding applications of the DLA Employment Impact System to other procurement programs.

BACKGROUND

As a result of the economic downturn after the Korean War, President Truman directed a government-wide policy to set-aside a portion of federal procurements for areas which had extremely high levels of unemployment. In implementing this Federal policy, the Director of the Office of Emergency Preparedness, under Executive Orders 10480 and 10773, issued Defense Manpower Policy (DMP) No. 4. This policy was to encourage the:

"placement of contracts and facilities in areas of persistent or substantial labor surplus with regulations prescribed by the Secretary of Labor"

DMP No. 4 introduced a policy concerning the utilization of manpower in LSAs. Immediately upon issuance of DMP No. 4, Senator Burnet R. Maybank of South Carolina introduced an amendment which exempted the DoD from this requirement. His rational was that the DoD should not be required to pay a premium for its essential goods and services in order to relieve economic dislocation. Not long after this so called "Maybank Amendment," the General Accounting Office effectively prohibited total LSA set-asides within the DoD. That is, the difference between the price that would be awarded under restrictive bidding to LSA firms and the price that contracts awarded on the basis of unrestricted competition could result in the payment of a premium which is prohibited by the Maybank Amendment.

THE DLA MAYBANK TEST

Thus, until 1981, each annual DoD Appropriations Act has specifically prohibited the DoD from setting aside total procurements or paying price differentials to relieve local economic dislocations. However, through the efforts of a coalition of Northeast and Midwest Congressmen, the DoD has been directed to test a modification to the Maybank restriction. Specifically, the 1981 DoD Annual Appropriations Act (Public Law 96-527) required that DLA test a program of awarding certain contracts to firms that agree to perform the contracts in LSAs. Departments of the Army, the Navy, and the Air Force are exempted from this test program. The purpose of the test is to increase the award of DLA contracts in LSAs even if this requires the payment of price differentials. Initially, this price premium was not to exceed five percent (5%). The test also requires that DLA measure the effects of the contract awards as they impact on employment in both the gaining LSA and losing non-LSA. This test (popularly referred to as the DLA Maybank Test) has continued with each annual DoD Appropriation Act since 1981, although the premium has been reduced to 2.2 percent in FY 1983.

Exemptions From the Test: The following items are exempted from the test by the Secretary of Defense as authorized by the law.

1. Fuels and related products.

2. Certain purchases $25,000 and below.

3. Perishable substances.

4. Items purchased by DLA for resale in military commissaries.

In addition, a memorandum issued by the Secretary of Defense provides for several other exceptions.

1. One or more firms in the Defense Industrial Preparedness Program are located in a non-LSA.

2. One or more firms whose products are on a Qualified Products List are located in a non-LSA.

3. Offers for eligible products from designated countries under the Trade Agreement Act of 1979 are received.

Implementation of Test Procedures: The test began by including the test requirement in contract solicitations issued on and after 26 February 1981. While implementing the test, DLA undertook a comprehensive review of its procurement regulations and directives. Until the passage of this law, these procurement regulations and directives contained the same prohibitions as the Maybank Amendment. The following priorities have been established for making LSA set-asides under the test.

PRIORITY 1: A Total LSA/Small Business Set-Aside is a procurement where the total requirement is reserved or set-aside for small business firms as long as the contracting officer determines that there is a reasonable expectation that awards can be made at reasonable prices and that two or more small business firms offering products of different small business

concerns will bid. Under this priority, offers can be submitted by any small business concern, regardless of its LSA status.

PRIORITY 2: A Partial LSA/Small Business Set-Aside is a procurement that cannot be set aside under Priority 1, but can be divided into economic production runs, generally into two equal portions: (1) solicitations on an unrestricted basis under which any firm, regardless of size or LSA status, may submit a bid; (2) solicitations restricted to small business firms, regardless of its LSA status, can submit a bid providing it bids on the unrestricted portion. Under this priority, the contracting officer is required to determine that there is a reasonable expectation that awards on the unrestricted portion can be made at reasonable prices and that one or more small business firms will bid on the restricted portion.

PRIORITY 3: A Total LSA Set-Aside is a procurement where the total requirement is neither set-aside under Priority 1 nor divided under Priority 2. Under this priority, offers may be submitted by any concern, regardless of size of LSA status.

Measuring Employment Impacts: To measure the employment impact due to the DLA Maybank Test, an "employer's representation" was developed by DLA and issued as part of each contract solicitation subject to this test. The employer's representation requests (but does not require) that each bidder identify the number of employees that (1) would be laid off if the contract were not awarded, and (2) the number of new employees that would be hired if the contract were awarded to that firm. The sum of the employer's representations for the gaining LSA contractor and the losing non-LSA contractor is the employment impact under the DLA Maybank Test.

THE DLA EMPLOYMENT IMPACT SYSTEM

In order to validate the employer's representations and to make reasonably accurate predictions of the impact from DLA contract awards on employment, assistance was obtained from the Department of the Army. A computer-aided system was developed for this purpose by the U.S. Army Construction Engineering Research Laboratory at Champaign, Illinois. This system, called the "DLA Employment Impact System" is described in Figure 1. It is used to validate or question the employer's representation when the number of employees appears unreasonable. The DLA Employment Impact System includes (1) procedures used to determine the range of the number of workers to be hired or laid off because of a contract award (called the Employer's Representation Check), and (2) a method used to estimate the total employment impact in the economies of the regions affected by DLA contracting activities (called the Employment Impact Estimate).

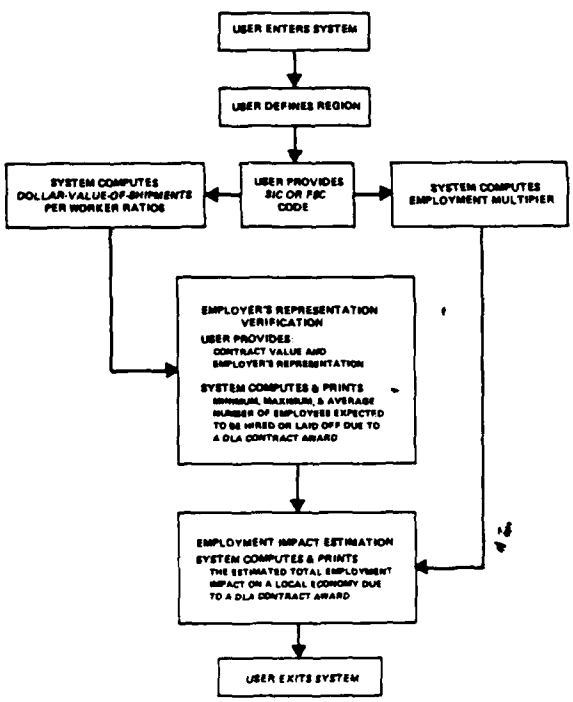

FIGURE 1 DLA EMPLOYMENT IMPACT SYSTEM

The Employer's Representation Check: Since one of the major purposes of the DLA Maybank Test is to measure the impact that contract awards made under the test have on employment levels, it is important to establish the number of

employees required to perform a given contract. Thus, DLA requests that all bidders submitting solicitations complete an employer's representation. The employer's representation attests to the bidder's intention regarding (1) the number of employees likely to be laid off if the bidder does not receive the contract award, and (2) the number of new workers that will be hired if the bidder is awarded the contract.

Not long after the test began, some highly suspect employer's representations were received that clearly indicated that contractors did not understand this requirement. Experience to date has shown that this method of determining the contractor's labor requirement has several problems. The major ones are:

1. There is a tendency for bidders to exaggerate the employer's representation, possibly in the mistaken belief that it is a factor for the contract award. For example, it is not uncommon to have a bidder state that 50 new workers will be added if a contract for $20,000 is awarded; obviously this appears out of proportion.

2. There have been problems with contractors counting part-time workers as full-time employees.

3. Contractors are sometimes unable to accurately estimate the level of employment on an annual basis, especially for contracts with short performance periods.

4. There are difficulties in determining the employment impact in the manufacturer's labor market area.

The DLA Employment Impact System uses a simple but accurate method to verify employer's representation estimates submitted with contract solicitations. If the contract is awarded, a bid represents a sale to the bidder, and he/she is expected to deliver a product or service for the agreed price (i.e., the contract value). With the revenue from the contract award, the bidder is presumed to cover all his costs, including payments to labor, rents, taxes, purchase of materials and supplies, etc., and net a profit as well. As a result, a natural way of verifying employer's representation estimates is to compare the dollar value of sales to the number of workers employed ratio with the ratio of the dollar value of the contract bid to the employer's representation estimate. Thus, this figure is the ratio of the dollar value of the contract bid to its employer's representation estimate compared with the minimum and maximum dollar value-of-shipments (i.e., sales) per worker ratios observed for the bidder's industrial classification and geographic location.

This method relies heavily on the assumption that firms tend to have relatively constant relationships between the dollar value of their sales and the number of workers employed at all levels of production. In other words, as a firm expands and contracts its production levels, it also expands and contracts the number of workers it employs, roughly in proportion to the change in production. In other words, the sales of a firm and its production level are considered synonymous.

The DLA Employment Impact System exploits the industrial and spatial variation of the value-of-shipments ratios by compiling sales-per-worker ratios that are unique both to the industry in which the contracted product is made and to the geographic area in which the commodity's producer is located. This industrial and spatial variation is illustrated in Table 1 (Value-of-Shipments per Worker Statistics by SIC) which presents a variety of sales-per-worker statistics for manufacturing firms located within various Standard Metropolitan Statistical Areas (SMSAs) throughout the U.S. Furthermore, the DLA Employment Impact System uses an approach to compute both the minimum and maximum sales-per-worker ratios that are likely to be found for producers of similar goods within the same geographic area. This is done by assuming a constant relative distribution of sales-per-worker ratios by size of firm for the same industrial category as the contracted product at the national level.

