PROGRAM MANAGER

(11)

CONTENTS

PROGRAM MANAGER

JOURNAL OF THE DEFENSE SYSTEMS

Program Manager is intended to be a vehicle for the transmission of information on policies, trends, events, and current thinking affecting program management and defense systems acquisition.

Statements of fact or opinion appearing in *Program Manager* are solely those of the authors and are not necessarily endorsed by the Department of Defense or the Defense Systems Management College. Unless copyrighted, articles may be reprinted. When reprinting, please credit the author and *Program Manager*, and forward two copies of the reprinted material to the Director of Publications.

To subscribe, government personnel should submit written requests (using their business addresses) to the Director of Publications.

Manuscripts and other correspondence are welcome and should be addressed to the Director of Publications. Inquiries concerning proposed articles may be made by phone at (703) 664-5082/-5974 or AUTOVON 354-5082/-5974.

Vol. XVI, No. 3
DSMC 78
May-June
1987

MANAGEMENT COLLEGE

Cover: The B-1B can deliver large weapon payloads over intercontinental ranges, penetrating sophisticated defenses at very low altitudes and very high speeds.

Cover background: The J79 engine was developed as a reliable, high-thrust, low-weight, mechanically simple, jet engine to perform efficiently at Mach 9 cruise and Mach 2 combat speeds. More than 17,000 J79s and the commercial version CJ805 have been built since the first flight test in 1955.

Stock #708-045-00015-2
Price: $3.00

Also

Program Manager (ISSN 0199-7114) is published bimonthly by the Defense Systems Management College, Fort Belvoir, VA 22060-5426. Non-government employees and organizations may subscribe at $17 annually through the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Second class postage paid at Fort Belvoir, VA.

POSTMASTER: Send address changes to *Program Manager*, Defense Systems Management College, Fort Belvoir, VA 22060-5426.

COVER STORY

B-1B PROGRAM IN PERSPECTIVE

General Lawrence A. Skantze, USAF

Many of you will recall that on October first of last year, I appeared before the Pentagon Press Corps to announce that the Air Force had placed the first B-1B on operational alert according to a plan laid out 5 years earlier. This significant milestone in our nation's quest for a modern penetrating bomber—a quest that spans most of my 28 years in weapon system acquisition—was accomplished on schedule, but not without a certain amount of risk and a certain amount of pain.

Acquiring the B-1B, or any other weapon system for that matter, entails developing, testing and producing new technology. In any high-tech endeavor, the defense acquisition team faces a continuous challenge: that of managing risk, whether it be technical, cost schedule, or all of the above. The B-1B, a vital element of President Reagan's strategic modernization program, provides a timely lesson in the art of risk management, and we have a B-1B today, thanks to a significant risk management decision made in 1981.

The Triad

In the late stages of the previous Administration, there was a strong consensus that the nation needed to modernize the bomber leg of the strategy triad. The Congress recognized this need as early as 1980 and, in the FY 81 Defense Authorization Act, directed the Secretary of Defense to develop a multirole bomber for both nuclear and conventional missions. The Congress directed us to bring that bomber on line as soon as practicable, but not later than 1987. I was the commander of the Air Force Aeronautical Systems Division then and thus became immediately and heavily involved in the alternative studies that the Congress directed beginning in the early Fall of 1980. The Congress told us to look at the B-1, derivatives of the B-1, derivatives of the FB-111, or a new Technology Bomber.

The new Administration immediately picked up the challenge to implement the new bomber program. Our goal was a single new bomber which could *rapidly* redress a growing strategic imbalance and provide an *enduring* capability to penetrate Soviet defenses.

Photo courtesy Rockwell

As production schedules were being met to deliver the first B-1B off the line in the fall of 1984, U.S. Air Force and Rockwell test pilots conducted a rigorous flight test program.

Based solely on its projected capabilities, the advanced technology bomber, or ATB, easily would have been the choice in a one-bomber approach. In the Spring of 1981, Defense Secretary Caspar Weinberger, General Richard Ellis, then CINCSAC, and I discussed the bomber issue at Strategic Air Command Headquarters, Omaha, Neb. We recognized the dramatic potential of the ATB, but we also recognized that, first and foremost, we needed time to reduce a number of major technical risks to assure ourselves that the ATB could be designed and engineered successfully.

The Bomber Leg

There was little hope of seeing the emergence of a viable ATB force before the early 1990s. In the final analysis, the only way to modernize the manned bomber leg quickly was to build a limited number of highly-effective B-1Bs, deploy them as rapidly as possible and, in effect, buy the time for ATB development; the B-1B, alone, could not provide the long-term enduring penetration capability that an ATB offered.

That's the background for why this Administration proposed the two-bomber program: 100 B-1Bs for a highly-capable, near-term modernization and as a hedge against ATB technology uncertainty; and the ATB for the long-term capability. That decision, like all major acquisition programs, carried with it the management of a significant degree of risk. For the ATB, the management focus was to attack the unknown risks in the technology to establish a firm base to ensure we could move into full-scale development and production on a confident and predictable basis. In the case of B-1B, we decided on a totally concurrent development and production program to expedite the fielding of the system and minimize the acquisition cost.

In January 1982, I signed both the B-1B development and production contracts and we began a challenging production schedule; specifically, to deliver all 100 aircraft by June 1988. Our plan was twofold: rapid development and production of 100 B-1Bs with an initial operational capability in 1986 for a cost of $20.5 billion in constant 1981 dollars; and, in parallel, long-term risk reduction, development and production of 132 ATBs to be deployed in the early 1990s. That was our plan in 1981. It remains our plan today. It will be our plan tomorrow.

Where Do We Stand?

Where does the B-1B program stand today? We have all 100 B-1Bs on contract. We achieved the initial operational capability in September, on schedule. To date, we have delivered 34 aircraft, on schedule.

The major program challenge *was* and *still is* meeting the production schedule. Eighty-four percent of the $20.5 billion, which is a Presidentially certified and Congressionally imposed cost cap, is devoted to production. We currently spend $500 million per month on production. At that rate, a slip of even 1 month means big financial trouble. So, production demands intense and constant management attention. For example, had we elected to delay the production contract for 1 year past development start and hold the production rate at three aircraft per month, as opposed to four, we certainly would have reduced the overall risk associated with high concurrency. But, we would have increased the cost by about $3 to $4 billion and delayed the achievement of the full operational capability by 1 year and 7 months.

It's impossible to overstate how much planning and management effort went into making the four aircraft per month rate happen. We went from one aircraft per month to four aircraft per month in less than 1 year and achieved rate in November 1986, as planned. In fact, we delivered five aircraft in December. There was great risk. For example, final checkout and assembly was tough. To contain costs, we had to reduce checkout time from 3.5 months, for the first aircraft, to 20 days, at rate production. And we did it. Had we not achieved this reduction in checkout time, stretchout costs could have grown by more than $1 billion. Meeting rate production is a significant achievement for the more than 3,000 contractors involved in the program and something in which they, and we, can and do take great pride.

This is adapted from an address given to the National Press Club the past February by General Skantze, USAF, Commander, Air Force Systems Command.

Below: Workers ready the right forward fuselage section of the first B-1B for mating. The section is being built at Rockwell's Palmdale, Calif., plant.

Photos courtesy Rockwell

Above: Employees wire the forward-intermediate fuselage section, built at the company's Columbus, Ohio, facility.

Lightweight carbon fiber-wound rotary launcher for B-1 bomber provides precise weapon positioning and super-strength to withstand inflight bending and shear loads.

It is truly a great defense industry production story which I hope will be told someday.

Maturation

The question raised in the media, and I'm sure on your minds, is: Are we delivering B-1Bs today that are as capable as we had planned? Frankly, no. The B-1B is not yet as capable as we had planned. However, we are absolutely confident that as the aircraft matures, it will be. Even given its maturation problems, as it sits on alert right now at Dyess Air Force Base, Texas, the B-1B is the best strategic bomber in the world, capable of meeting the threat it faces today, and ready to perform its mission. The B-1B can deliver large weapon payloads over intercontinental ranges, penetrating sophisticated defenses at very low altitudes and very high speeds. The Soviets are well aware of this.

Not surprisingly, most problems we have experienced relate to areas where we changed the B-1A design. When we embarked on the B-1B program, we purposely, and very wisely, incorporated new technology and design changes in selected areas to increase capability and survivability. In some of these areas, results have already been successful; in other areas, we've experienced what I characterize as development problems and delays in achieving the full capability of the system. We are finding and fixing problems in the test program which is what a test program is for. It has simply taken longer to mature the system than we had planned. Here are the facts.

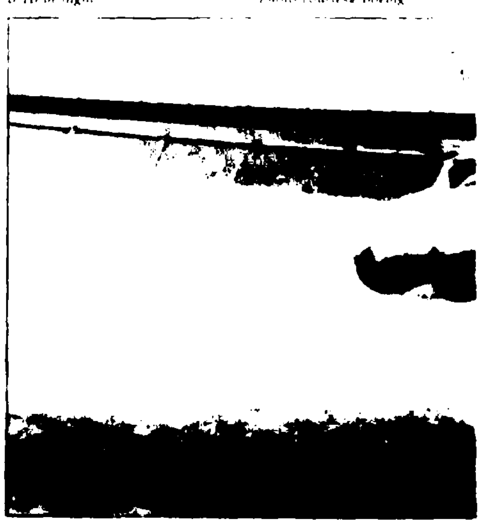
One of the changes made in the design of the airframe was to increase its gross weight capability to permit it to carry cruise missiles externally in addition to internal weapons. We did this very deliberately so that when the threat increases to where the B-1B is no longer an effective penetrator, it can perform the role of a standoff Cruise Missile launch platform. The same thing was done with the B-52. I might add that had we built the B-1A, we would have eventually modified it to carry Cruise Missiles and also would have increased its gross weight to do so. Specifically, the empty weight of the B-1B was increased by about 7,000 pounds to beef up its structure to carry the added weight of Cruise Missiles. As a result, the weapon payload was increased from 75,000 to 125,000 pounds and its fuel capacity with maximum payload was increased by 25,000 pounds. This 82,000 pound increase in gross weight was possible because the B-1A had excess energy over that required for the low altitude, high subsonic penetration mission of the B-1B.

Low Altitude Penetration

As so-called evidence that this gross weight capability increase is bad, some critics point out that the plane can't fly as high as a B-52 or even a 747. That's absolutely true, but I would add quickly that a B-52 or a 747 can't fly as low and as fast as a B-1B. The point is the B-1B was designed as a low, not high, altitude penetrator and was optimized for that mission with a penetration speed 50 percent greater than that of the B-52. The bottom line is that the aircraft meets the weight and range specifications we contracted for.

About a year after we signed the contracts, when we began evaluating flight test performance, we recognized that we could take advantage of the available lift at higher angles of attack, where the B-1B does not have pronounced stall warning, through the development of a stall inhibit system. Later, we started developing the stability enhancement function which allows the aircraft to operate safely in regions beyond the inherent design capability. This will not only increase

B-1B in flight Photo courtesy Boeing



performance throughout the operational flight envelope, but will significantly add to our ability to operate at very high gross weight during terrain following, thus increasing range over that specified in the contract. The contractor agreed to do the improvement within the cost baseline, though it is primarily needed for Cruise Missile carriage gross weight missions which are some years away.