TABLE 1
1977 Value-of-Shipments per Worker Statistics by SIC

SIC		freq	mean	min	max
				$1,000	
20-39	Total Mfg	268877	67.8	33.1	502.4
20	Food & Kindred Prod	13686	124.6	42.4	337.1
22	Textile Mill Prod	1528	43.6	22.8	78.7
23	Apparel	3849	32.9	8.3	74.6
24	Lumber & Wood Prod	3465	62.7	26.3	103.0
25	Furniture & Fixtures	2434	40.3	22.8	70.3
26	Paper & Allied Prod	3699	72.5	34.0	169.5
27	Printing & Publishing	23667	48.4	21.5	71.1
28	Chemicals	8571	126.9	54.0	345.8
29	Petroleum Refining	731	491.6	100.2	1762.0
30	Rubber & Plastic Prod	4953	52.2	19.3	124.2
31	Leather Goods	447	34.8	19.0	61.0
32	Stone, Clay & Glass Prod	7937	61.1	26.0	147.3
33	Primary Metal Prod	4653	83.9	28.7	196.0
34	Fabricated Metal Prod	20528	57.4	28.0	138.8
35	Nonelectric Machinery	27531	57.0	23.7	142.0
36	Electric Machinery	9445	49.3	26.0	76.6
37	Transportation Equip	4665	86.0	28.4	211.8
38	Instruments	3245	46.3	19.0	102.7
39	Misc Mfg	3910	43.1	23.9	71.7

Source: 1977 Census of Manufactures (data from 277 SMSA's)

The procedures used by the DLA Employment Impact System to compute the minimum and maximum sales-per-worker ratios are presented in Table 2 (Value-of-Shipments per Worker Calculations for Non-Textile Bags (SIC 2643) Made in Los Angeles-Long Beach SMSA). The statistics shown in Table 2 are classified according to firm size, as measured by the average number of workers employed by firms producing non-textile bags (SIC 2643). At the U.S. level, Table 2 provides the number of workers, the dollar value-of-shipments, and the value-of-shipments-per-worker ratios by firm size and in total for non-textile bag producers. The column entitled "value-of-shipments-per-worker relative to U.S. total" is the distribution of value-of-shipments-per-worker ratios by size of firm relative to the sales-per-worker ratio for all firms producing non-textiles bags within the United States. The distribution of sales-per-worker ratios by firm size for firms producing non-textile bags in the Los Angeles-Long Beach SMSA is estimated by applying the distribution of sales-per-worker ratios relative to the United States total to the value-of shipments-per-worker ratio for all firms producing non-textile bags in the Los Angeles-Long Beach SMSA. An implicit assumption is that the relative distribution of sales-per-worker ratios , for an industry by firm size is the same for a region as it is at the national level. After these computations are complete, the DLA Employment Impact System then chooses the minimum and maximum estimated sales-per-worker ratios as the range of sales-per-worker ratios to verify the employer's representation estimate. For the example of non-textile bag producers in the Los Angeles-Long Beach SMSA, $64,200 is the minimum sales-per-worker ratio and $77,000 is the largest value-of-shipements per worker ratio. Note that $68,000 is the expected or average sales-per-worker ratio for all firms producing non-textile bags in the Los Angeles-Long Beach SMSA.

To actually carry out an employer's representation verification check, the DLA Employment Impact System deflates the current-dollar value of the contract bid to reflect the

TABLE 2
Value-of-Shipments per Worker Calculations for
Non-textile Bags (SIC 2643) Made in Los Angeles-Long Beach SMSA

Firm size by number of workers	---- U.S. Level ---- Number of workers (1,000)	Value-of-shipments ($million)	--- Value-of-Shipments per Worker -- U.S. level ($1,000)	Relative to U.S. total	LA-LB SMSA ($1,000)
all firms	48.7	3,482.3	71.5		68.0
1-4	.2	13.5	67.5	.94406	64.2
5-9	.4	31.3	78.3	1.09510	74.5
10-19	1.1	89.1	81.0	1.13287	77.0
20-49	3.8	278.4	73.3	1.02517	69.7
50-99	6.4	465.2	72.7	1.01678	69.1
100-249	15.7	1,068.4	68.1	.95245	64.8
250-499	12.8	974.4	76.1	1.06434	72.4
500-999	8.3	562.1	67.7	.94685	64.4

Source: 1977 U.S. Census of Manufactures (1977 dollars)

price level of 1977 using an appropriate product-price deflater.[1] This procedure results in a constant-dollar contract bid in terms of 1977 dollars. Next, a maximum range of estimated employment values is computed by dividing the constant-dollar contract bid by the maximum and minimum sales-per-worker ratios. Finally, the employer's representation estimate is compared with the range of estimated employment values. If the employer's representation estimate falls within the estimated range, then it is presumed to be reasonable. On the other hand, if the employer's representation estimate falls outside the estimated range, then the employer's representation estimate may be invalid or, at least, questionable.

Employment Impact Estimation: The DLA Employment Impact System carries out a regional employment impact analysis using region/industry-specific employment multipliers. These multipliers consider both the unique nature of the geographic area and its industrial structure where the product is made, as well as the technical process used to manufacture the commodity. Like the economic base multiplier, a region/industry-specific multiplier estimates the secondary employment effects (both indirect and induced) that are caused by an initial change. However, unlike the economic base multiplier, a region/industry-specific multiplier is unique to the industrial sector that is initially affected by an autonomous change. The region/industry-specific employment multiplier is computed using two complementary methodologies: first a region/industry-specific output multiplier is computed, then the region/industry-specific output multiplier is converted into a region/industry-specific employment multiplier.

First, region/industry-specific output multipliers are computed within the DLA Employment Impact System using the procedures developed at the Bureau of Economic Analysis (BEA) and then improved and extended by Regional Analytics, called the Regional Industrial Multiplier System (RIMS).[2] RIMS produces input-output type multipliers. That is, they relate changes in regional gross-output to changes in final demand for a specific regional industry, such as due to a DLA contract award for ball bearings. Using these multipliers has several advantages. Being I-O type multipliers, they provide results which are specific to a particular regional industry (i.e., for any of approximately 500 industrial sectors), thus avoiding errors that occur when different industries are combined. These

multipliers also offer a consistent set of assumptions across regions, making comparisons between regions more meaningful than if the results were based on different procedures and conventions.

The output multiplier procedure follows from the decomposition of the multiplier into three components: the initial effect, the direct effect, and the indirect-induced effect. The initial effect, always equal to one, represents the initial final demand change (e.g., the DLA contract award). The direct effect is the sum of the first round of interindustry sales. It is simply the sum of the regional direct requirements for inputs of the industry experiencing the initial final demand change. The indirect-induced effect is the sum of all other rounds of expenditures. The output multiplier is then the sum of these three components or effects, or

$$MQi = 1.0 + Di + Ii$$

where MQi is the output multiplier for some regional industry, Di is the direct component for that industrial sector, and Ii is the indirect-induced component for the industry.

The direct component is estimated by "regionalizing" a column from the "technical coefficients" matrix of the most recent National Input-Output model, using four-digit Standard Industrial Classification (SIC) location quotients computed from County Business Patterns (CBP) employment data.[3] The column from the technical coefficients matrix is made up of per dollar elements representing the column-industry's productive requirements for other industrys' (i.e., row elements) goods and services. The "regionalization" is carried out by evaluating the productive capacity of each of the local producers represented in the column of technical coefficients. If the area's needs for an industry's products can be met by local production then that industry's technical coefficient (row element) is not adjusted. If, on the other hand, local firms within an industrial category do not produce enough to meet local demands for their goods and services, then their technical coefficient is adjusted downward to reflect local productive capacities. Local productive capacities are measured by location quotients in the DLA Employment Impact System, as they are in RIMS. A location quotient is a measure of the relative size of an industry in a region compared to that industry for the nation. It can be argued that location quotients also measure the productive capacities of local industries.[4] That is, if an industry's location quotient is equal to or greater than one, then it is producing at least enough to meet local requirements for its products and, as a result, its technical coefficient should be unadjusted. But, if an industry's location quotient is less than one, then that industry must not be satisfying local needs for its products and its technical coefficient should be adjusted accordingly.

The indirect-induced component is based on its relationship with the direct component, taking into account a region's economic size and industrial structure. For I-O models, it has been found that the indirect-induced component of the multiplier can be approximated adequately by a linear homogeneous function of the direct component.[5] Of the thirteen urban and regional I-O tables examined, Drake found a positive and statistically significant association (i.e., correlation coefficient) between the direct and indirect-induced components of the industry-specific regional output multipliers. Also according to Drake's work, the indirect-induced component was best predicted with the following equation:

$$\ln(Ii) = .65 - .79*P1 - .13*P2 + .17*\ln(S) + 1.03*\ln(Di)$$

where ln(Ii) is the natural logarithm of the indirect-induced component of the industry-specific output multiplier for the region, P1 is the agriculture proportion of local nongovernmental wage and salary earnings, P2 is the manufacturing proportion of local nongovernmental wage and salary

earnings, ln(S) is the natural logarithm of the relative size of local nongovernmental wage and salary earnings to national nongovernmental wage and salary earnings, and ln(Di) is the natural logarithm of the direct component of the industry-specific output multiplier for the region. That is, he was able to explain 86.6 percent of the variation in the dependent variable with this equation, even though the seventeen urban and regional I-O models used in the estimation process represented a wide variety of industrial structures and large differences in economic size. For example, the sample included I-O tables for Sullivan county in Pennsylvania, St. Louis city in Missouri, Teton county in Wyoming, and states like West Virginia, Nebraska, and New Mexico.

Second, the region/industry-specific output multiplier is converted into a region/industry-specific employment multiplier using a simple procedure developed by R.L. Burford and J.L. Katz as an extension of Drake's work.[6] This work can be summarized as a formula to convert any region/industry-specific output multiplier into an appropriate region/industry-specific employment multiplier; or

$$MEi = 1.0 + [E./Ei * (MQi - 1.0)],$$

where MEi is the industry-specific employment multiplier for the region, E. is the average ratio of employment to output for all industries in the region, Ei is the ratio of employment to output for the industry of the region, and MQi is the industry-specific output multiplier for the region.

THE DLA MAYBANK TEST RESULTS

A consolidated summary of the test results during the entire test period (February 1981 through 31 December 1982) are:[7]

1. A total of 35,770 contracts (worth approximately $3,100,000,000) were awarded under the test.

2. Premiums of about $1,800,000 have been paid in order to award 956 contracts in LSAs. A two percent premium price has attracted approximately $88,000,000 in contract awards.

3. The employment changes that resulted from award of these 956 contracts were an increase in LSAs of 3,207 employees, while the non-LSA firms that otherwise would have been awarded the contract reported that they lost 3,335 employees for an overall net loss of 128 jobs.

4. The labor areas in which the contracts included in the test were awarded. A total of 10,388 contracts were awarded in LSAs, while the balance of 25,382 were awarded in non-LSAs.

CONCLUSIONS/SUMMARY

The major conclusion from this test program is that the DLA Maybank Test has not had the major affect on local employment that its sponsors had hoped. In fact, quite the opposite appears to be true. That is, DoD procurement expenditures, when set-aside to relieve economic dislocation, have little effect on local employment, at least as evidenced by the results so far. Of the almost $3.1 billion in contracts awarded under the DLA Maybank Test, only 6,500 jobs have been affected in total from which there have been a net loss of 128 jobs throughout the nation. These results can hardly be termed significant.

Apart from the rather minimal results of the DLA Maybank Test, the methodology used to validate the employer's representation and to measure the employment impact on local economies does have wide applicability. Although the DLA Employment Impact System was developed for DLA and their contracting activities, it can be used to measure local employment effects for any federal, state, and local procurement program. It is easy to use and incorporates many of the advances in regional economic impact methodology found in the literature of recent years. Consequently, it applies "state of the art" technology to reliably answer a major question for many regional analysts and policy makers at all

levels of government; that is, "what affect do government expenditures programs have on local economies?"

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SOURCE SELECTION

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Papers:

Automating the Source Selection Process
by John M. Barry and Bruce G. Pratt

Increasing the Contractor/Subcontractor/Vendor Bidding Lists
by John G. Beverly, Frank J. Bonello, James M. Daschbach and William I. Davisson

Selection of Multiple Sources in Weapon Systems Acquisition
by James W. Hargrove, Jr.

The "SCORE" Technique: An Analytical Approach for Assessing the Results of Manufacturing Reviews
by Raymond S. Lieber and Malcolm C. Edelblute

AUTOMATING THE SOURCE SELECTION PROCESS

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AD P002635

ABSTRACT

A typical source selection involves considerable adminstration which contributes to the consumption of program and staff office resources. Normally these resources are expended at the sacrifice of regular program office project activities since a permanent, dedicated source selection team is not cost effective. The loss to a program can be measured in terms of schedule delays, contractual gaps, and loss management control over existing programs. Therefore, the efficient and speedy conduct of a source selection is essential to the Acquisition Process. This efficiency cannot be achieved by shortcutting the required processes of source selection evaluation, analysis, and ranking. However, the automating the administrative aspects of a source selection can result in a 30-50% reduction in time and resources required to evaluate the proposal. This paper will focus how this adminstration can and has been reduced on an existing Air Force Program through the use of microcomputers.

DISCUSSION

Conducting a source selection is similar to organizing and managing a small program office. First, one must select specialists in various management and technical disciplines who are competent to evaluate contractors' proposals in a specific field. Then these specialists must be organized into management, technical, and cost areas in order to establish the criteria for award prior to the release of the request for proposal. In the Air Force, this organization is known as the Proposal Evaluation Group (PEAG). The PEAG is composed of the chairperson, recorder, members, advisors, and consultants. These last three groups of individuals perform the evaluations and analysis for the chairperson who must make a recommendation to the Source Selection Authority, who makes the final decision. The process of the source selection involves documentation, numerical analysis, and correlation. This paper will discuss the automation of much of this process. However, before this automation is described, the documention required in the selection process must be explained in a cursory manner.

Most source selections require the completion of deficiency notices, clarification requests, evaluation narratives, strengths and weaknesses narratives, labor accounting, price breakdowns, and most probable costs. These forms will be described only to provide a foundation and appreciation for the automation of these efforts. Then the software tools used will be explained in further detail throughout this paper.

Application of the techniques and commercial software products described in this paper could significantly raise acquisition productivity throughout the Defense Department. Exposing the acquisition community to this automated capability should encourage programs to apply similar approaches to their source selections.

The effort required to complete and track the various forms during a source selection is substantial. Deficiency notices are developed and sent to one of the bidders whenever the proposal fails to meet a certain part of the special provisions, specification, or statement of work. A clarification request is used to ask to information which is unclear in a bidder's proposal. The current status on these forms must be maintained in order to assist the proposal evaluation team in arriving at their analyses of the contractor's proposals which are documented in the evaluation narratives and the strong and weak point forms. These various forms can number close to 1,000 in a source selection as few as two bidders. This is why tracking the information is a formidable task. To reduce the size of this task, key information from each one of the forms was extracted. This extraction helped automate two recently conducted source selection programs within DMSP.

The automation of the previously described forms was done using a commercial program for microcomputers, dBaseII™, which is both a programming language and a relational data base. Menu screens were developed for both input and output which made the programs user friendly. Key data was "captured" from each form and entered into the data base using each form as a unique record and the data as fields which described information such as Request For Proposal Reference, bidder's proposal reference, criteria, area, item and factor. The integrity of the data was maintained by each team chief having their own terminal and separate data base. This program architecture also allowed the data to be typed in from several terminals, thereby speeding the input process. At the end of each day the team recorder used another menu oriented program to combine the data bases and check for duplications and continuity. The output routines allowed extraction of any of

the reports by author, title, bidders proposal reference, RFP reference, rating, type of deficiency or clarification, and criteria, area, or factor. Since the database was relational, any combination of the previous data could be extracted for management use. In addition, this entire database was contained on a single 5 1/4 inch diskette instead of hundreds of sheets of paper. This capability in not possible to duplicate in a cost effective manner if done manually.

The only difficulty encountered in the database was the inability to combine extensive narrative and captured key data. This obstacle was partially overcome by typing the narrative information using a word processing program and the placing the key data in dBaseII™ along with brief one sentence descripters. Then the source selection information could be extracted and summarized in several different ways using these descripters. As the database grew in size, correlating and extracting this voluminous information consumed several minutes on the microcomputer since dBaseII™ performs a significant amount of manipulations by "swapping" portions of the program to an from the floppy disk. The database operations were significantly accelerated by placing the entire dBaseII™ program and our software routines into the microcomputers random access memory. This same technique was used to speed up the numerical operations involved in this automated source selection which will be discussed next.

Scoring bidder's proposals using an electronic calculator rapidly becomes an exercise in poking keys and frustration. This nightmare was simplified by using a commercially available electronic worksheet, Supercalc2™, to perform the operations and create the printout in a matter of seconds instead of hours. This was done by creating a "template" with all the necessary formulas and tiltles involved in the complexities of scoring. A template, or stencil for electronic spreadsheets such as Supercalc2™ is created whenever the format and formulas for arriving at numerical results will not change between applications. The only thing that is subject to change is the factors or numerical inputs. This same template can be used over again among a multitude of bidders. This approach of creating templates was also used to develop numerous financial spreadsheets. This was the last and most important step in automating the tedious aspects of the source selection process.

CONCLUSION

Automating any activity requires looking at the total environment and assesing the data and analysis needs. This paper briefly described the source selection process to provide the reader with a perpspective needed to appreciate the complexity and magnitude of the effort involved. Having described the process, the requirements to capture the relevant data was discussed in order to explain the requirements of the management outputs. In addition to data, numerical and financial analysis is extremely important to the process. Automating these jobs enable the two previous DMSP source selections to drastically to reduce the lead time and resources required to complete these efforts. Presently the software and templates created in these activities are being considered for use Space Division wide.

INCREASING THE CONTRACTOR/SUBCONTRACTOR/VENDOR BIDDING LISTS*

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Traditionally the Department of Defense (DOD) has not involved itself directly in the subcontractor selection process required by any prime contract. Rather, the process of selection of subcontractors as well as the "make-or-buy" decision is basically left to the prime contractor. Except for the identification of critical components (by subcontractor) the prime contractor is not required to report any information regarding subcontracts or subcontractors. Further, the rules which the DOD uses for dealing with prime contractors may not be the same rules used by the prime contractors in dealing with subcontractors. For instance, where a prime contractor might not be held to a firm fixed price contract for some system, the prime contractor will almost always hold the subcontractor to a firm fixed price contract. Finally, advantages such as advance progress payments available to prime contractors from the contracting agency may not be reflected in prime contractor payments to the subcontractor.

For whatever reason, the subcontractors available in the defense industrial base appear to be diminishing over time. It is not our intention here to document this point. Rather, our intent in this paper is to demonstrate a method by which DOD (the Air Force) can increase the defense industrial base by increasing the list of companies that could bid on DOD vendor contracts as well as be available to bid on contracts from prime contractors. Our focus will be on small private business although the technique shown here could be applied to existing databases available for the establishments of SEC-registered corporations.

IMPORTANCE OF SMALL BUSINESS UNITS: MEL DATABASE

Given the focus of this article on the world of small business, it seems useful to begin by indicating the environment of the world of small business. The overall or generic definition of small business is a firm with under 100 employees or a manufacturing establishment with under 500 employees. One aspect is shown in Table 1 which presents the breakdown of the number of establishments and employees that fall into the following three size categories:

a. Small - Establishments with fewer than 100 employees owned by firms with fewer than 100 employees.

b. Apparent Small - Establishments with fewer than 100 employees owned by firms with more than 100 employees; and

c. Large - Establishments with more than 100 employees owned by firms with more than 100 employees.

Data are presented for all industry and two individual industries, Manufacturing and Services. This table indicates that for all industry approximately 80 percent of all establishments can be classified as small and about one-third of total employment is with such establishments. Small establishments in manufacturing are relatively less important; approximately 60 percent of manufacturing establishments are classified as small and account for 16 percent of manufacturing employment. For services small establishments constitute about 90 percent of the establishments and provide 30 percent of the employment.

Table 1

EMPLOYEES AND ESTABLISHMENTS
SMALL BUSINESS ESTABLISHMENTS
(In Thousands)
1981

	Small	Apparent Small	Large
ALL INDUSTRY			
Establishments	4,036.0	556.0	137.0
Employment	30,262.0	14,329.0	48,487.0
MANUFACTURING			
Establishments	367.9	139.4	62.1
Employment	4,999.5	3,458.2	23,250.6
SERVICE			
Establishments	928.4	93.0	31.5
Employment	6,452.9	3,205.2	11,691.3

Source: State of Small Business, 1983, p.201.

Using the generic definition of small business, as firms with 100 employees or less, then for all industries small business had 54.8 percent of total sales and 54.2 percent of total employment for the period October 1981 - October 1982. Mining and Manufacturing are the two industries that are most clearly dominated by large firms. Manufacturing had 77.0 percent of all sales and 73.4 percent of all

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employment in establishments with more than 500 employees. The small business dominated industries were Construction Retail Trade, Real Estate and Service.