We wanted to have the stall inhibit system in the aircraft last September and the stability enhancement function about a year later. Regrettably, development of both has lagged. The Strategic Air Command will have the stall inhibit system capability in April, and we will complete retrofit of the first 16 aircraft by the end of the year. We will begin flight test of the stability enhancement function this spring and should complete testing in early 1988.

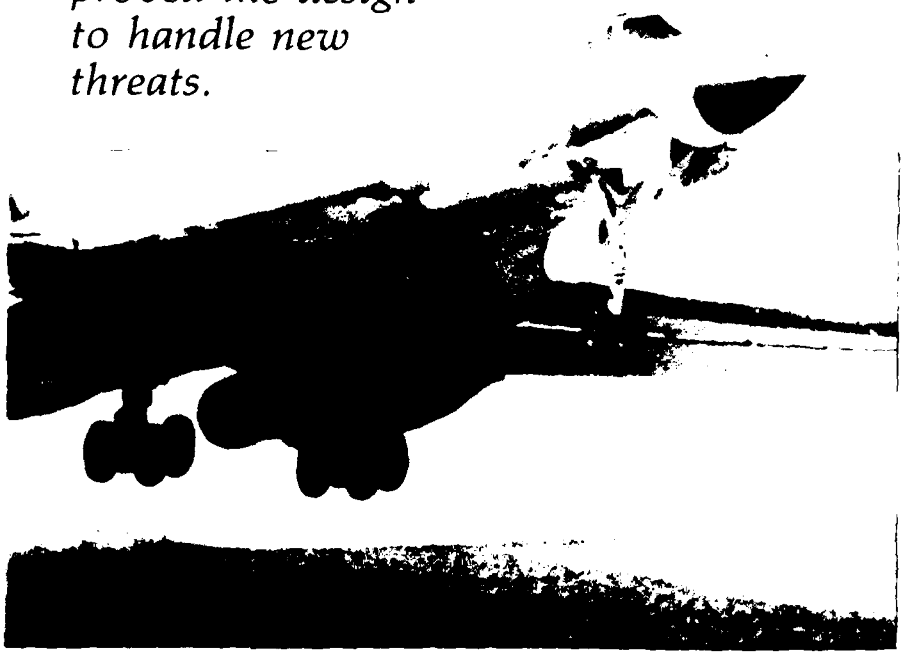
We took the electronic countermeasure system from the B-1A and redesigned it to incorporate lessons learned....and improved the design to handle new threats.

Survivability

We made another major change in the B-1A airframe to increase survivability. We reduced the radar cross section by a factor of 10 over the B-1A and 100 over the B-52. We redesigned various areas of the aircraft, including the engine nacelles, using technology developed in the Stealth program. The redesign was totally successful, with no degradation in aircraft performance.

We incorporated a new offensive avionics suite in the B-1B. The 1960 vintage F-111 radar in the B-1A was replaced with a new, state-of-the-art derivative of the F-16 radar, and new avionics based on the B-52 developed avionics system were added. The result is increased capability and unparalleled navigation and weapon delivery accuracy, with sharply reduced radar emission signature. The offensive avionics development has been a great success.

Another innovation was to use this same F-16 radar derivative not only for navigation but for terrain following. While this approach reduces cost and the amount of electronics, it adds to the software complexity. However, software, once developed, doesn't break like hardware. Again, this was another risk-management decision made to balance aircraft cost, schedule, and performance. As some of you know, development of this software proved to be a very tough integration job—which is nearly complete. However, we are late in releasing the automatic terrain following capabiltiy to the Strategic Air Command for routine training. It should be noted that all of the aircraft at Dyess Air Force Base have had terrain following capabilty for wartime use since September. We have demonstrated that the system works and have flown it repeatedly at low altitude and high speed as designed, and we will release the capability for training to the Strategic Air Command this month.



The Challenge

This brings me to the most ambitious development challenge we undertook in the B-1B program—the electronic countermeasure system (ECM). We took the ECM system from the B-1A and redesigned it to incorporate lessons learned from the bomber penetrativity evaluation that was conducted after the cancellation of the B-1A production. We improved the design to handle new threats.

That task entailed taking a system with 88 black boxes weighing more than 5,000 pounds, and increasing it to 118 black boxes weighing less than 5,000 pounds. This is the first totally integrated and the largest electronic countermeasure system we have ever attempted. By comparison, the latest ECM system we developed for the B-52 has 23 black boxes. Clearly, this area was the greatest challenge from a program concurrency standpoint and, quite simply, development is not complete. But, ECM development and upgrades never end anyway!

Our ECM problems fall into two categories. First, although each of the black boxes checked out individually, they don't function well as a system. This is the integration problem I mentioned earlier. Secondly, electronic countermeasures are always a cat and mouse game—you have to know a great deal about the threat in order to counter it. The first thing we collect about an electronic threat is its tramsmitted signals. But, to counter it effectively, we need to know about, or make judgments about, the receiver, processor and logic of the radar operations. In the absence of hard intelligence, we have to make assumptions. Once we get the good information, we sometimes find we are surprised. That's partially the case with the B-1B. Fortunately, and for that very reason, we designed the B-1B system to be very flexible and reprogrammable so that we can respond to changes in the threat. It is important to understand that the design of the ALQ-161 defensive avionics system is sound and constitutes the most flexible, robust ECM system we have ever built. There's a consensus among experts who have examined it that it will achieve the expected performance.

Large and Complex

The early focus in the program was on the production challenge. The AIL division of Eaton Corporation had an excellent technical reputation, but no one had ever attempted to build such a large, complex electronic countermeasure system on an accelerated production schedule. There was real concern that the defense industrial base could not provide the required numbers of high-quality radio frequency (RF) components such as high-frequency traveling wave tubes to support the program's rate production needs. Because the production contract with AIL is roughly 10 times the magnitude of the development contract; because the system worked so well in the laboratory tests; and because of the industrial base concerns that I just mentioned, our focus was properly on production. As we began flight testing the more sophisticated aspects of the system, the problems became evident—starting in February 1986.

There is no question that we have been disappointed in our ECM development progress to date, but I am equally confident we have a good game plan to mature the system and we will achieve the design capability. I'm confident because some of the best minds in the country, some very skeptical, have taken independent looks at the system. They've concluded our recovery plan is solid and the system design is sound. I might add that there have been a number of excellent recommendations to improve the get-well plan, all of which are being implemented. A three-step maturation process lies ahead. Capability is increased with each step, beginning this summer and ending in about 2 years.

Fuel Leaks

The last problem area I want to discuss is fuel leaks. We made no basic change in the design of the fuel containment system between the B-1A and the B-1B. The B-1 uses a design concept called "integral fuel" tanks to contain fuel in which the aircraft structure is also the "fuel tank." There are no internal bladders or tanks, only the structure. This design is used in most modern aircraft, but not as extensively as in the B-1B. Why this concept instead of bladders? Bladders would decrease the range of the aircraft by 10-30 percent. That, in turn, would require a larger and more expensive aircraft to meet the range requirement. This decision, like others, was made to balance cost, schedule and technical risk.

In the Fall of 1985, the B-1B at Dyess Air Force Base began to experience fuel leaks at a higher than anticipated rate. All aircraft, paticularly those with integral tank designs, develop leaks. Most of the leaks, 69 percent to date, have been what I termed in October as "weeps and seeps." So far, we have experienced only two leaks that would have prevented immediate wartime use. Nevertheless, the minor leaks are a problem.

In July of 1986, as I stated last October, the leaks were seriously impacting the flying operations at Dyess Air Force Base. The leaks prevented us from flying when we wanted to. Although we had taken a number of actions to correct the problem beginning in the Fall of 1985, we intensified our efforts in the Summer of 1986 and continue with monthly manufacturing audits to ensure that corrective actions are implemented. As a result, fuel leaks no longer seriously impact flying operations. That's not to say that we don't have some minor leaks, but the number of leaks is decreasing as the aircraft matures. For example, in July 1986, we were experiencing 6.25 leaks per aircraft per month; in January 1987, the rate was less than two leaks per aircraft per month. By way of comparison, the leak rate for the B-52 was still at one leak per month 13 years after delivery of the last aircraft.

Balanced Reporting

That sums up the B-1B major problems but, since I know the media likes balanced reporting, I want to point out some areas which have plagued other aircraft that the B-1B has *not* experienced; i.e., take the F-101 engine. As far back as I can remember, new aircraft have experienced engine problems. The P-51, B-29, B-52 and our modern fighters have had problems with engines that, in some cases, caused loss of aircraft. The B-1B hasn't had these problems. Its engine is not only meeting all specification requirements but, in fact, has a higher thrust and lower specific fuel consumption than contracted for. A second "non-problem" that comes to mind is cost. We are confident that all of the problems that I have discussed can be corrected within the $20.5 billion cost cap.

Our nation's military capability is dependent, absolutely so, on developing and fielding the highest technology systems our scientific base can offer.

I must admit, however, that support for the B-1B cost cap has been a severe disappointment. When we committed to the $20.5 billion in FY81 dollars in late 1981, we were criticized by the Congress and the Government Accounting Office during the 1982-83 congressional cycle. I know, because I was the Air Force Deputy Chief of Staff for Research, Development and Acquisition. In testimony on Capitol Hill, I was asked, point blank, when the Air Force would own up to the fact that we couldn't do the program within the cap. By 1984-85, the charge became, "You have too much money in the program," and despite our insistence that we needed the contingency funds for our high program concurrency risk, a little more than $1 billion was removed from the program in fiscal 1986 with the promise, "Well, if you need some more later come back and ask us." Thus, to tout the FY88 request as additional costs for the B-1B is a cheap shot.

B-1B on assembly line

Managing Risk

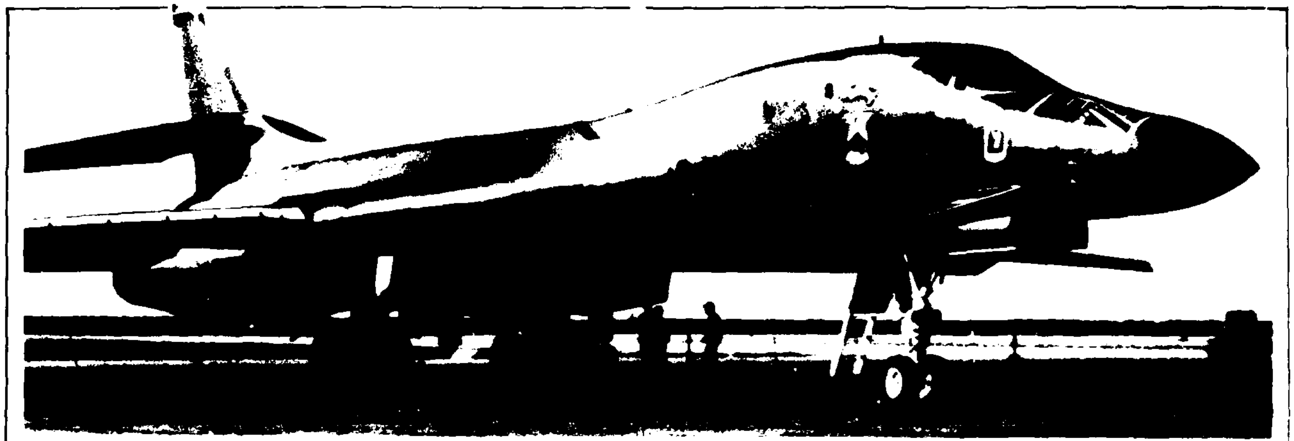
I'd like to shift the focus of my remarks to a broader issue, one central to the weapon system acquisition process—managing risk. As you know, our nation's military capability is dependent, *absolutely so*, on developing and fielding the highest technology systems our scientific base can offer. It is the only effective tool we have to counter an adversary who consistently outspends us, outproduces us and outnumbers us. We must continue to grow and exploit our technological advantage so that our military forces can deter aggression and, if necessary, fight outnumbered and win. That means taking risks, prudent ones, and managing them to the best of our ability.