In summarizing this overview several points are worth noting. First, because an establishment is the smallest unit in which "business activity is conducted and on which statistical information is collected" (while an enterprise represents businesses that are separately owned and operated), it is probably more appropriate for DOD to concentrate on establishments in its efforts to increase its contractor/vendor bidding lists. Focus on the establishment seems appropriate because it pinpoints as specifically as possible the unit at which productive activity takes place.

A second point suggested by this overview is that efforts to expand bidding lists must extend to small business (units with less than 500 employees). This is the case because small business represents a significant portion of the business community and employs large numbers of people. Even for the manufacturing industry, which is dominated by large business, small businesses generate over 20 percent of sales and 25 percent of employment.

A third and final point is that business organization patterns in the United States are complex and changing. This creates a need for further analysis of this structure and for careful monitoring of change. This must be done if the appropriateness of bidding lists is to be maintained.

The importance of the small business community as well as its precarious position has been recognized. In this regard the Small Business Administration, Office of Advocacy (SBAOA) is involved in an overall effort to develop and organize data on the role of small businesses in our economy. This is in accord with Public Law 96-302 which states that a small business database is necessary for historical purposes as well as for public policy purposes. One of the databases developed by SBAOA is referred to as the Master Establishment List (MEL). Information in the MEL database includes, as a minimum: company name, company address, industry classification by SIC code, and geographic location. The basic function of the MEL database appears to be communication with the small business community. Based on the Dun & Bradstreet, Dun's Market Identifier File (DMI) and national business list files (MDR Inc.) the MEL database contains 8.1 million records (establishments) including more than 500,000 manufacturing establishments and 900,000 service establishments. It would appear, initially, that the DOD interest would be in the manufacturing establishments and the service establishments insofar as the contractor/subcontractor/vendor bidding lists are concerned. Because of its inclusiveness, it seems that the MEL database would be an appropriate database for increasing existing contractor/subcontractor/vendor bidding lists.

GENERAL CONCERNS IN INCREASING BIDDING LISTS

As an initial point consider the implications of Public Law 96-354, the overall purpose of which is to create procedures to analyze the availability of more flexible regulatory approaches for small business entities. One of the major areas of study of the SBAOA, and one of its charges in developing and using the MEL database, is to determine the ability of small business to comply with government regulations. For instance, if the paperwork required presently by DOD acquisition policies (boilerplate) is so onerous that a small business cannot afford it; then DOD may be missing out from existing and valuable technology, efficiency and delivery. Consequently, DOD may wish to re-evaluate its acquisition policies with respect to small business if it is to gain access to all the technology and efficiency presently existing in the United States economy.

Assuming that DOD is willing to engage in follow-up activity, the minimum database must provide the names and addresses of the establishment officers for all manufacturing businesses with their SIC code. This would permit the DOD to directly contact the desired firms to determine the following:

a. Within the four digit SIC code, the products specifically produced by that company; and

b. If the products are desirable, what conditions would be required for the companies to be willing to bid on (i) contracts directly from DOD and (ii) on outstanding subcontracts from prime contracts.

It seems clear that the MEL database would solve this access problem. Further, the SBAOA is directly charged by Congress to investigate problems of regulatory flexibility and cost when applied to small business establishments and enterprises. Therefore, it seems likely that DOD working with the SBAOA would provide a natural alliance in attempts to determine a suitable middle ground by which small businesses could accommodate DOD contractor/subcontractor/vendor business without suffocating from "boilerplate."

PROCEDURES FOR USING A DATABASE TO INCREASE THE CONTRACTOR/ SUBCONTRACTOR/VENDOR BIDDING LISTS

It is clear that in order to maintain and improve the effectiveness of DOD and Air Force

acquisition, it is useful to inform as many firms as possible about prime contracts to be awarded by DOD and the Air Force. In addition it is useful to identify as completely as possible the firms in the lower tiers of the production process that may supply prime contractors with subassemblies, parts and components, and raw materials. This allows firms to resolve the make-or-buy decision more effectively. But other goals besides acquisition effectiveness may be served by appropriately constructed bidding lists; these include the achievement of social objectives with regard to small business and minority owned business. But how can bidding lists be expanded and what represents a database approach to such expansion?

These questions are the focus of this section. A bidding list at the very minimum consists of various product designations and the firms that are currently producing or capable of producing the designated products. The product information may be descriptive or may be in numerical form such as SIC codes. The firm information would include the firm's name and address. Again, this is the minimal information necessary for a bidding list; additional product information as well as production and financial information would be useful but not essential for purposes of determining firms who might be interested in bidding on a contract and/or in being a subcontractor/supplier to a DOD prime contractor.

Bidding lists can be developed and expanded in a variety of ways. One informal approach is simply to rely on the knowledge of DOD acquisition officers. These individuals, through their experience, will be familiar with various firms and the products they produce or are capable of producing. These individuals may also use their contacts to determine that other firms have the ability to produce the particular products. The difficulties associated with this type of bidding list determination and expansion are rather obvious. It may be awkward and problematic for some acquisition officers to "pick the brains" of other acquisition officers. And what happens if the knowledgeable acquisition officer leaves the field, especially if the departure is sudden and unexpected? At the very least then this type of informal bidding list determination must be converted into some sort of written form. Even then it remains limited by the experience and memory of individual acquisition officers.

The database approach to bidding list determination involves a reliance on computerized files where the purpose for the compilation of the files was not primarily an identification of various firms who produce various products. As defined there is an immediate disadvantage to reliance on a database approach to bidding list construction: the product definitions and designations may not be as precise as they could otherwise be. The database approach offsets this potential disadvantage with several potential advantages: first, it is likely to be more inclusive in the sense of covering more firms; second, it is likely to provide more than the minimal amount of information; and third, it is computerized, and as a consequence, is likely to be readily useable at a variety of different cities simultaneously through time sharing. Whether these potential advantages actually obtain depends on the particular databases used to formulate the bidding list.

It is likely that a coordinated approach by the DOD and the prime contractors would be necessary to develop a policy for handling subcontractors/vendors. It is further likely that this policy would have to be coordinated with the potential subcontractors/vendors for a fruitful result to occur. The entire approach here assumes that the DOD would be interested in increasing such a bidding list and that prime contractors, if not actively interested in such a policy, would not actively oppose such action. Clearly, increasing a contractor/subcontractor/vendor bidding list would impinge upon the prime contractors "make-or-buy" prerogatives. It would finally be necessary that a feedback policy or system be established between the three basic actors to the policy.

In 1981 Dun & Bradstreet initiated a system designated as Purchasing and Procurement Information System (PPIS) using the DMI database. (Luchsinger, 25 May 1982, and James P. McGinty, Dun & Bradstreet, 1983.) It is our understanding that the system was developed and is presently operational but that it is not being either updated or expanded.

The methodology to use PPIS is as follows. A product is identified as one that is required for DOD acquisition. Let us say, for example, that it was desired to establish an increased bidding list for cathode-ray-tubes, or monitors. A search of the four digit SIC codes, even superficially, would indicate that the following four digit SIC codes would be likely suppliers of "monitors":

3651 Radio TV and Receiving Sets
3661 Telephone, Telegraph Apparatus
3662 Radio and TV, Commerical Equipment
3671 Electric Tube, Receiver Type
3672 Cathode Ray Picture Tube
3673 Electric Tube Transmitting
3811 Engineering & Scientific Instruments
3823 Process Control Instruments
3825 Instruments, Measuring, Electric
3829 Measurement & Control Devices

Using the Dun & Bradstreet manual for 1982, there are 3,210 establishments in the DMI file in the indicated SIC code categories. Dun & Bradstreet on the basis of either personal

contact, telephone, or mail contact created three additional digits to the existing four digit SIC code, where the added digits were then associated with each appropriate establishment for specifically defined products. It is possible to envision other PRODUCT designation methods than adding three digits to the four digit SIC code. The four digit SIC code indicates only product line and it is necessary to get considerably more specific than product line. The three added digits accomplish this.

The critical point is that the four digit SIC code is simply too broad to be useful for acquisition purposes. An alternative or supplement is required to move the relevant focus from product line (four digit SIC code) to product (seven digit code).

Thus, on the newly devised PPIS system, the word MONITOR is input to the computer. The computer then prints out the following information:

PRODUCT	PRODUCT DESCRIPTION
3693273	BLOOD LOSS MONITORS, SURGICAL SUPPORT, ELECTRO MEDICAL MONITORS
3662229	BROADCAST, STUDIO AND RELATED ELECTRONIC EQUIPMENT VIDEO EQUIPMENT (EXCLUDES CONSUMER TYPES), OTHER POWER SUPPLIES, SYNCHRONIZATION EQUIPMENT, TERMINAL EQUIPMENT MONITORS, VIDEO TAPE RECORDERS AND PARTS AND ACCESSORIES THEROF, LIVE CAMERAS, CONTROL CONSOLES AND SWITCHERS, FILM EQUIPMENT AND TV OUTSIDE VANS.
3662241	BROADCAST, STUDIO AND RELATED ELECTRONIC EQUIPMENT CLOSED CIRCUIT TELEVISION SYSTEMS AND EQUIPMENT (EXCLUDES BROADCAST AND CONSUMER PRODUCTS) SPECIALLY DESIGNED CAMERAS, MONITORS, VIDEO RECORDERS, RECEIVERS, SCAN CONVERTERS, CONTROL CONSOLES, OTHER.
3829106	NUCLEAR RADIATION DETECTION AND MONITORING INSTRUMENTS, NUCLEAR MONITORING INSTRUMENTS (INCLUDES ENVIRONMENTAL, PERSONAL DOSIMETERY AND MEDICAL MONITORS, BOTH STATIONARY AND PORTABLE.

The user of the system then examining the initial information printed out and is able to determine that the probable seven digit code that is appropriate is "3662229."

The user then enters the code "3662229" into the computer system, and the following type of information is printed out. (Notice, for this illustration, only the name of the company and the Dun's number are printed out, but modifications could be accomplished to print out name, address, chief executive officer, telephone number. Only a few of the total companies from the actual sample run are shown.)

DUN'S NUMBER	PRIMARY NAME OF ESTABLISHMENT
001306448	SONAR RADIO CORPORATION
001392778	SUPEREX ELECTRONICS CORPORATION
001556976	COMSPACE CORPORATION
002229607	MICROWAVE SYSTEMS INC
003234887	LONG ENGINEERING CO. INC
003262920	MCCARTHY MANUFACTURING CO INC
004203568	HARRIS CORPORATION
005476477	WINEGARD COMPANY
006299648	CRAWFORD ELECTRONIC CORP
... ...	... ...

A total of over 75 companies was printed out on this search. As described, the PPIS system may not exactly fit the needs of the DOD. Presently, it is our understanding that the system contains some 10,000 establishments. We were unable to obtain information on how often the database is verified to determine that the firms are actually as indicated (changes over time) or the cost of undertaking such a system by Dun & Bradstreet.

It is clear that the methodology developed by Dun & Bradstreet using the DMI file has the primary advantage of moving the appropriate focus from the PRODUCT LINE to the PRODUCT. The MEL file developed by the SBAOA has the logical advantage that it approximates the complete industrial base of the United States. It is updated biannually and it is maintained in database form. It has the further advantage that it integrates the MDR Inc. database with the DMI database in creating the MEL database. Thus there is considerable cross-checking or validity checking in the creation of the final MEL file from the other two files. The methodology behind the DMI file is credit rating and insurance, while the methodology behind the MDR file is telephone and product/service listing.

SELECTION OF MULTIPLE SOURCES IN WEAPON SYSTEMS ACQUISITION

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CAVEAT

The opinions expressed herein are solely those of the author and do not represent official positions of the Naval Sea Systems Command or the Department of the Navy.

ABSTRACT

Discussion of source selection and evaluation techniques usually focus on selection of a single source to fulfill the government's weapon systems acquisition requirements. There are numerous instances when selection of multiple sources is an objective. The additional requirement to select multiple sources can greatly complicate the source selection process. Two major source selections conducted by the Naval Sea Systems Command for the Fast Logistic Ship SL-7 conversion (TAKRX) program and the Maritime Prepositioning Ship (TAKX) program illustrate techniques for selection of multiple sources in a highly complex situation. This paper discusses the significantly different procedures used in these two programs and identifies lessons learned. Selection of multiple sources requires considerable forethought to identify complicating factors and possible variations. Control of the number of variables is necessary to ensure a manageable process.

INTRODUCTION

Classical source selection and evaluation techniques are centered around selection of a single source to fulfill the government's weapon systems acquisition requirements. There are numerous instances, however, when selection of multiple sources is either advantageous or a necessity. Multiple sources may be desired to maintain competition and surge capacity. An example is a competition between two sources which has been developed under a leader-follower concept. Variations exist in all of these situations and each is unique. The source selection process, however, is usually structured on the basis of a single-source competition with the simple acknowledgement that multiple sources may be selected.

There are many variables that may be considered in a source selection process. These include the design or technical quality of the product to be supplied, the quantity required, schedule requirements, and price. Choosing the proper source selection criteria and procedures is a complex and critical process. The more variables that are considered, the more complex is the source selection, and the more difficult is the determination and weighting of evaluation criteria. The addition of the option or requirement to select multiple sources can greatly complicate the source selection process. There is no set of rules or formula that will generate the best combination of evaluation criteria and process in a given source selection. Therefore, as the complexity of the process increases the more important it is to review methods that have been used successfully in the past. Two particular major source selections conducted by the Naval Sea Systems Command for the Fast Logistics Ship SL-7 conversion (TAKRX) program, and the Maritime Prepositioning Ship (TAKX) program illustrate techniques for selection of multiple sources in a highly complex competition.

The objective of the Fast Logistics Ship SL-7 Conversion (TAKRX) program was to convert eight (8) SL-7 class containerships, acquired from Sea Land Corporation, to a roll-on, roll-off configuration to support rapid sealift of Army equipment as a part of the Rapid Deployment Force. The performance specification for the converted ships was detailed in a Circular of Requirements. There were certain basic minimum requirements and some optional enhancements. Program funding for ship conversion was limited to an average of $75 million per ship. The program goal was to convert the eight ships incorporating the basic minimum requirements and as many of the optional enhancements as possible for the funding available. Maximizing competition was considered important in encouraging innovative design approaches to the requirements while keeping costs within budget. The constraint to deliver converted ships in as short a period of time as possible dictated the use of more than one shipyard for conversion. More than three shipyards were considered uneconomical because of the initial start-up costs.

The objective of the Maritime Prepositioning Ship (TAKX) program was to acquire through long-term (up to 25 years) charter, prepositioned sealift of supplies and equipment for three Marine Amphibious Brigades (MAB). One MAB support capability was required to be added in each of the fiscal years 1984, 1985, and 1987. Each chartered ship was to be configured to provide either one-fourth of a MAB or one-fifth of a MAB sealift. Performance specifications were outlined in a Circular of Requirements, which may be met through conversion of existing ships for construction of new ships. Based on a survey of ships available for conversion, and the new construction building times, it was likely that more than one source would be required. Since the program was structured as a charter, financing of the ship building or conversion was to be with private funds arranged through commercial banks with Navy

payments after the ships were configured as TAKX and tendered for charter.

The source selection processes and criteria for the TAKRX and TAKX programs were vastly different, even though they had similar objectives: the selection of multiple sources to provide ships meeting a set of performance criteria through different approaches in a loosely defined time frame. The two source selections were being conducted simultaneously by the same program office, with many of the same shipyards participating.

DISCUSSION

The TAKRX program used a three-phase approach to the source selection process. The three phases were for program, design, and price competitions. Each phase used different evaluation criteria and selection procedures that were tailored to the objective of the phase. A summary of the criteria and procedures for the second and third phases was included in the solicitation for the first phase. The specifics of the source selection process were issued prior to the receipt of proposals for Phases II and III. The phases were structured to progress from concept formulation to preparation of contract specifications.

The Phase I source selection criteria were structured to evaluate a competitor's ability to execute the entire program. Factors considered, in order of importance were: Technical, Resources, Management, Experience and Cost. In each area the offeror was asked to address both the ship design and ship conversion aspects of the program. The solicitation also stated that only those offerors selected for Phase I would be eligible to compete for Phases II and III. Special contract provisions provided the general source selection procedures and evaluation criteria for Phases II and III.

Nine Phase I proposals were received from eleven shipyards. Two proposals were from joint ventures in which two companies proposed to combine their efforts during the design process and then compete separately for the actual ship conversions. Evaluation of the proposals resulted in the selection of four proposals, including two proposals from joint ventures that were acceptable in all aspects, and were clearly superior to the other proposals. This selection met the objectives of providing sufficient competition throughout the program. Therefore, contracts for the initial design effort were awarded to the top four offerors without holding discussions. In fact, the Phase I selection was similar to a competitive range determination in a normal, single source competition.

The purpose of the Phase II competition was to evaluate the initial design proposals based on conformance with program objectives, and to select those offerors with a reasonable chance of completing the engineering design, and conversion pricing proposal in the program time frame. The Phase II effort was an extension of the Phase I effort, and as such was structured as a priced option on the Phase I contract. This allowed for rapid execution of Phase II contracts after the source selection had been completed. This was an important consideration because of the strict time constraints on the program. Evaluation of the proposals indicated that all four offerors could convert their designs to the Navy standard configuration, and complete the engineering design, and conversion pricing in the allotted time. Thus, all four offerors were continued into Phase II.

The Phase III competition for the conversion of the ships was significantly different from the previous competitions. The offerors' design effort still had to be considered, but the conversion effort and the price for the conversion were much more important than earlier. The source selection procedures were structured such that the design, resources and management sections of the proposals would be evaluated for acceptability. Then for those offerors with acceptable proposals in these areas, the source selection would be reduced to a price competition. The basic structure of the competition had been provided to the offerors in a contract clause. The specific procedures and criteria were further delineated in a solicitation and draft contract provided to the offerors forty-five days prior to receipt of proposals.

Since rapid completion of the conversions was a program objective, the method for accomplishing this became an important factor in the structuring of the source selection criteria. The original plan had been to have both price and schedule as factors in the final selection of sources, and to allow offerors to propose differing schedules. Several methods of objectively relating price and schedule were considered, including the establishment of a predetermined value for a month of schedule that would be added or subtracted to the offeror's price, depending on his variance from a nominal baseline schedule. The option of improving delivery schedules by selecting three shipyards rather than two for conversion was also a consideration. The addition of variable schedules to the problem of selecting two or three contractors to convert eight ships located on two coasts greatly increased the complexity of the problem. Therefore, the decision was made to standardize the delivery schedules and to depend on the option to select three shipyards to accelerate

deliveries. A consideration in this decision was the desire to use procedures and criteria that could be easily understood by the offerors, so their pricing decision was not overly complex for the time allotted.

After evaluation of proposals and one round of technical discussions, all offerors were determined to be acceptable, and the source selection became a price competition. Analyzing the various combinations of price offers with either two or three shipyards took only a few hours. The result was that three shipyards could perform the conversions at a price that was well within budget. Contracts were awarded at the time of the final source selection. Debriefing of unsuccessful offerors was easily accomplished using a tabulation of the contract prices. The source selection process had met the program objectives of providing early ship delivery within budget.

The TAKX program used a single phase approach to the source selection process. The source selection evaluation technical and price categories were of approximately equal importance, and management was significantly less important. Since different ships with varying designs and capabilities could be offered to meet the Circular of Requirements, the technical category evaluation was structured to determine those ships that were best suited for conversion, offered the best conversion design, and best satisfied the Circular of Requirements. The price category evaluation concentrated on the life cycle costs to the Government, and the realism of the proposed cost. Consideration of the management category consisted of the corporate experience, and capability to organize, finance, convert and operate the ships. Several variables were left to the discretion of source selection officials because they could not be determined until after receipt and evaluation of proposals. One variable was the number of ships to be acquired which could be affected by the charter of either one-fifth, or one-fourth of MAB ships. Another variable was the schedule which could be accelerated from the minimum of one MAB sealift in each of FY 84, FY 85 and FY 87. The delivery schedule was dependent on the availability of the ship, and the conversion period. The other major variable was the number of contractors to be selected, which was dependent upon the number of ships offered by each company.