Risk is inherent to the weapon system acquisition process, and is essential if we are to keep expanding the technological frontier. But, by accepting risks, we build uncertainty into defense acquisition programs—uncertainty that increases the further we push into the technology future. One of our jobs is to ensure that the risks we take at each step of the acquisition process are prudent when balanced against the technical challenges, the national urgency, and the resource requirements of a prospective new system.

That's what we did with the Peacekeeper ICBM, a remarkably successful program and a perfect example of one in which we pursued a prudent risk approach at each sequential step of the weapon system acquisition process. Peacekeeper went into development in 1979, did not enter production until 1984, and achieved a successful initial operational capability in December 1986. The development and production steps were accomplished largely sequentially, and total time spent from development to IOC—7 years—is representative of a "normal" or prudent risk program, one in which we understood reasonably well the uncertainties we were accepting at each step in the acquisition cycle.

Risk Versus Urgency

The acquisition cycle for the B-1B, on the other hand, was compressed and development and production proceeded concurrently. This involved more risk than in the more classic, sequential process, and entailed more



B-1B receives ground servicing

uncertainty. The Congress of the United States and the current Administration fully recognized these risks, and accepted them as prudent when balanced against the urgency to bolster the increasingly obsolescent bomber leg of the triad.

My point is that the problems we are seeing in the B-1B today are products of the risks we accepted when we decided to develop *and* produce the aircraft concurrently. In the short term, problems attract great attention and require great energy and careful management to resolve. However, in the longer term, we will view these problems as part of the normal maturation process all programs and all systems experience.

That was precisely the case with today's front-line air superiority fighter, the F-15. We fielded the F-15 in the early 1970s, not without some of the same maturation pains, but we bought a decade of air superiority which is now being eroded by the capabilities of new Soviet aircraft. We must buy that margin back—and we will—with the advanced tactical fighter in the 1990s. The ATF wi'' have not only superior performance but greater reliability and maintainability as a result of a little-known, quiet revolution in our technical thrust for greater reliability and maintainability. In 1980, the F-15 was criticized as being too complex and "always" out of commission. Today, the more "mature" F-15 enjoys an in-commission rate far greater than older, more simple aircraft. The F-16 fighter has an even higher in-commission rate and can, on a continuing schedule, generate more sorties per aircraft per day than could an F-4, F-86 or even the P-51, each the technology standard-bearer of its day. We achieved this by pressing the frontier of technology and shouldering the associated risks, which were substantial.

Realistic Expectations

Our challenge, then, is to create and foster a development environment which brings realistic expectations to the acquisition process but that allows us to field weapons as rapidly and affordably as possible. All systems entail risks—be they cost, schedule or technical—or all three. Given realistic goals, a prudent amount of risk generates a great deal of technology leverage and ultimately superior combat capability. Technological superiority remains the wellspring of defense for this country, and that's why we simply cannot accept a "no risk" policy in acquiring and fielding our future weapons systems.

As members of the media, you have an important responsibility in conveying to the public a balanced account of defense acquisition stewardship. I believe strongly in the need and in your right to tell that story, but I also believe strongly that weapon system acquisition must be portrayed for what it really is—an undertaking in risk management. In his book, *Governing America*, Joseph Califano offers advice to those who would try to understand American politics: "Try to tell the difference between tides, waves and ripples." The same advice is appropriate for those who report on the business of defense acquisition.

"Go-Ahead" Decisions

I think we share the view that technical problems in development, cost growth or schedule slips do not, of themselves, tell us whether a program is worthwhile or not. We must make our "go-ahead" decisions judgmentally, measuring the goals of an undertaking against its expected payoff, a calculation that requires estimates of risk and uncertainty. We didn't stop the space program, or the Panama Canal or the Nation's great experiment with democracy when we encountered the growing pains associated with risk. We cannot afford to create an environment in which decision-makers will, under perceived pressure, accept only those decisions which guarantee zero risk because zero risk translates to zero achievement.

We have a lot to be proud of in the B-1B. It is a magnificent aircraft. The problems, business and technical, that remain to be solved are trivial when compared to the ones we've put behind us during development and production. I expect the B-1B to mature rapidly, and to perform better than we expected when we began the program. It will serve us well for many years, largely because of the risks we took to incorporate new technology. Had we chosen to delay production by a year or two, with a certain cost increase of $3-4 billion, we probably would still not have averted all the problems.

The Payoff

The B-1B is the most advanced bomber in the world. It is here today, on alert at Dyess Air Force Base and capable of carrying out its strategic mission—that's exactly what we set out to do when we committed to the program. This aircraft, like other upgrades to the combat capability and deterrent power of the U.S. military, did not result from improvements "at the margin." If aviation history teaches any lesson at all, it is this: "no risk" means "no payoff."■

THERE HAS TO BE A BETTER WAY

Richard R. Heroux

The Department of Defense is, figuratively, finding its hands tied when operating in the world of research and development contracting. The Defense Department has seen uncontrollable costs growth, development delays, specification variances; also, undesirable delivery rates equating to delayed deployments and a lower-than-desirable fleet and/or combat readiness as milestones of weapon system programs.

These problems can be traced to the full-scale development phase of affected programs and the two most common methods used in research and development contracting. These problems are complicated during full-scale development by approaches used to implement the program acquisition strategy. These methods and implementing approaches were developed and intended to satisfy government requirements. They often contributed to the problems by creating specific environments where problems flourished. Through careful planning and innovative approaches to program acquisition strategies, these problems can be minimized or eliminated.

Acquisition Methods and Problems

Methods used to implement full-scale development contracts unintentionally contribute to these problems. Most full-scale development contracts are executed as a result of an unsolicited proposal or a negotiated competitive award; both usually result in a sole-source situation which is the most significant contributor to problems facing the Department of Defense. Sole-source situations are usually the result of poor or inadequate program acquisition strategy planning, which often fosters contracting problems rather than providing early problem identification and alternate courses of action.

To appreciate the situation, we must review these contracting methods, implementing strategies, and the precipitating results. Using the unsolicited proposal method, a contractor will submit a proposal not formally requested by the government (request for proposal, request for quotation) and for which the government has no known requirement, has not isolated a peculiar problem, or has not directed itself (the government) to the solution of a known problem. The unsolicited proposal is a self-motivated proposal in which a contractor identifies a problem and proposes a solution, often representing a unique and/or proprietary idea that only the submitter can perform.

The mere fact that this solution is unique dictates an acquisition strategy which justifies and provides for a sole-source contract award with acknowledged limitations throughout the life of the acquisition program. A sole-source program forces the government to contend with and accept a limited (single source) production capacity to meet ever-expanding combat deployment requirements. The production capacity of the contractor who designed and developed a peculiar item, when evaluated in light of that contractor's other ongoing programs or new starts, often will be the factor determining when combat forces can employ the capabilities our nation needs.

The alternative to the unsolicited proposal offers little difference in the method of government contracting. With the negotiated competitive method, a contractor will submit a proposal in response to a formal government solicitation. The government evaluates proposals and selects one that offers the best response in terms of technical understanding, approach, and overall cost. The proposal will present a solution which may, depending on the solicitation, push the state of the art, amplify technical expertise of the particular contractor, be of a proprietary nature based on a previous project or current work, or render the government unable to exploit fully results of the proposed solution.

Acquisition strategies implementing this contracting method vary little from that used to implement the unsolicited proposal because usually the resulting contract creates a sole-source environment in which the only difference is an initial negotiation. Occasionally, sufficient program funds are available to permit the award of more than one contract for the same full-scale development effort, but this is the exception. Specifically, the dual-award procedure is rarely undertaken and then with the following conditions: low level of technical complexity, relative low research and development cost, high level of adaptability from commercial item, and high initial investment in independent research and development effort and cost by the contractor.

In addition to problems generated by a sole-source environment, others relating to proprietary questions and production capacity contribute to the failure of full-scale development programs. Even in programs where complete engineering design data have been disclosed, manufacturing processes often are proprietary: processes themselves are techniques developed by the particular contractor to solve fabrications problems transcending individual programs. In reality, only the original contractor can utilize and implement the particular manufacturing processes required to produce a peculiar item. This leads us to the next major problem found in any sole-source environment; that is, production capacity limitations. Having only a single source to depend on for requirements, the government is forced

To overcome problems and drawbacks associated with methods and approaches to full-scale development contracting, a new procedure must be implemented addressing limitations of current methods and approaches.

to contend with a limit production capacity to meet ever-expanding deployment requirements. The production capacity of the contactor who designed and developed the particular item, when evaluated in light of other on-going programs or other new starts that the contractor may have, often will determine when our combat forces can employ the new capabilities.

Neither of the two methods described can seriously lead to improvements in the Defense Department's conduct in weapon system acquisition; these methods are implemented by strategies fostering sole-source environments. Long-term results will be higher unit prices, higher risk of probable cost growths, schedule delays, and questionable specification compliance.

Innovation Is the Alternative

To overcome problems and drawbacks associated with methods and approaches to full-scale development contracting, a new procedure must be implemented addressing limitations of current methods and approaches; it will, through a well-planned acquisition strategy and selection of appropriate contract type, foster logical approaches to obtain desired results—program success. I believe the procedure I propose is dynamic because an orderly systematic approach to the total program could be realized.

The first major change in this new procedure is the literal splitting of a full-scale development. This is accomplished by performing the actual research, paper study, (formulation of design, cost estimates, concept, specification, etc.) under small multisource contracts, and the costlier hardware development and fabrication under a separate contract. One major benefit is that the government is forced into a detailed evaluation of program progress before approval and authorization of the significant funds required for the hardware development phase. This evaluation can be performed without pressures fostered by contract termination; i.e., Do I terminate now for "X" dollars or do I terminate in 60 days for "Y" dollars, and how much wasted effort will the contractor expend if I don't terminate immediately? Sometimes, the design formulation is not sufficient enough effort to evaluate whether or not a certain item can be fabricated successfully. To assure all design aspects are ready for fabrication, a critical item or component demonstration would require that detailed testing be performed on any proposed items or components which may present a high-risk factor to the program. This critical item or component demonstration can be and should be performed in parallel with the research (formulation of design) phase described earlier. In scheduling these two efforts in parallel, the built-in evaluation period becomes more valuable in that both the "paper" design and high-risk aspects of the research and development program can be evaluated in detail. This evaluation will ensure sounder judgmental decisions earlier in the program to avert a later stretchout or termination for lack of money or misdirection of effort.