Thirteen proposals were received from eleven companies, with one company submitting proposals for converted ships, new construction ships, and a combination of conversion and new construction. Four rounds of negotiations, and two competitive range determinations spanning more than six months were required before a final source selection decision was made. Through most of this period, the evaluations, procedures, and problems were similar to those experienced in a single source selection competition. The complexity of the multiple source selection only became significant in the final selection process as the source selection officials had to evaluate the ship MAB sealift capabilities, delivery schedules, and number of ships in addition to the established criteria of technical, price, and management. Each proposal was considered from the highest ranking to the lowest, to establish the number of ships that could be provided to meet the required delivery schedule. Tentative selection was made, awarding the higher rated offerors as many ships as possible. The most difficult criteria to satisfy was the delivery of one MAB sealift capability in 1984. Conversion of existing ships could meet this capability, however, new construction ships could not. The new construction ships, and three converted ships were offered in a one-fourth MAB sealift configuration. The rest of the ships offered were conversions to one-fifth MAB sealift configurations. The one-fourth MAB ships were preferred because their life cycle cost on a per MAB basis was significantly less expensive. The decision was made to select two one-fourth MAB and two one-fifth MAB ships offered by Waterman Steamship Company and Maersk Lines, Ltd., respectively, for delivery in 1984. This substantially satisfied the 1984 sealift capability requirement. A third one-fourth MAB ship offered by Waterman, and the other three one-fifth MAB ships offered by Maersk were selected for delivery in 1985. This left the last one and one-fourth MAB lift capability to be supplied by five new construction ships offered by General Dynamics Corporation. This combination provided the best compromise among the alternatives. Although the variables could not be evaluated and weighted prior to the receipt of proposals, the alternatives had been reduced by the offerors in their proposals, and the source selection decision complexity had been reduced to a manageable level. The source selection process resulted in the selection of multiple sources that met program objectives, although the process took longer than expected.

CONCLUSION

Selection of multiple sources to satisfy program requirements can greatly complicate the source selection process. The Fast Logistic Ship (TAKRX) and Maritime Prepositioning Ship (TAKX) source selections used vastly different approaches to similar problems, and both approaches were successful in meeting program objectives. A number of

lessons can be learned from these programs. Identification of the complicating factors and analysis of the possible variations is essential to keeping the process manageable. The number of variables should be kept to a minimum. A strictly objective selection process is very difficult to structure, although it does simplify the source selection process. A subjective selection process may be necessitated by the complexity introduced by multiple sources. The many variations possible in a multiple source selection will normally be reduced to a reasonably manageable level simply because offerors will provide a limited number of options in their proposals. An important point to remember is that a relatively subjective source selection is easier to structure in advance, but generally requires more analysis and deliberation by source selection officials than does an objective procedure.

THE "SCORE" TECHNIQUE: AN ANALYTICAL APPROACH FOR ASSESSING THE RESULTS OF MANUFACTURING REVIEWS

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AD P002838

ABSTRACT

Since the early 1970's, the techniques for conducting manufacturing assessments have improved as the "lessons-learned" from each new team were passed on the next. However, one area of the manufacturing assessment process, the scoring, has remained relatively unchanged over the years. This paper presents a fresh approach to the scoring process.

The process outlined in this paper was first developed and used on the Next Generation Trainer Program. Since then, it has been applied successfully to other Aeronautical Systems Division manufacturing reviews both in Europe and the United States.

This research paper responds to the challenge posed by Deputy Under Secretary of Defense William A. Long at the 1982 Federal Acquisition Symposium. He called upon us, the acquisition research community, to develop practical solutions which solve everyday acquisition problems. The methods discussed here can be applied to other scoring scenarios such as source selection, Cost/ Schedule Criteria System (C/SCS) reviews, and related review. The technique is generally applicable to any problem whose solution can be improved by adding objectivity and traceability to an otherwise subjective scoring process.

AD P002838

INTRODUCTION

This paper describes a technique for scoring manufacturing reviews which has been used at Aeronautical Systems Division for nearly two years. It was developed during the Next Generation Trainer (NGT) Source Selection(4th Qtr, 1981) by the authors and Terry Hamilton, Captain-USAF★. The approach was given the name SCORE, an acronym for Systematic COntractor Rating and Evaluation technique.

The SCORE approach had to be sufficiently flexible to meet the challenges generated by the unique characteristics of the NGT Program. The five airframe contractors in the competition were given the opportunity to choose the engine. After the source selection, the engine was to be "broken out" as a component and purchased directly by the Deputy for Propulsion. The engine was then supplied to the winning airframe contractor as Government Furnished Aeronautical Equipment (GFAE).

BACKGROUND

Prior to the NGT program, most of the manufacturing assessments were score using variations of other scoring and reporting techniques- the color codes used in program reporting(blue, green, yellow, red), the rating system used by the Inspector General (outstanding, excellent, satisfactory, marginal, unsatisfactory), and numerical (1 to 7, 1 to 9, 1 to 10, 1 to 100, etc.). All of these approaches suffered common drawbacks. The scoring process tended to be both subjective and untraceable. The various sub-elements being scored were not systematically related to each other. A subjective approach was generally used to assure that the scores of the more important sub-elements carried more weight in the overall assessment.

The source selection approach and the time frame for completing the NGT source selection made it essential that two different government teams be fielded to perform the manufacturing reviews. Thus, it was mandatory that the scoring technique be consistent across all airframe and engine competitors. The SCORE technique was used to score the Manufacturing Management/ Production Capability Reviews (MM/PCRs) at all engine and airframe contractors. These results of the individual assessments were then combined into a single system score for each airframe/engine team. The MM/PCR evaluation results were considered as part of the overall source selection scoring process.

★ This paper is dedicated to Captain Hamilton who was tragically killed in an automobile accident in December, 1981.

The complications of the NGT Program and the need for consistency across two different manufacturing review teams caused us to rethink the previous approaches and to develop a new approach which added objectivity to the scoring process. In addition, since the manufacturing review was an MM/PCR, the approach had to include an approach for evaluating the risk associated with each contractor's approach.

APPROACH

The SCORE technique consists of five steps:

(1) Establish the work breakdown structure (WBS) for the review.

(2) Perform a Delphi analysis of the elements in the work breakdown structure to establish the weight of each element using a forced-choice, matched-pair comparison technique

(3) Consolidate all of the Delphi inputs into a composite assessment of the relative importance and weight of each element contained in the work breakdown structure.

(4) Provide the scoring system complete with the weights associated with each element, the work breakdown structure, and the description of each element of the work breakdown structure to each of the team members prior to the review.

(5) Score the review on-site, summarize, and report the results.

Each of these steps will be discussed in detail in the remainder of the paper.

STEP #1. ESTABLISH THE WBS

All activities can be represented as a hierchy comprised of its component parts. This is also true of manufacturing reviews. The exact form of the hierchy or work breakdown structure (WBS) will vary with the type and purpose of the activity. In the Air Force, manufacturing reviews tend to have related though different structures depending upon where the program is in the acquisition cycle. Figure 1 shows the WBS used on the NGT program. It reflects that NGT program was in source selection and that the manufacturing review was an MM/PCR.

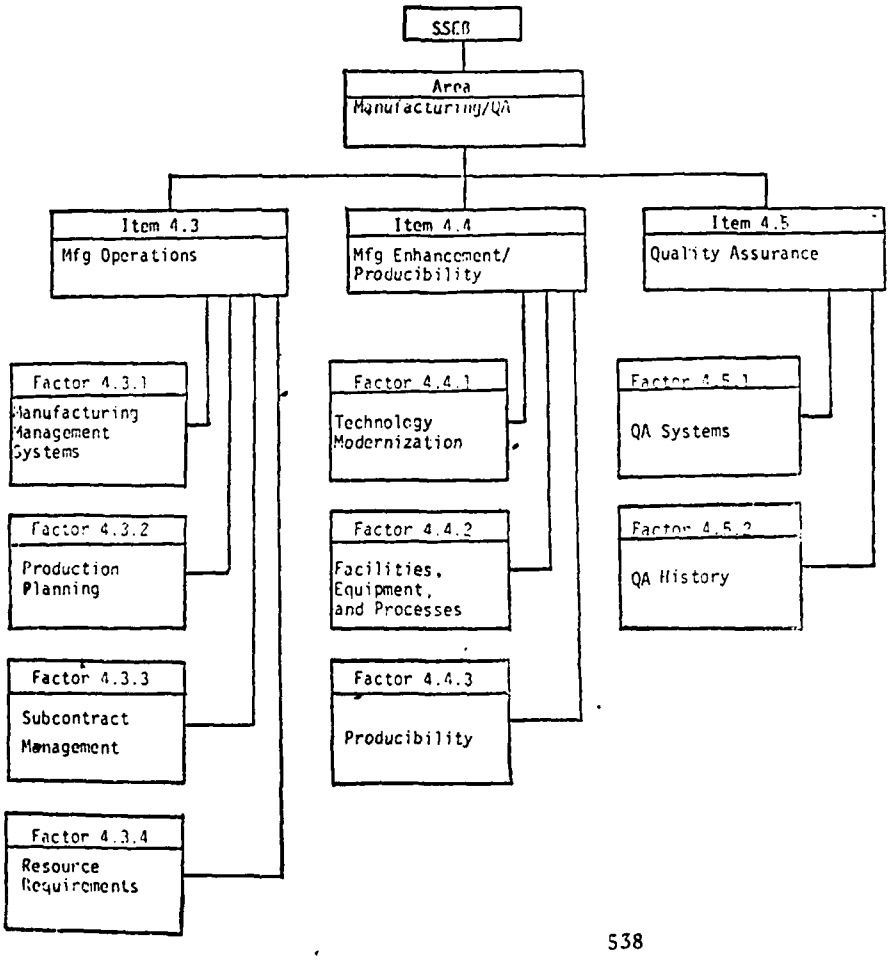


FIGURE 1. NGT WORK BREAKDOWN STRUCTURE

The Source Selection process breaks the work into Areas (the MM/PCR was performed under one single area called Manufacturing), Items under each area, Factors under each item, and Subfactors under each Factor. The Source Selection terminology was for the MM/PCR to assure that the MM/PCR results could be incorporated into the source selection evaluation without terminology changes.

A Production Readiness Review (PRR) will have a different but related work breakdown structure because it addresses later time frames in the acquisition cycle. Planning for Rate Reviews (PFRRs) are still later in the acquisition cycle and have a much narrower focus than the MM/PCR or the PRR. Thus, while the work breakdown structure for a PRR and PFRR are related to the work breakdown structure for the MM/PCR, the focus of the manufacturing review tends to narrow from a management systems planning focus to a product focus as time moves to the right in the acquisition process.