Another change in this new procedure is the actual development. This phase will involve building full-scale operational engineering models of the hardware being developed. This phase is similar to the hardware fabrication phase under present research and development effort except that, in the new procedure, success and costs of the engineering model can be more accurately monitored and forecast due to evaluations and risk reduction occurring during the previous phase. Current research and development programs usually falter in the period where transition from a paper design to functioning hardware is undertaken. Using the new procedure, this transition period is a systematic examination of past efforts and a clearer forecast of future progress and program direction.

A factor lending itself to success of the new procedure is the smaller initial effort that can be dual-sourced easily. This naturally would be established via a competitive request for proposals/quotations. One could say that such a small initial effort would not be attractive enough to interest a large response from industry; that most of industry would "sit-back" until the larger effort is required and available dollars are more attractive. But, this is where the new procedure excels. Though initial effort is small, it would provide a clear projection and outline of the total program required. Anyone wanting a chance at the larger dollars in the program must participate first in the initial effort. The time and experience that would be lost through non-participation would be impossible to make up within timetables required by the government.

Another innovative facet of the new procedure is the teaming of industrial concerns. Teaming is not new, but its application here is unique. Each team member must have a full capability to produce the required weapons system or hardware. One team member may be more advanced in a certain field of technology, but the other may be advanced or a leader in another field, tending to make team members complement one another, rather than having an industrial concern be the "leader" with followers or subordinates (See Figure A).

"National honor is national property of the highest value."

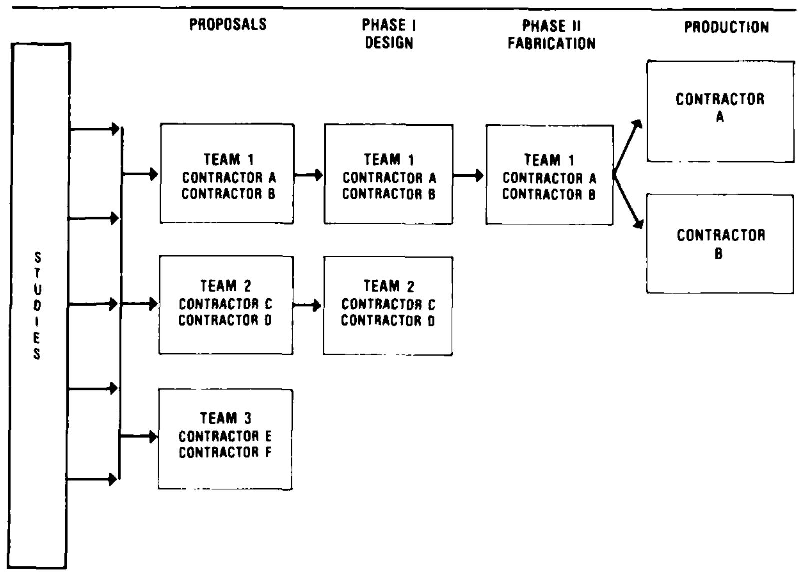
—James Monroe, 1817

This form of teaming promotes a more attractive and technically feasible design. It also creates two additional factors to benefit the total program—beyond the research and development period. These factors, a by-product of teaming, are assurance of continued built-in price competition and full design data disclosure. Built-in price competition is assured because after the winning team successfully completes research and development, team members can compete against each other for disproportionate amounts of the production quantities, thus providing continued price competition. Full design data disclosure is guaranteed by the nature of the teaming.

Since team members must share technologies, no information concerning proprietary processes or techniques can be withheld from one's teammate or the government, which will be monitoring all technology transfers and design data. This peculiar facet is a benefit to the government in that it need not procure a full unlimited data package to attain the same results that technology cross-breeding provides under teaming. In other words, the government will not have to procure a full unlimited design data package to provide another possible competitive source for future contracts. Finally, teaming utilizes more economically potential industrial excess in a peculiar field by spreading the available business base. One contractor will not forsake the entire field by expanding and cornering the market while the rest of the industry "dry-up" from lack of business.

In efforts this new procedure was designed to benefit (item of moderate to technical complexity, item requiring large initial production quantities, and cost range where price competition is essentially desirable), the teaming concept provides the multiple qualified production sources which would be impossible to obtain using any other method of research development contracting. The multiple production sources will provide the government with a high initial quantity of production deliveries. In this way, fleet/combat readiness can be maintained with earlier deployment of essential equipment. Future production contracts would not affect fleet/combat readiness because competitors would be prior producers and would require

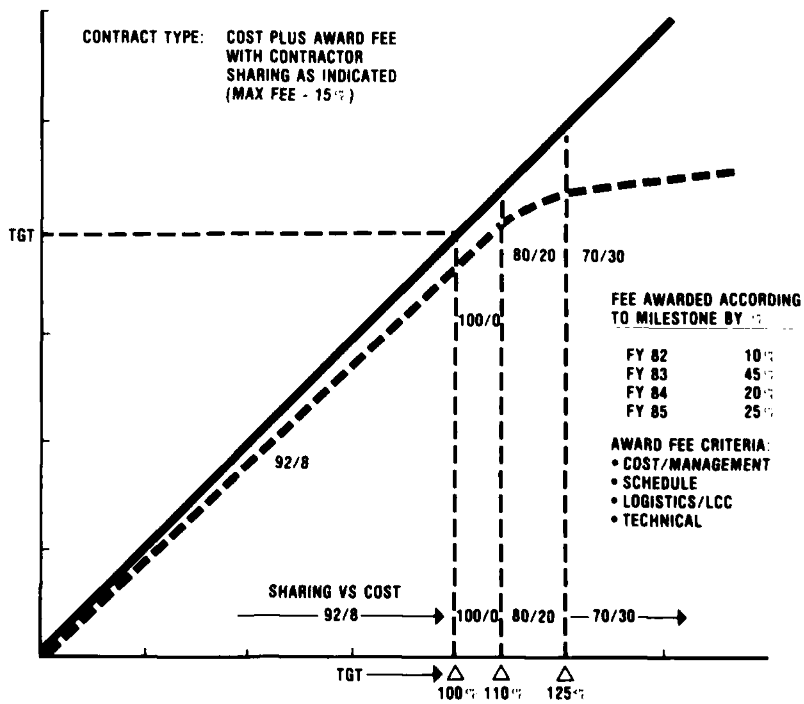
Figure A. Competitive Teaming



little, if any, start-up time until full production capacity is attained.

Lending itself to the success of the approach I propose is the selection of an appropriate contract type. The contract type should represent the most advantageous business arrangement for the government while not driving the contractor to seek other work or implementation of "get well" programs. I propose the contract be flexible enough to reward the contractor for exceptional performance, while forcing him to share costs for marginal performance. A contract with no base fee, subjective award fee, and cost sharing on overruns would, in certain cases, fill this requirement (Figure B is

Figure B. Contract Characteristics



The end-question is the same: What will assure program success, especially in the critical period between the end of development and the start of full production?

an example). In other cases, a firm-fixed priced or fixed-priced contract is most appropriate. The complexity and maturity of the commodity, the acquisition strategy, and the overall program requirements and goals should be analyzed and become key factors in determining the appropriate contract type.

Dual development, "fly-offs," lead-follower arrangements, and management controls have been attempted by the Defense Department. Unfortunately, successes have been few and far between. Dual developments, when not initially hampered by limited funds, usually terminate when the deployment decision is required. Since deployment of multiple designs of the same capability would impact the supportability and operational costs, termination and establishment of single design is required due to affordability issues. Once one design is terminated a sole-source environment, with associated problems and drawbacks, is created. "Fly-offs," while similar to dual developments, insert a high level of competition and aggressiveness because both contractors vie from the start of development to the production decision. But, again, after the production decision only one source continues and a sole source is created. The lead-follower arrangement had shown the best record of improvement; under this approach, the developing contractor agrees on some point to bring on board a second qualified source for future competition. The lead-follower arrangement has problems and drawbacks. First, the agreement and cooperation of the developer is essential for success; without this the approach cannot be implemented. Second, in most cases, the developer, while agreeing to bring on board a future competitor, will not release proprietary manufacturing processes for fear of adverse impacts in other programs and business areas. Third, this approach does not allow for high initial production rates because the follower would need one or two minimum production runs to establish his capabilities and demonstrate his ability to meet specifications. Fourth, once the follower is up-to-speed and the liaison between the leader and follower ended, there is no assurance that price competition will be meaningful since the experience of the lead will far exceed that of the follower. Management controls applied internally and externally by the Defense Department are another attempted approach to correct the situation. These controls, or tools, tend to be applied only in the most crucial or critical defense programs and, in doing so, are not usually available for the many programs not falling into these categories. The OMB Circular A-109, for example, attempts to internally implement a logical, common-sense and front-end approach to program management through formal decision reviews. These reviews require a complete, detailed and initial "bottoms-up," "cradle to grave" examination of the proposed program and at specified milestones. Used internally is the selected acquisition reporting process, which maintains a "cradle to grave" audit trail of the program. This process assures that high-level review of problems will be performed since reports resulting from this process are provided to the Congress for oversight. For external control of the contractor, CS[2] criteria (cost/schedule control systems criteria) has been established and implemented on all major contracts. The CS[2] requires that the contractor establishes and implements a company internal system which tracks cost, schedule, and performance to the individual work units within the contractor's work packages. The criteria require the contractor to be able to track current and cumulative efforts and project cost and schedule at contract completion. The CS[2] is intended to show readily if a program is over or under cost, behind or ahead of schedule, or right on track. The CS[2] is a valuable tool if properly implemented and tracked. Another external tool used with limited positive results is the production readiness review (PRR). A PRR is a "state or condition of preparedness of a system program to proceed into production." A system is ready for production when the completeness and producibility of the production design and the managerial and physical preparations necessary for initiating and sustaining a viable production effort have progressed to the point where a production commitment can be made without incurring unacceptable risks that would impact schedule, performance, cost, or other established criteria. The actual PRR is a detailed analysis of the contractor to uncover facts; this proves validity of the PRR definition, and production status of the equipment being developed. A detailed PRR can assure a successful transition from development to production.

Conclusion

In looking at the methods of research and development contracting and the new approach set forth, the end-question is the same: What will assure program success, especially in the critical period between the end of

■ *Mr. Heroux is the Manufacturing and Quality Manager for the Universal Modem program, Electronic Systems Division, Hanscom Air Force Base, Mass.*

development and the start of full production? The procedure I set forth provides that the involved contractor make a real contribution to the desired success. This is accomplished since price competition is maintained throughout the program and actual management is less tightly controlled by the government bureaucracy. Management of the program itself becomes a simple exercise in common sense. Finally, the criteria dictating innovations I proposed are satisfied; that is, a dual production base is established with limited expenditure of dollars, a high production rate is easily established and maintained because of the availability of two qualified sources at all times, and price will never be out of government control since two qualified competitive sources have been established early in the program. This innovated procedure will result in these benefits:

—Cost-free sharing of technology between the co-developers
—Built-in price competition during the life of the program
—High level of fleet/combat readiness through higher initial and prolonged production rates from proven, qualified sources.

In the very end, deliveries are guaranteed, scheduled deployments are assured, and fleet/combat readiness is maintained. ■

Handbook Provides Assistance to Defense Management Programs

The Defense Systems Management College has released the second edition of a practical manual designed to give the user an understanding of, and a basic working familiarity with, the newest and most effective manufacturing methods used in the defense systems acquisitions programs. *Manufacturing Management Handbook for Program Managers* is designed as a desk reference for program managers and staffs to be used during the defense systems acquisition process, particularly in preparing for and executing the production phase of a program.

The handbook focuses on basic activities associated with producing defense systems and related equipment, current critical issues affecting manufacturing management, common causes and cures of manufacturing problems, and lessons learned from past programs. It relates the manufacturing function to the fielding of defense systems and subsequent logistics support activities.

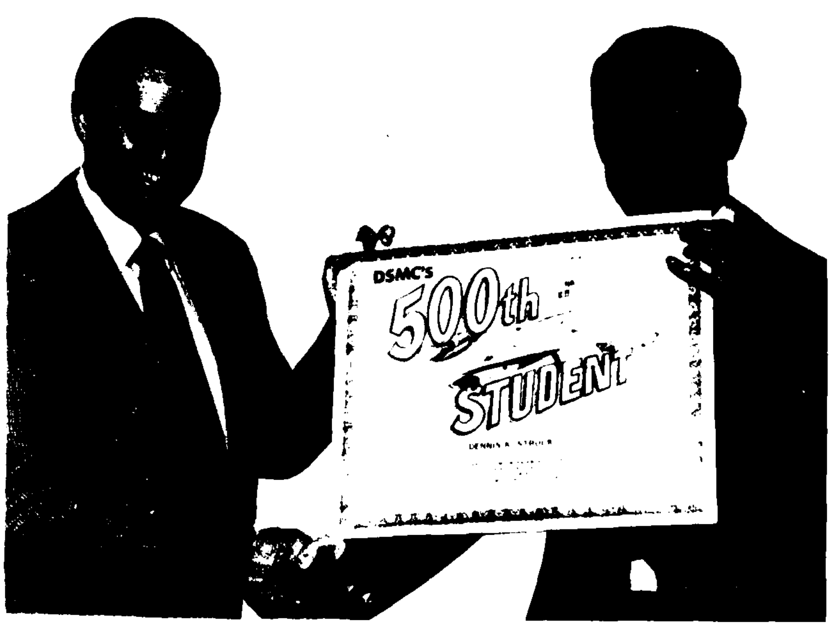
This comprehensive 502-page publication, *Manufacturing Management Handbook for Program Managers*, stock number 008-020-01095-2, is available for $23.00. Send prepayment to Dept. 36-VE, Superintendent of Documents, Washington, DC 20402-9325; to order with Visa, MasterCard or Choice, phone (202) 783-3238. ■

DSMC Alumni Association Meets June 24-25

The DSMC Alumni Association has scheduled June 24-25 for its annual symposium and meeting. The theme, "Procurement Reform—What's Happened and What's Ahead," should be a timely topic for the acquisition community.

The association is scheduling government and industry speakers for a 2-day lecture/workshop format, which proved popular last year.

The symposium is open to all DSMC graduates and alumni members. For more information send your name, address, and DSMC class year to: Jerry Tobey, Texas Instruments, Suite 605, 1745 Jefferson Davis Highway, Arlington, Va., 22202; or phone (703) 892-9333.

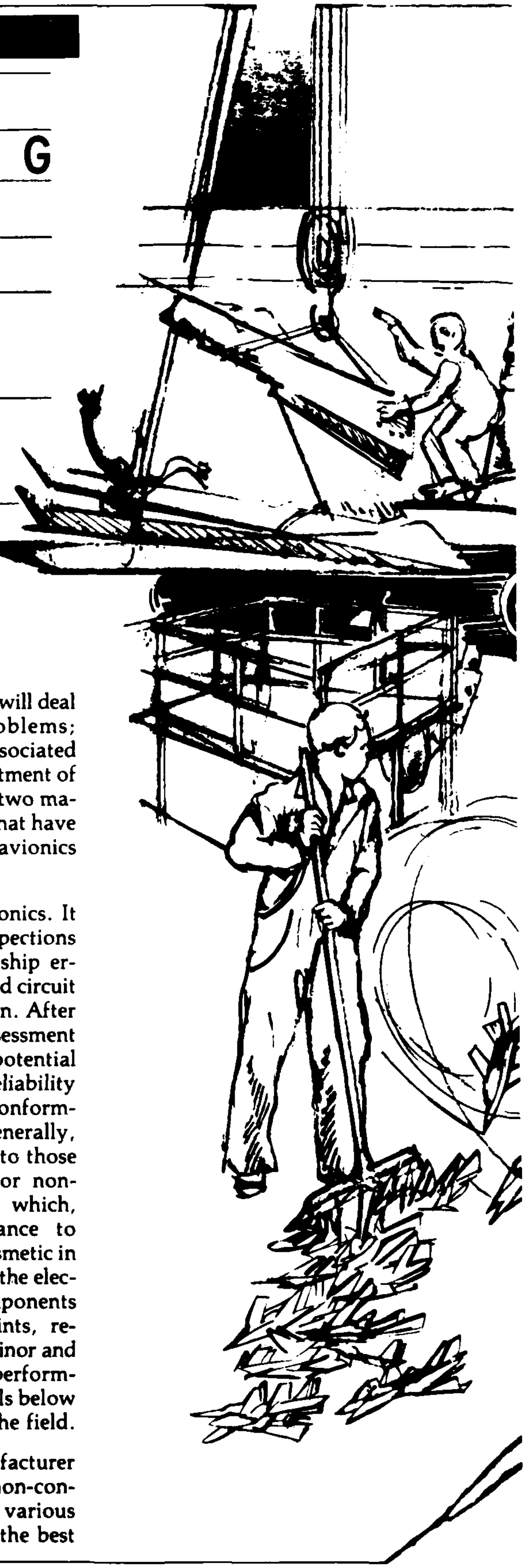


IN ST. LOUIS...Dennis E. Stuck (left) receives his "oversize diploma" from Dr. Julius Hein, Director of the Defense Systems Management College Central Region, St. Louis, Mo. Mr. Stuck was the 500th student to be graduated from the Technical Management Course. He is a Department of the Air Force civilian at the Strategic Air Command, Offutt Air Force Base, Omaha. The DSMC Central Region comprises 22 states.

U.S. Army Photo by Gary Cooper

GUIDELINES

SERIOUS MANUFACTURING DEFICIENCIES VERSUS THE DELIVERY SCHEDULE



Commander Frank J. Vertovec, USN

The purpose of this paper is to establish guidelines for dealing with manufacturing quality deficiencies and the associated corrective action plans with minimum impact on deliveries and readiness.

Periodically the Army, Navy or Air Force will conduct an inspection of a military equipment manufacturing plant. These inspections may be done at required intervals or they may be formalized reviews because of problems in reliability, maintainability, or scheduled delivery. Frequently, there will be unsatisfactory findings in workmanship, planning, test procedures, and engineering drawings. Poor training programs, inadequate flowdown of contract specifications, lack of accept/reject criteria, poor subvendor control, no corrective action feedback loop, and configuration incompatibilities are some of the inspectors' comments.

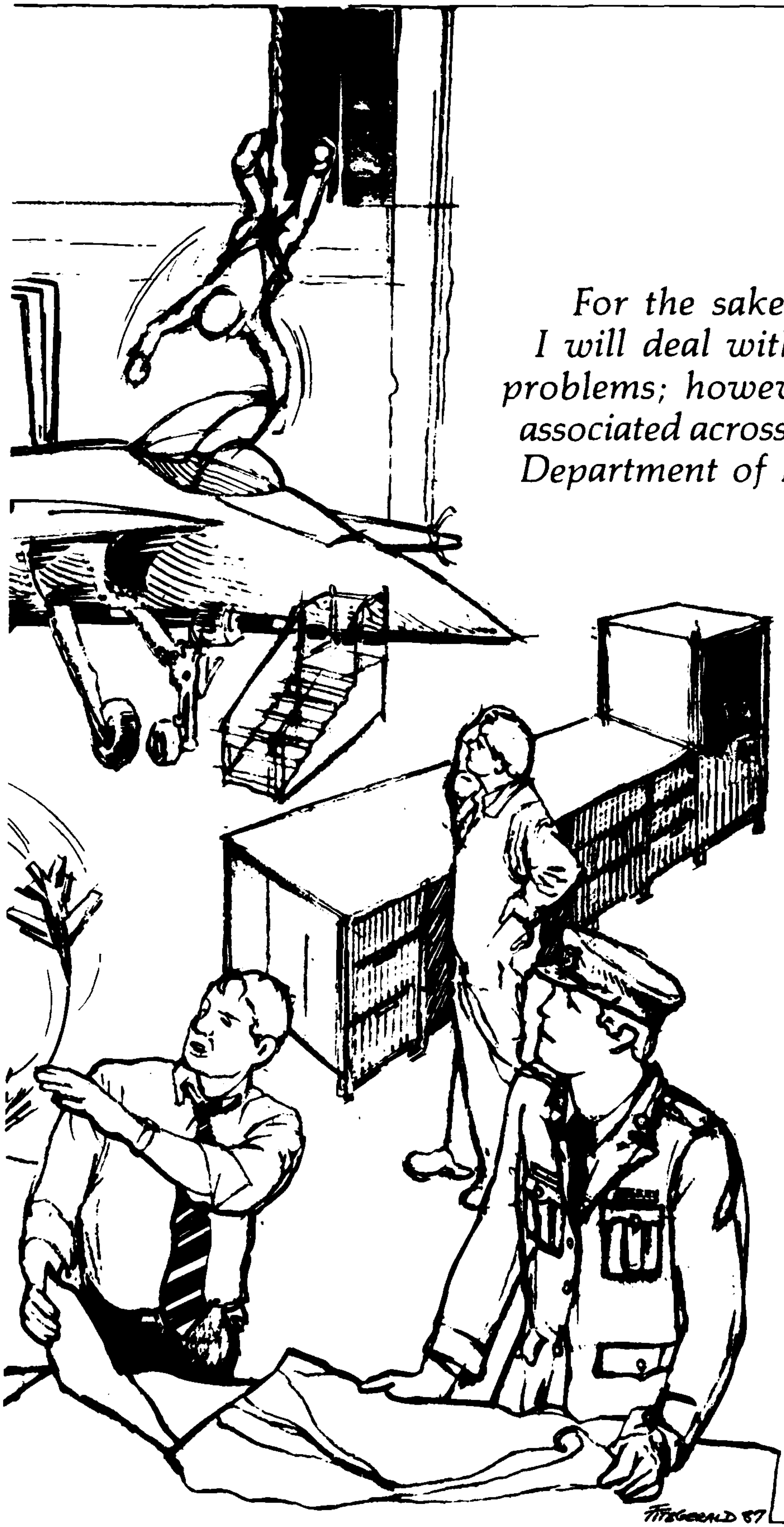
Generally, management is cooperative and willing to make corrections but military insistence of the development and implementation of a corrective action plan is required. Unfortunately, because of what we have uncovered during the review, we are faced with substandard equipment in the field and items with the same type of defects as those discovered in the test articles.

Aircraft

For the sake of discussion, I will deal with aircraft-related problems; however, concepts can be associated across-the-board for all Department of Defense hardware. There are two major subsystems of an aircraft that have to be dealt with separately; avionics and airframe components.

First, I will discuss the avionics. It is apparent from previous inspections that assembly and workmanship errors, particularly on the printed circuit boards, are of greatest concern. After discovery, an engineering assessment of the technical severity and potential impact on performance and reliability of these workmanship non-conformances must be computed. Generally, the problems will be divided to those having an impact; i.e., major non-conformance, and to those which, while still a non-conformance to military specifications, are cosmetic in nature. With the exception of the electrical shorts, misaligned components and improperly soldered joints, remaining problems would be minor and not be expected to degrade performance and/or reliability to levels below those currently exhibited in the field.