The important message from this section of the paper is to identify the elements of work and the scope of work to be accomplished under each element. In the MM/PCR, the elements of work were subfactors, factors, items, and area. Figure 2 shows the first page of the descriptions used in the NGT MM/PCR plan. These descriptions of the work effort were supplied to each person who assisted in the Delphi analysis which is step #2 of this scoring process.

STEP #2. THE DELPHI ANALYSIS

This approach uses a modified Delphi technique as a basis of determining the weight of each item, factor, and subfactor. The approach differs from a standard Delphi approach in two ways:

(1) A special form is used for the analysis. It is completed by each individual participating in the weight determination. The form forces each participant to choose the more important element (item, factor, or subfactor) when presented with a pair of elements. The choice must be one or the other of the elements; it is a forced choice. The theory behind the forced choice is that if all of the participants really have no opinion concerning the more important of two particular elements that the overall analysis will reflect the perception that the two elements are of equal weight.

(2) The analysis is performed only once by each participant. While this technique is a pooling of knowledge as is the standard Delphi approach, the cost of additional analysis was not perceived as being sufficiently beneficial. The purpose of the additional analysis by each participant is to reduce the variation among the participants. Discussions about the results with each participant revealed that no one had any major problems with the results.

Figure 3 shows a typical form which has been completed by an individual participant. This form shows the factors under management systems. Notice that it is really half of a matrix with the diagonal missing. It is set up in this manner because a comparision of factor A, Business Plan with itself is nonsense. Furthermore a comparison of factor A, Business Plan, with factor B, Management Systems should be the same result as comparing Factor B, Management Systems, with factor A, Business Plan. The object of each participant is to decide which of the two factors being compared is more important. There are not "right" answers, but the opinions do end up being nicely clustered. Individual biases tend to cancel each other so that the composite result of the responses from all participants provides a good basis for quantitatively weighting the subfactors, factors, and items. The results from Figure 3 are shown below.

Factor	Score
A. Business Plan	0
B. Management System	2
C. Work Measurement System	1
D. Concurrency/Risk Analysis	3
TOTAL	6

SECTION VIIA. AIRFRAME FACTOR/SUBFACTOR DESCRIPTION

ITEM: 4.3 Manufacturing Operations

FACTOR: 4.3.1 Manufacturing Management Systems

DESCRIPTION: This factor involves the assessments of the offeror's management philosophy and management systems to include the offeror's Business Plan, Work Measurement System, and risk analysis.

SUBFACTOR: 4.3.1.1 Business Management

DESCRIPTION: This subfactor addresses the offeror's corporate management structure and operations. It encompasses the offeror's actual and projected business base, past performance, actual resource requirements, program risk, and concurrent production. Specific topics which will be emphasized are:

a. Offeror's Experience. The offeror's performance over the past five years on systems of comparable size/complexity relative to the proposed NGT aircraft. It will include a review and analysis of contract types, delivery versus contract schedule:, manufacturing problems encountered during production, and the action taken to prevent future occurrences.

b. Master Development Plan. Includes the offeror's total current and projected business plans/schedules covering the next five years. It will assess the offeror's planning regarding the integration of the NGT workload into the total plant production.

c. Total Resource Requirement/Availability. Examine the offeror's planning to identify future resource requirements for both firm and projected business and the methods to be used to insure they are available.

d. Concurrency and Risk. Addresses how the contractor proposes to manage a program when faced with concurrent R & D and production work and the proposed method of management to insure compatibility with current company practice. It also includes the evaluation of what the offeror considers to be the program risks or areas of concern associated with integrating the aircraft system into the overall plans and schedules of the company. Also, if any risks are identified, what can be done to minimize or eliminate the risks.

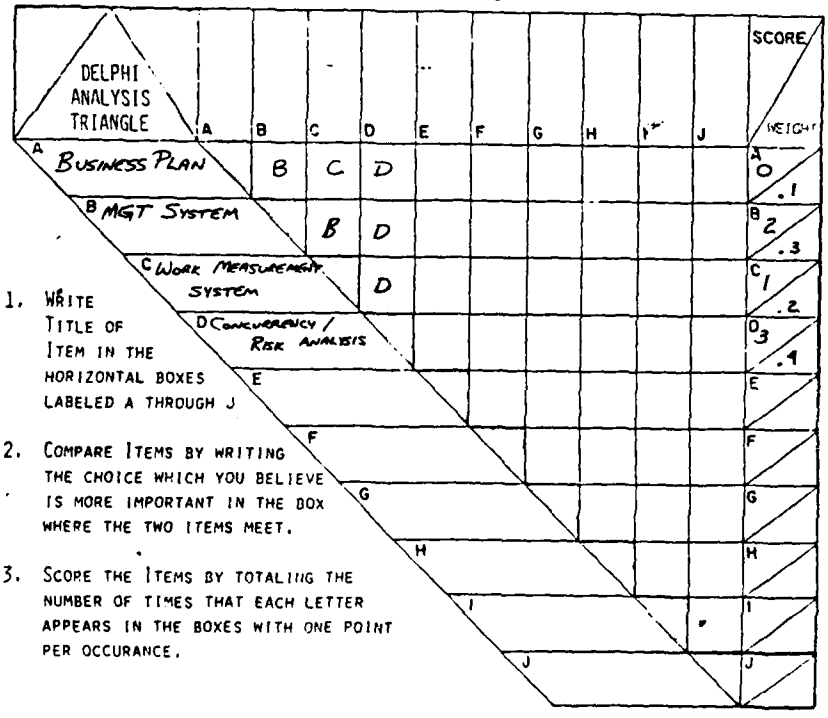
SUBFACTOR: 4.3.1.2 Manufacturing Management

DESCRIPTION: This subfactor assesses the offeror's total manufacturing organization and how it integrates with other functional disciplines. Specific topics to be highlighted are:

FIGURE 2. FIRST PAGE OF THE NGT SUBFACTOR DESCRIPTION

FIGURE 3. DELPHI FORM

DELPHI ANALYSIS WORKSHEET



STEP #3. CONSOLIDATING THE RESULTS

It should be intuitively obvious that a zero score for the business plan in Figure #3 does not imply that the business plan is of no importance to the participant. Under most conditions, the use of at ten participants will tend to eliminate a zero score for any single factor. However, it is possible to obtain a zero score for any particular element. When that occurs, it will be necessary to follow a procedure which eliminates the zero score so that the weighting process provides the appropriate weight to areas having a zero raw score. In an attempt to reduce the calculations shown in this paper while demonstating the process of weighting when a zero raw score occurs, the results from Figure three will be used to derive a set of weights. Please, note that under normal conditions, the weighting is not performed on the individual results. It is performed using the results from the entire participating group (See Figure 4).

In order to eliminate the zero score, it is necessary to add one to each factor. This does not change the overall results, but it does provide a baseline for the zero score. This changes the results in Step #2 to become:

Factor	New Score
A. Business Plan	1
B. Management System	3
C. Work Measurement System	2
D. Concurrency/Risk Analysis	4
TOTAL	10

To establish the weights for our participants data, simply divide each score by the total as shown below:

Factor	Weight
A. Business Plan	.1
B. Management System	.3
C. Work Measurement System	.2
D. Concurrency/Risk Analysis	.4
TOTAL	1.0

Normally, this operation is performed by summing the scores of all participants and dividing by the total as shown in Figure 4. The method is the same whether it is performed for the group or an individual. The sum of the weights must always be one. This is a good cross-check for arithmetic errors.

STEP #4 PROVIDE SCORING SYSTEM TO TEAM

Once the weights have been determined, they should be included in the plan for the manufacturing review. This plan includes a graphic portrayal of the WBS structure, descriptions of each item, factor and subfactor, and a description of how the scoring system works.

The rating system provides a means of readily identifying the strong and the weak areas in a contractor's plant. Each subfactor is rated. The subfactor ratings are then integrated into a factor rating, the factor ratings are integrated into an item rating, and the item ratings are consolidated into an area rating. On the NGT program, the area ratings for the engines and the airframe were combined into a system score.

There were seven different possible ratings:

NUMERICAL SCORE	COLOR CODE	DEFINITION
1	RED	Unsatisfactory
2	YELLOW	Marginal leaning towards Unsatisfactory
3	YELLOW	Marginal leaning towards satisfactory
4	GREEN	Satisfactory with weaknesses
5	GREEN	Fully Satisfactory
6	GREEN	Satisfactory with major strengths
7	BLUE	Excellent or superior, at the state of the art and above the industry norms; the strengths are easily and readily identified.

AIRFRAME:

REVIEWER	4.3.1	4.3.2	4.3.3	4.3.4	4.4.1	4.4.2	4.4.3	4.5.1	4.5.2
1	7	8	3	4	0	1	2	6	5
2	3	6	1	7	0	6	6	5	2
3	3	8	5	1	4	0	5	6	4
4	8	5	5	4	1	2	5	6	0
5	5	7	3	6	2	4	0	8	1
6	3	6	5	1	0	2	4	8	7
SUBTOTAL	29	40	22	23	7	15	22	39	19

ENGINES:

REVIEWER	4.3.1	4.3.2	4.3.3	4.3.4	4.4.1	4.4.2	4.4.3	4.5.1	4.5.2
1	0	8	7	6	1	5	4	3	2
2	8	7	3	5	6	4	1	2	0
3	6	4	5	4	1	2	3	3	8
4	8	3	6	4	0	3	1	7	4
5	6	8	1	9	2	1	5	4	0
6	3	8	2	1	7	5	4	6	0
7	7	6	2	5	1	4	3	8	0
8	3	6	5	1	0	2	4	8	7
9	7	7	2	4	1	3	7	4	1
10	8	6	1	5	3	7	3	3	0
11	5	4	3	8	2	7	1	6	0
SUBTOTAL	61	67	37	52	24	43	36	54	22
TOTAL	90	107	59	75	31	58	58	93	41
WEIGHT FACTOR	.15	.18	.10	.12	.05	.09	.09	.15	.07

FIGURE 4. CONSOLIDATION OF PARTICIPANT'S RESPONSES

Risk assessment is normally only part of an MM/PCR. In the NGT MM/PCR four different levels of risk were used:

RISK	RISK FACTOR	RISK VALUE
None	1.00	1
Low	.95	2
Moderate	.83	3
High	.67	4

The risk shows the relative likelihood of success. No risk corresponds with a 91%-99% chance of success, a low risk corresponds with a 76%-90% chance of success, a moderate risk corresponds with a 61%-75% chance of success, and a high risk corresponds with below a 60% chance of success. The risk value provides a numerical value which is used to modify the score for the subfactors to include the impact of risk. The high risk factor will cause the numeric value to change two levels. For example, a score of five will become a score of three if a high risk is present. A moderate risk factor will cause the numerical score to change one level; if the score is five under the influence of a moderate risk, the score will become four. Under a low risk, the score is only slightly reduced, and under no risk, there is no change in the numerical score.