Normally, a large manufacturer may have several thousand non-conforming circuit boards in various stages of production. It is in the best



For the sake of discussion, I will deal with aircraft-related problems; however, concepts can be associated across-the-board for all Department of Defense hardware.

interest of the government that criteria be established to salvage a good percentage of these non-conforming boards in order to continue production. The following may be the type of criteria to suggest:

—Rework/repair all boards not conformally coated to full conformance.

—Rework conformally coated items where any possibility of functional or reliability impact exists or where integrity cannot be verified.

—Use-as-is conformally coated boards where functional integrity and reliability are not questionable and a risk of damaging the hardware exists in attempting rework/repair.

General Guidelines

A set of general guidelines must be developed to provide the local government agency (AFPRO, NAVPRO, DCAS) specific quality criteria to determine which boards will be reworked or used-as-is. The tedious process then begins to evaluate every circuit board and rework those with major non-conformances and continue to build end-items with those boards considered acceptable. This allows some units to be built while training and facilitizing take place, which will bring about the manufacturing process required to meet military specifications.

The second issue regarding avionics is similar to problems associated with non-conforming airframe components; that is, what to do with end-items that have completed assembly or manufacture but have not yet been purchased by the government. They may still be at the manufacturer's plant or they may have been installed in the aircraft and are awaiting DD-250.

Here again, we first must make a technical assessment about the potential impact of the non-conformance on the safety, reliability, performance, and readiness of our aircraft. We can make a valid assumption that non-conformances discovered during the manufacturing review have existed for some time and squadron aircraft contain equipment or parts with similar non-conformances. Hopefully, our assessment of the impact will not require total grounding of aircraft but may halt deliveries and require an aggressive return-for-repair program. There certainly will be a delay in receiving new material and equipment while the corrective action program is established.

To preclude extensive delays we must evaluate two separate courses of action. The first would be a teardown of existing equipment and some intermediate level of repair to bring the unit up to an acceptable level of reliability and performance. While not the optimum solution, it allows us to continue delivery of new aircraft with only a modest delay.

The second approach is to accept the manufactured units that are beyond the easily repaired stage and use them as is. This obviously has the least effect on readiness, but can only be the solution when reliability and performance are only modestly impacted by the units non-conformances. In other words, we can live with the problem a little longer in order to continue deliveries and maintain a satisfactory level of readiness. When the manufacturing problem is solved, we'll have new items to use in the return-for-repair program to upgrade all aircraft.

We have a more difficult task in deciding on financial considerations associated with non-conforming equipment. The first topic to address is a special warranty to cover units that will not be reworked, and avionics components that will have minor non-conformances only after some rework. While the government clearly is not getting what it contracted and paid for, the implementation of a special warranty to cover specific types of defects, particularly workmanship problems, is difficult to determine and is demanding on squadron personnel.

Avionics

In the case of avionics, each failed unit must be analyzed by the government for the type of failure and then transported to the vendor for repair. This method is extremely time-consuming and costly due to the increased number of units required for the return-and-repair delays. Airframe components may be more adaptable to a special warranty program if their failure characteristic is more predictable. In this case, special provisions can be made in advance, replacement units can be stock-piled where needed, and a contractor field team can make repairs in a more orderly manner.

Depending on the severity of the problems encountered, it may be in the best interest of the government to self-warrant and assume the responsibility of repair...

Depending on the severity of the problems encountered, it may be in the best interest of the government to self-warrant and assume the responsibility of repair if we have the internal capability for the particular work involved. This approach has the least complications and does not require special marking of components which fall under this warranty, complicated trouble-shooting, transportation of defective units and, most importantly, delay in the repair cycle. There are several methods of regaining the cost of this self-warrant, one of which would be a downward adjustment in contract price.

As we have assumed that the discovered non-conformances have existed in the particular units for some time, we are faced with non-conforming equipment currently in our squadron aircraft. If the problems have a long history, perhaps we can cite the contractor for a latent defect; in this case an engineering change proposal (ECP) will be prepared for new production and, if required or desired by the program office, inspection bulletins, repair and retrofit proposals will be submitted. Generally, on less-critical airframe components and avionics, a notice of defect will be given to the contractor stating the problem. This drives a stake in the ground at a certain date to allow aircraft deliveries while the problem is being worked and repair procedures established. It makes sure the previous 6-months deliveries are included in the aircraft's original warranty, thereby including them as items to be repaired at no cost to the government.

Formal Actions

There are several formal actions that may be taken by the cognizant contract administration service (CAS) office when wide-spread non-conformances are discovered. Method "C" or Method "E" are the most common. These two actions require a formal corrective action plan be submitted within a specified period of time, usually 60-90 days. This is very important for our programs because it requires the manufacturer to focus on improved visibility and measurement of inefficiency, methods for problem resolution, integration of efforts, and day-to-day operation philosophy. This corrective action plan must be derived from a clear management quality policy.

In most of our programs, the prime contractor has been paid a management fee to supervise all aspects of the manufacturing and assembly process. When non-conformances to military specifidations have been found at a subvendor, the prime has not accomplished his management task properly. A withhold of a portion of the final payment will incentivize the prime to a more timely implementation of a suitable corrective action plan. Management initiatives and a clear commit-

■ *Commander Vertovec is the F/A-18 Program Manager's Representative, Navy Plant Representative Office, McDonnell Douglas Corporation, St. Louis, Mo.*

ment to quality by the highest levels are required.

Recommendations

In summary, when a product review discovers non-conformances to military specification in equipment or components, the following actions are recommended:

—A technical assessment of the impact of non-conformances on safety, reliability, performance, and readiness.

—Develop engineering guidelines to provide criteria for acceptance of completed circuit boards and structural subcomponents. This will allow for some end-item manufacturing to continue, hold down cost of scrappage, and allow for an acceptable delay in deliveries of equipment rather than a catastrophic stoppage of the production line while the item vendor regroups.

—Determine acceptability of items on-the-shelf in the final assembly area and installed awaiting delivery. Current field readiness and reliability statistics will assist in our decision. If it is not a significant problem in the field, our timetable for the full implementation of corrective action should not effect readiness.

—When required, a notice of defect should be issued calling for an inspection bulletin or ECP to be submitted within 30-90 days.

—An extended warranty or a reduction in contract price must be negotiated. It is clear that the government has not been receiving what it had contracted for and there should be some financial consideration. If the non-conformances can be easily fixed, then a return-for-repair program must be established. If problems are too difficult to determine if they fall in the category of these non-conformances, the government may want to self-warrant and repair items at government facilities. In the last case, a reduction in contract price may be called for.

—The cognizant CAS office should issue a Method "C" or Method "E" to ensure that an adequate corrective action plan will be submitted within the designated time period.

—To incentivize the prime contractor to exercise proper management on a vendor and others, a suitable withholding of final payment should be made until acceptable equipment is delivered. The amount of the withholding will vary with severity of the problem.

—The prime contractor should be required to present a plan of action and milestones (POA&M) to pinpoint management initiatives to correct problems at the subvendor level and eliminate their reoccurrence.

Issues Charter for Under Secretary of Defense For Acquisition

Secretary of Defense Caspar W. Weinberger has issued DOD Directive 5134.1 which assigns responsibilities, functions, and authorities of the Under Secretary of Defense (Acquisition). The position is occupied by Richard P. Godwin. This is the final step in fulfilling a key finding of the President's Commission on Defense Management, which recommended all DOD acquisition management functions be consolidated under a single, top-level DOD official reporting to the Secretary of Defense. The charter provides that the Under Secretary of Defense (Acquisition) shall serve as the Defense Acquisition Executive, the DOD Procurement Executive, and the principal assistant to the Secretary of Defense for acquisition management. As such he/she will supervise all matters within the Department of Defense relating to the acquisition system including research and development; production; logistics; command, control communications, and intelligence activities related to acquisition; military construction; and procurement.

Consideration initially was given to granting the Under Secretary direct line authority over the Service Acquisition Executives and their subordinate structures. During coordination of the charter in draft form, the General Counsel of the Department of Defense advised that such an arrangement would be inconsistent with statutes that establish Service Secretaries as heads of Military Departments. Accordingly, the Service Acquisition Executives will continue to report directly to Service Secretaries.

Under the charter, the Under Secretary of Defense (Acquisition) has the authority to direct the Service Secretaries on all matters falling under his cognizance. This provides the Under Secretary with ample authority to carry out responsibilities and to oversee the Service Acquisition Executives and the acquisition programs of the Military Departments.

The Under Secretary of Defense (Acquisition) will supervise the following Office of the Secretary of Defense officials: Director of Defense Research and Engineering, Assistant Secretary of Defense (Research and Technology), Assistant Secretary of Defense (Acquisition and Logistics), Assistant Secretary of Defense (Command, Control, Communications, and Intelligence), Assistant to the Secretary of Defense (Atomic Energy), and Director of Small and Disadvantaged Business Utilization.

In addition, the following Department of Defense organizations will report directly to the Under Secretary: Defense Advanced Research Projects Agency, Defense Communications Agency, Defense Logistics Agency, Defense Mapping Agency, Defense Nuclear Agency7, and the *Defense Systems Management College*.■

EXPERTISE

MIDDLE MANAGEMENT SURVIVAL SKILLS

Richard F. Gordon

You have completed one of the most difficult, demanding, and challenging assignments within any organization—a stint as first-line supervisor. Success in this initial managerial assignment probably was due to your technical and human relations skills. Technical expertise or mastery of a specific functional area are prerequisites for most first-line supervisory positions. Human relations skills at this level usually are keyed to interpreting and applying organizational goals to the work group. Effective goal orientation is accomplished only when you demonstrate interest in the staff's needs and problems.

When you complete first-line supervisory experience in a technical or specialist role, you are ready to advance to the middle-manager generalist role; you will find roles and responsibilities expanded. A generalist perspective is needed for the new interdisciplinary role.

I suggest a simple definition of "middle management" could include everyone above the first level of supervision up to the vice-president; they manage people who manage others. This implies that within the middle-management hierarchy, managers lead in one group and follow in another.

George J. Lumsden in *How to Succeed in Middle Management* defines middle management as, "People who work below a policy-making level, but who have some say in how policy will be implemented and considerable involvement in carrying out the implementation." Policy implementation and execution require a new skill normally not required at the lower supervisory level. In this new role, you will be the conduit between upper-level policy formulation and lower-level system execution. Even though you may not set policy, you will be expected to ensure its implementation.

Robert L. Katz in the *Harvard Business Review* article, "Skills in Effective Administration," labeled the skill to implement policy as conceptual. He defines conceptual skill as, "The ability to see the enterprise as a whole; it includes recognizing how various functions of the organization depend on one another, and how changes in any one part affect all others." The ability to recognize these relationships and perceive the significant elements in any situation allows the manager to act in a strategic way to advance welfare of the total organization.

The Katz article identified two other basic management skills, technical and human. Katz defines technical skill as, "An understanding of and proficiency in a specific kind of activity, particularly one involving methods, processes, procedures, or techniques." Human skill is defined as "The ability to work effectively as a group member and to build cooperative effort within the team he leads." So, technical skill is concerned primarily with working with things, whereas the primary concern for human skill is working with people.

These basic skills are important at every level of management. However, the relative importance of each varies at different levels of responsibility. At lower levels, technical and human skills are most important; at middle-management level, conceptual skill is as important as technical and human skills. Increased need for conceptual skill is offset by the decreased need for special technical skills. Conceptual skill becomes increasingly critical in executive positions where its effects and results are observed easily. Human skill remains important at all levels of management; however, technical skill becomes relatively less important as you move up the managerial hierarchy.

A successful transition to middle management depends on one's ability to deal competently with the responsibility shift from specialist to generalist, and the expanded interdisciplinary personnel role.

Margaret Hennig and Anne Jardim in *The Managerial Woman* identify eight specific areas requiring shift in responsibility to accomplish middle manager job functions. They follow.

—*Technical Expertise*. Mastery of a specific function or work area role is expanded to a working knowledge of the other functions and work areas.

—*Goal Setting*. The responsibility shift is from meeting short-term goals set by superiors to breaking down broader and longer-term interdepartmental goals and setting subgoals for subordinates.

—*Planning*. The shift is from carrying out plans already decided on by superiors to developing plans for the achievement of specific objectives.

—*Problem Solving*. Solving problems as they arise requires a shift to anticipating problems and preparing alternative solutions in advance.

—*Interdepartment Liaison*. This type of coordination is usually not critical to job performance at lower management levels. However, it becomes more critical as you start to move up through the managerial hierarchy.

—*Learning Base*. The shift is from the formal and technically oriented—classes, courses, manuals, and texts; to informal and behaviorally oriented—learning from others (peers, superiors, and subordinates).

—*Informal System*. Incidental to getting the job done at lower management levels but increasingly critical at higher management levels. This is commonly referred to as networking.

—*Self-Reliance Versus Reliance on Others*. The responsibility shift is from being able to meet performance requirements by relying on one's own skills to increased dependence on the ability to delegate task performance to others.

This transition is difficult because the emphasis is from formal learning

and doing to an informal and behavior-oriented learning base. Your new role will demand a broader and more conceptual approach to planning, goal setting, and problem solving. Skillful intergroup relationship techniques will be required to satisfy interdepartment liaison, conflict resolution, informal networking, and reliance on others. The informal learning base will help to expand your technical working knowledge of other functional work areas.

Dr. Richard E. Wise in a research paper, *The Travelers Management Development System*, identifies future-oriented, middle-management skill and ability requirements. This study acknowledges some skills and abilities such as planning, oral communication, organizing, and monitoring will remain as important in the future as they are today.

Because of economic necessity, technological forces, and the need for fluid organizational structures, more responsibility will be pushed down to middle and lower levels of management.

Dr. Wise identified the following skills and abilities for middle managers to cope with new responsibilities.

—**Performance Management and Appraisal**. Develop job descriptions which support the organization's mission statement. Then, develop performance standards around the tasks identified in the job description. These standards need to be communicated to the employees, preferably in writing, before start of the evaluation period. Each employee should clearly understand what is expected and that performance evaluation will be based on these standards. Employees should understand that all forms of rewards—money, promotions, privileges, or status symbols—are directly related to performance.

—**Delegation.** Lower-level, one-on-one delegation will be replaced by functional organization task delegation. The middle manager will task the functional organization rather than an individual. This type of delegation will be the most prevalent for middle managers assigned to matrix organizations.

—**Problem Analysis and Decision-Making**. The basic transition is from following existing programmed decision rules or making routine decisions to a new dimension. This new dimension is conceptual because middle managers are required to choose among alternative courses of action and make decisions for interdisciplinary problems. A recent *Business Week* article, "A New Era For Management," said middle managers will find roles expanded and functions changed. Generalists, not specialists, are needed as companies demand solutions to interdisciplinary problems. This article stated people making decisions, not recommendations, are the only middle managers now in demand.

—**Collaboration**. Being able to work effectively with different personality types and different management levels, especially in joint intellectual situations with managers from different disciplines.

—**Writing Skills**. Modern business organizations could not function without the written word. Communicating effectively on paper is a valuable skill at all management levels. Tailor your message to the target audience, make it readable and objective and, above all, keep it simple. Regarding subordinates, have concern about content and substance, and not his/her writing style.

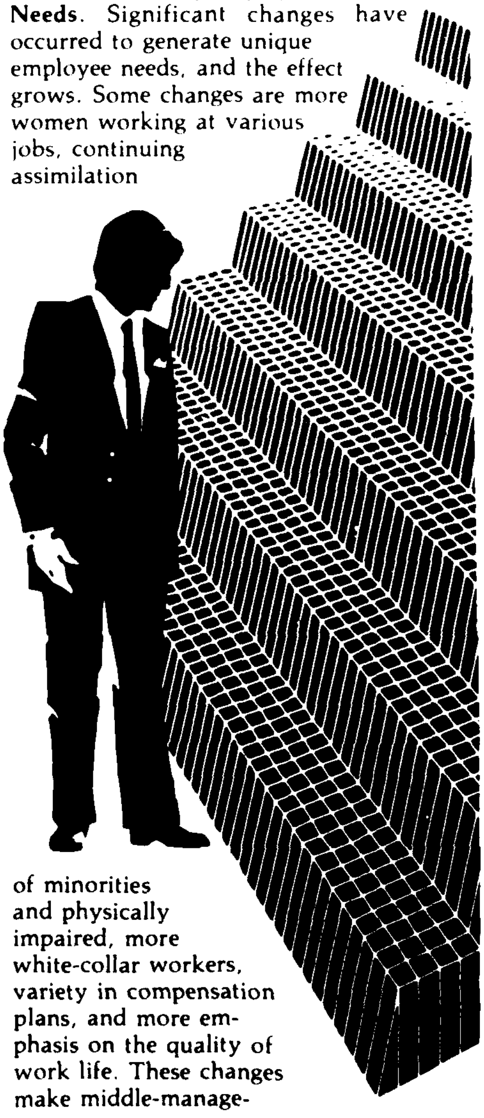
—**Ability to Resolve Conflict**. Conflict cannot be avoided. Understanding and dealing with conflict is an important skill for leaders at all levels. The transition for conflict resolution involves new skills dealing with intergroup conflict. As first-line supervisor, your conflict resolution experiences probably were limited to intragroup conflict. The continuum for conflict resolution extends from denial to dominance. Within the continuum there is no best approach; you need a situational perspective. Denial may be appropriate when an issue is relatively unimportant or raised inopportunely. Conversely, dominance may be appropriate if your position grants enough authority, and if this approach will not create future disruption. Approach conflict resolution with a win-win philosophy. Remember when the focus shifts from defeating each other to defeating the problem, everyone can benefit and be a winner.

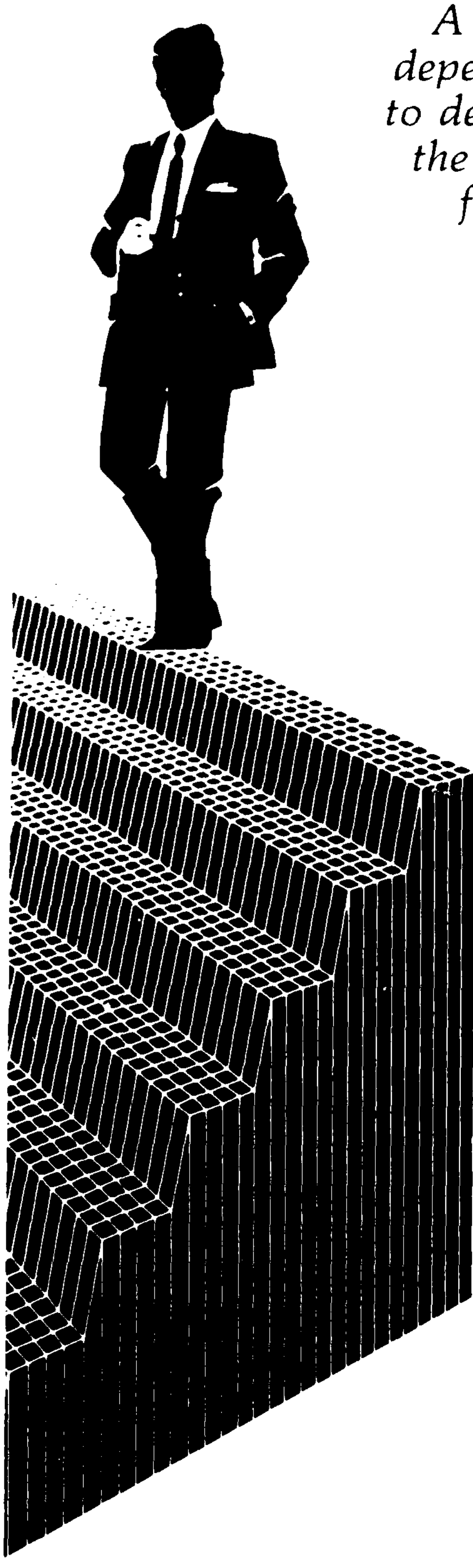
Dr. Wise's research paper identified issues and trends having a greater impact on how middle managers will do business in the future.

Some issues are listed below.

—**Developing Alternative Work Arrangements**. There are many approaches to alternative work schedules. The most common is flextime when employees arrive for work at any point within a 2-hour time span and adjust lunch breaks and departures accordingly. This system has a core period in midday when all employees must be present. For other than the core period, flextime allows employees to adjust working hours to their personal lives. A conservative variation of flextime is staggered hours, requiring the employee to choose a fixed daily arrival in advance. At the other extreme is the variable-hours system involving no core period during the workday, allowing employees to choose any 8-hour period.

—**Accommodating Employees' Unique Needs**. Significant changes have occurred to generate unique employee needs, and the effect grows. Some changes are more women working at various jobs, continuing assimilation of minorities and physically impaired, more white-collar workers, variety in compensation plans, and more emphasis on the quality of work life. These changes make middle-manage-





A successful transition depends on one's ability to deal competently with the responsibility shift from specialist to generalist.

ment positions more challenging because the manager must be more accommodating to the work force and more participative in approach to employees.

—**Helping Employees Respond to Change**. Most employees resist change and some may overreact. Some reasons for employee resistance are uncertainty and risk, being forced to abandon familiar ways, threatening in the sense of having to learn new skills, more skilled performance requiring an investment in time and effort, disruption of personal relationships, and inept initiation of change when employees do not know or understand the reasons for change. Employee understanding is critical if their acceptance of the change is a prerequisite for implementation. Edward Rodeman in *Managing the Problem Employee*, developed a five-step process for dealing with employees overreacting or resisting change. They follow.

—**Assess the Consequences of the Change**. Change that is intended to help the organizaion may hurt the individual. Determine in advance who may get hurt, in reality or in the employee's imagination. Be mindful that for any given change your total staff will not be affected equally, especially if relocation is needed.

—**Anticipate Specific Objections**. Place yourself in the employee's shoes, and think how he/she would react to the proposed change. Identify legitimate concerns you eventually will have to discuss with employees.

—**Prepare Employees for Change**. Employees need preparation for change. Give them as much advance notification as possible, or try to increase employees' psychological readiness for change by softening their first reactions and keeping change in the proper perspective.