The use of this system has caused the authors to recommend some changes from the risk approach used on the NGT. Currently, all of the Deputy for Propulsion MM/PCR plans identify a three level risk program:

RISK	RISK FACTOR	RISK VALUE
Low/None	1.00	1
Moderate	.83	2
High	.67	3

The reason for the change is that, in-practice, most people have difficulty in distinguishing the Low level of risk from None. Some people will argue that there is no subfactor which has no risk associated with it. The three level system retains the same basic characteristics as the four level system with the advantage of greater simplicity. The risk value provides a means of integrating the engine and airframe into a system score.

The one-up/ one-down rule allows for judgment to be exercised at each review level in the case of marginal scores. Each reviewer has the right to move marginal scores up one color code or down one code. This rule may only be used when a score is borderline-high red/low yellow, a high yellow/low green, and a high green/low blue. Any change made by the reviewer must be justified in writing. This provides some latitude for judgement if it is necessary. In our experience, this rule has never had to be applied; but it is there if it is needed.

STEP #5 INTEGRATE AND REPORT THE SCORES

The final step in the scoring process is to score each subfactor, integrate the scores to the factor, item, and area levels, consolidate the area level scores for engines and airframes into a system score, and report the findings to the appropriate authority. The scoring of each subfactor and the risk associated with it is performed by the government evaluator. The evaluator completes the factor scoring worksheet which is shown in Figure 5.

The risk values are used only when the two area evaluations are to be combined to form a system area evaluation. For example, on the NGT the engine and airframe evaluations were combined into a single system evaluation for the manufacturing area. Otherwise, the risk values need not be maintained in the SCORE system. Moreover, the scoring of risk is not always accomplished in manufacturing reviews. Neither risk factors nor risk values should be included when using SCORE for evaluating production readiness reviews and planning for rate reviews.

Figure 5 shows how four subfactors, 4.3.1.1. through 4.3.1.4, can be combined into a single factor score. At the subfactor level, the raw score is multiplied by the weight and the risk factor to obtain the weighted score. The weighted scores for each subfactor are then summed to obtain the factor score. The similar approach is used to calculate the risk value at the

FACTOR: FACTOR SCORE WORKSHEET

BLOCK 1: RAW SCORE RANGE

UNSATISFACTORY	MARGINAL	SATISFACTORY	EXCELLENT
RED	YELLOW	GREEN	BLUE
1	2,3	4,5,6	7

BLOCK 2: RISK ASSESSMENT

RISK	NONE	LOW	MODERATE	HIGH
RISK FACTOR (Rf)	1	.95	.83	.67
RISK VALUE (Rv)	1	2	3	4

BLOCK 3: FACTOR COMPUTATIONS

SUBFACTOR	RAW SCORE		WEIGHT		Rf		SCORE
4.3.1.1	5	X	.33	X	.95	=	1.5675
4.3.1.2	6	X	.30	X	1	=	1.8
4.3.1.3	4	X	.27	X	.83	=	.8964
4.3.1.4	6	X	.10	X	.95	=	.57
		X		X		=	
FACTOR SCORE							4.8339

Rv		WEIGHT		TOTAL
2	X	.33	=	.66
1	X	.30	=	.30
3	X	.27	=	.81
2	X	.10	=	.20
	X		=	
FACTOR (Rv)				1.97

FIGURE 5. FACTOR SCORING SHEET

AIRFRAME/ENGINE ITEM SCORING WORKSHEET

FIGURE 6. ITEM SCORING SHEET

BLOCK 1: GENERAL INFORMATION

ITEM:	CONTRACTOR:
ITEM EVAL:	

BLOCK 2: COMPUTATIONS

FACTORS	FACTOR SCORE		WEIGHT		SCORE
4.3.1.	4.8339	X	.27	=	1.3052
4.3.2.	5.3234	X	.32	=	1.7055
4.3.3.	6.1892	X	.18	=	1.1141
4.3.4.	5.2372	X	.23	=	1.2046
ITEM SCORE					5.3274

FACTOR RISK VALUE Rv		WEIGHT		TOTAL
1.97	X	.27	=	.5319
1.23	X	.32	=	.3936
1.68	X	.18	=	.3024
1.13	X	.23	=	.2599
ITEM Rv				1.4878

factor level. The risk value at the subfactor level is multiplied by the weight and the products are summed to obtain the factor level risk value.

This approach works because the weights all sum to one. Thus the weights retain all of the properties of a probability distribution. The risk factor does not change the relationships since it is actually modifying the raw score. The risk factor causes the raw score to be compensated for risk by being lowered. This approach does not differ significantly from the approach which a rater might take under a totally subjective scoring system. However, it does supply discipline and repeatability to the process.

The factor scores are combined into item scores by multiplying each factor score by its weight and summing the product. Item scores are combined into area scores in a similar manner. Figure 6 shows how factor scores are combined into an item score while Figure 7 shows the combination of the item scores into an area score.

Subfactors rated as red and yellow must have a discussion of the weaknesses, risks, and areas requiring improvement. Subfactors rated as green may have a discussion of strengths and weaknesses. Subfactors rated as blue must have a discussion of the strengths. Viewgraphs showing the strengths, weaknesses, and risks are prepared by the factor evaluators. The factor evaluators will combine the subfactor scores into a single factor score.

Figure 8 shows how the engine and airframe scores were combined into a composite score. The theory of combining the scores rests upon an assessment of risk and its relationship to program success. The concept is based upon the assumption that the portion of the system which has the higher risk should have the higher score weight because that element will have the greatest impact upon program success. In Figure 8, the airframe has the higher risk value. The equation shown in the low score weight is based upon a linear relationship which establishes a 50%-50% weight if the risk values are equal and 100%-0% weight if one component of the system has a risk value of one and the other component of the system has a risk value of four. The low score weight is determined in Block 3 using the equation shown. Note that if a three level risk approach is used, the equation must be changed to:

Low Score Weight=.25(LSRV-1)+.5

where LSRV is the low score risk value

The calculation of the high score weight remains the same as is shown in Block 4. The system area score is calculated by multiplying the high score by its weight and adding that to the product of the low score and its weight.

NEW APPLICATIONS OF SCORE

The SCORE technique offers a practical approach which can be used for bringing objectivity and traceability into any set of subjective decisions or scoring criteria.

Applications to source selection and C/SCS reviews are intuitively obvious. Less obvious, but still useful is the application of the SCORE weighting approach to the problem of determining the best force structure mixtures. This application uses the modified Delphi approach used in SCORE to obtain a set of objective assessments from senior military officers. It would then be used to pool the collective knowledge of the military officers for specific military scenarios, threat combinations, and methods of countering the threats.

The Modified Delphi approach used in SCORE has also been applied to rating personnel within Aeronautical Systems Division and establishing project priority precedence in the Air Force Wright Aeronautical Laboratories. The system has also been applied to manufacturing reviews on the Lantirn Program, and the F-16 Radar program.

II. DETAILED REPORT

AIRFRAME/ENGINE AREA SCORING WORKSHEET

BLOCK 1: GENERAL INFORMATION

FIGURE 7. AREA SCORING SHEET

AREA: MANUFACTURING/QUALITY ASSURANCE	CONTRACTOR:
TEAM DIRECTOR:	

BLOCK 2: COMPUTATIONS

ITEMS	ITEM SCORE		WEIGHT		SCORE
4.3	5.3274	x	.54	=	2.8768
4.4	4.6572	x	.24	=	1.1177
4.5	5.7230	x	.22	=	1.2591
AREA SCORE					5.2536

ITEM RISK VALUE Rv		WEIGHT		TOTAL
1.9878	x	.54	=	.8034
2.6045	x	.24	=	.6251
1.2320	x	.22	=	.2710
AREA Rv				1.6995

FIGURE 8. COMBINING THE ENGINE AND AIRFRAME SCORES

BLOCK 1: GENERAL INFORMATION

AREA: MANUFACTURING/QUALITY ASSURANCE	CONTRACTORS
AFD TEAM DIRECTOR:	AIRFRAME:
YZD TEAM DIRECTOR:	ENGINE:

BLOCK 2: AREA SCORE/RISK VALUE

AREA SCORES		RISK VALUE (RV)
AIRFRAME:	4.3129	2.0500
ENGINE:	5.2536	1.6995

BLOCK 3: LOW SCORE WEIGHT

LOW SCORE WEIGHT = .1667 (LOW SCORE RISK VALUE -1) +.5
LOW SCORE WEIGHT = .1667 (2.05 -1) +.5
LOW SCORE WEIGHT = .6750

BLOCK 4: HIGH SCORE WEIGHT

HIGH SCORE WEIGHT = 1 - LOW SCORE WEIGHT
HIGH SCORE WEIGHT = .3250
HIGH SCORE WEIGHT = .3250

BLOCK 5: SYSTEM AREA SCORE

SYSTEM SCORE = (HIGH SCORE X HIGH SCORE WEIGHT)+(LOW SCORE X LOW SCORE WEIGHT)
SYSTEM SCORE = (5.2536 X .325) + (4.3129 X .675)
SYSTEM SCORE = 4.6457

SUMMARY

The challenge of planning and executing the Next Generation Trainer Program Manufacturing Management/ Production Capability Reviews (MM/PCRs) resulted in a new scoring system which applied a Delphi Type approach to establishing weights. The scoring system responded to the requirement to assess risk during an MM/PCR and met the complications posed by the requirement to fully integrate the engine MM/PCR scores with the scores from the airframe for each of five different airframe proposals and the necessity to integrate the results of each of the MM/PCRs conducted at both the engine and airframe manufacturers with the results of the source selection evaluation. The result of meeting those challenges is a scoring approach called SCORE. It has become a standard approach for scoring manufacturing reviews at Aeronautical Systems Division.

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