—**Help Employees Separate Rational and Irrational Thoughts**. Help the employee to recognize when his/her thinking may be irrational. A counseling session may aid employees broaden their thinking so that any decision reached is based on full consideration of critical factors.

—**Follow Up After the Change**. After implementing change, solicit feedback and give support. Supportiveness continuum may extend from simply listening to scheduling more counseling sessions. Remember that change is not complete until implemented smoothly. Follow-up actions and supportiveness show your interest in a positive outcome.

This process shows change is necessary and inevitable if an organization is to survive. It recognizes change can be disruptive and resisted. In order to minimize resistance, managers must plan, implement carefully, prepare subordinates, and be supportive before, during and after.

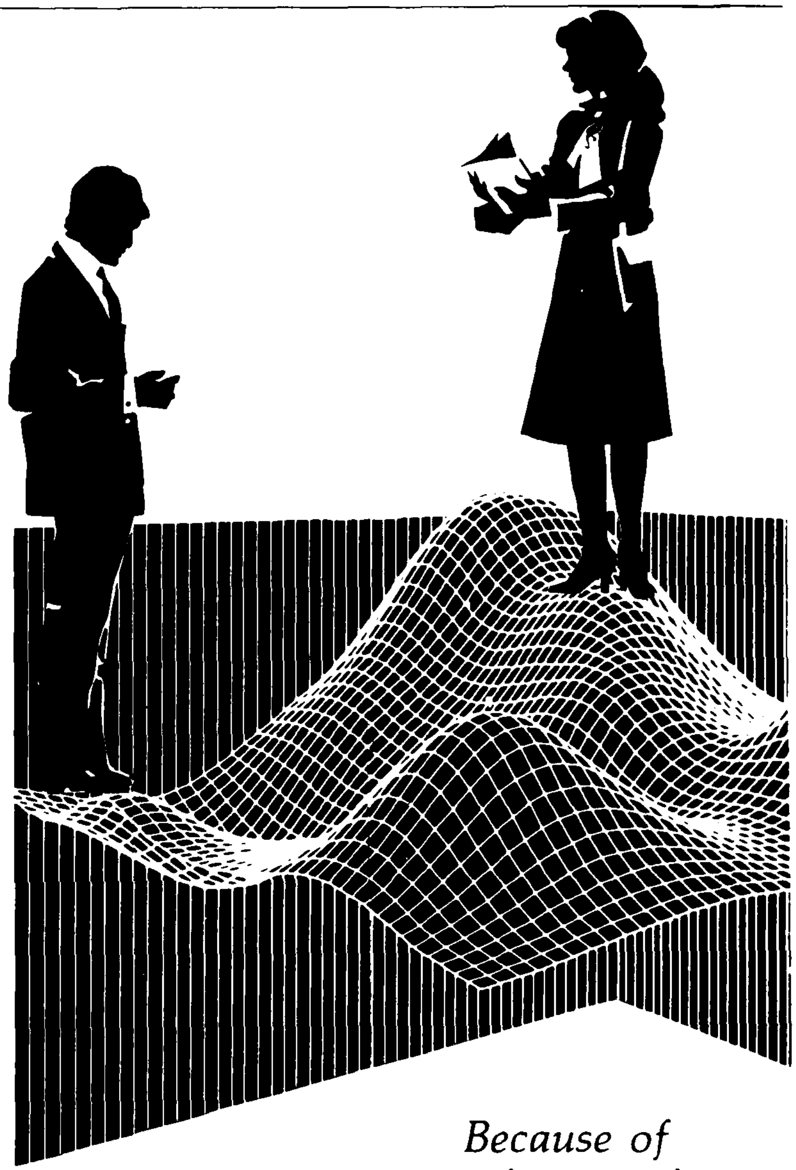
E. Kay in *The Crisis in Middle Management* tries to answer the question: What will the middle manager's role be in the organization of the future? The three organization aspects he identifies as being most critical in defining the role of the future middle manager are information technology, behavioral science technology, and innovations in organization structure.

—**Information Technology**. The electronics revolution is changing the role of middle managers. Economic necessity and technological forces are combining to reshape and reduce middle-management positions; most adversely affected are those that collect information, analyze or interpret data, monitor the work of others and/or serve as advisors. In effect, middle managers with these responsibilities do not run anything. They advise and do not make decisions, only recommendations; they contribute little to customer service or profit, but very much to overhead. The decision to automate these middle management jobs is based on the same cost and productivity considerations as in other work areas. In a Louis Harris poll of middle managers, 85 percent use computer generated data they consider essential to their jobs; 91 percent believe this computer access increases their productivity; 84 percent agreed computers can increase number and variety of responsibilities they can handle; and 67 percent reported their companies are moving ahead with office automation. Information technology does offer middle managers a tool to eliminate information accumulation and processing drudgery. However, in the long run, it will lead to more consolidations and reductions in middle-managment positions.

—**Behavioral Science Technology**. A *Business Week* article titled "Business Fads" identified many management theories evolving since World War II. When these theories were introduced many were thought to be instant solutions to many managerial problems. It was discovered that most were fads, which were quickly discarded. Two of these innovations survived and will have a significant impact on the role of middle managers in the future: job enrichment and participative management. There have been significant changes in the work place to restructure jobs and roles to provide greater participation and job enrichment. A good example is the General Motors joint venture with Toyota in New United Motor Manufacturing, Inc. (NUMMI), where workers are organized into teams of 6-8. Three teams form a group headed by a salaried employee. Decision-making is pushed down to the team level where possible. Problems are solved by team consensus rather than by individuals. The middle manager's role in this type of organization is to serve as a facilitator: as such, establishing a climate for participation in the organization and helping team members become proficient in expanded roles. Dr. Lee E. Garner in *Building Teamwork and Commitment* offers the following advice for managers trying to create a good climate for teamwork:

—Be realistic in expectations of what you can create.
—Demonstrate ethical behavior; be the model for the team.
—Show respect for staff.
—Know and care about employees.
—Involve staff in planning and problem solving.
—Delegate work when possible.
—Recognize when a worker demonstrates commitment.

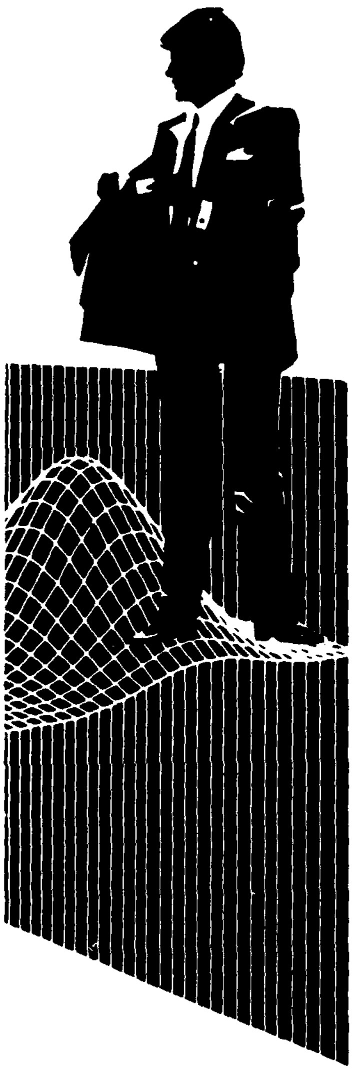
■ *Mr. Gordon is Logistics Management Specialist, Integration Logistic Support Office, Tank Automotive Command, Warren, Mich.*



You will still be required to perform coordination functions not practical for team members, and for complex services, products, or manufacturing technologies, you are a key technical resource to team members.

—**Innovations in Organization Structure**. Another innovative fad surviving is the matrix organization concept, which goes one step beyond the traditional functional organization and provides additional focus on major customers, projects, products or problems. The term matrix, relative to traditional organizational structures, derives from arranging projects in horizontal rows cutting across the traditional organization's vertical func-

Because of economic necessity, technological forces, and the need for fluid organizational structures, more responsibility will be pushed down to middle and lower levels of management.



tional rows; this violates the "one supervisor concept" in that the functional worker now has two supervisors. This arrangement allows matrix managers to draw upon the resources of the different functional work areas to help meet commitments. The matrix organization and variations have significant implications for middle managers. The negative aspects are:

—Reduces need for middle managers because hierarchy tends to be reduced or flattened.
—Provides more opportunities to reward individuals adequately for technical performance without having to promote to middle management positions.

Matrix organizations have positive aspects for middle managers, such as:
—Affords opportunity to expand skills and get a broader view of how organization operates.
—Offers more opportunities for lateral moves into new functional work areas.
—Provides more intrinsically satisfying jobs because the individual is closer to contributing more directly to final product or service.

John Naisbitt and Patricia Aburdene in *Re-inventing the Corporation* discuss the middle manager's future role in relation to information technology, behavioral science technology, and innovations in organization structure. For information technology they say that "Today, computers are replacing middle managers at a much greater rate than robots are replacing assembly line workers. Once indispensable to senior executives, many middle managers are now watching computers do their job in a fraction of the time and at a percentage of the cost." In regard to behavioral science technology, self-management is replacing staff management. This change in management philosophy is recognizing that human beings can make or break a business. Innovations in organization structure will flatten out traditional hierarchies. The wide array of largely self-managing structures include networks, multidisciplinary teams, *ad hoc* and small work groups. The authors state that "Worldwide, middle management has shrunk more than 15 percent since 1979. And there is more to come."

Your success as a middle manager will depend on your ability to deal competently with the responsibility shift from specialist to generalist, and the expanded interdisciplinary personnel role. Some skills and abilities like planning, communicating, organizing, and monitoring will remain as important in the future as they are today. Skills and abilities becoming more important in the future are performance management and appraisal, problem analysis and decision-making, collaboration, and conflict resolution. Technology is changing the very nature of, and need for middle management positions. Middle managers of the future will have to be generalists who can readily adapt to changing technologies. ■

Generator Saves $6 Million

If you haven't noticed, there's a new look in the Army. It's not the wet look, dry look, or dramatic fashion change. It's a new look in power units and power plants. The Army's standard power units and power plants fabricated on 1 1/2- and 3/4-ton trailers at Tobyhanna Army Depot, Pa., are hitting the streets looking sleeker and lighter.

Trailer design changes initiated by James Zoerb and Dan Krenitsky of the Troop Support Command Belvoir Research, Development & Engineering Center have simplified and standardized construction of new power units and plants. Instead of performing all welding operations to fabricate the trailers' decks, the decks are stamped and formed into standard shapes. This method has improved material usage, reduced depot-level fabrication, handling, and labor by approximately 20 percent and reduces the average sheets of steel used per trailer from 2 to 1 1/2.

Additionally, an overall reduction in the thickness of steel stock used for the trailers' flatbed decks was incorporated. By reducing deck thickness from 1/4-inch steel to 1/8-inch steel, an average weight reduction of more than 500 lbs. per trailer was achieved.

Total fiscal '86 savings, shared with Tobyhanna Army Depot, amounted to more than $6 million on all power units and power plants fabricated. A Value Engineering proposal submitted by Krenitsky from the Support Equipment Team, within the Power Conversion and Distribution Division of the Logistics Support Directorate, outlined and documented the cost savings. ■

Whenever in this publication "man," "men," or their related pronouns appear, either as words or parts of words (other than with obvious reference to named male individuals), they have been used for literary purposes and are meant in their generic sense. ■

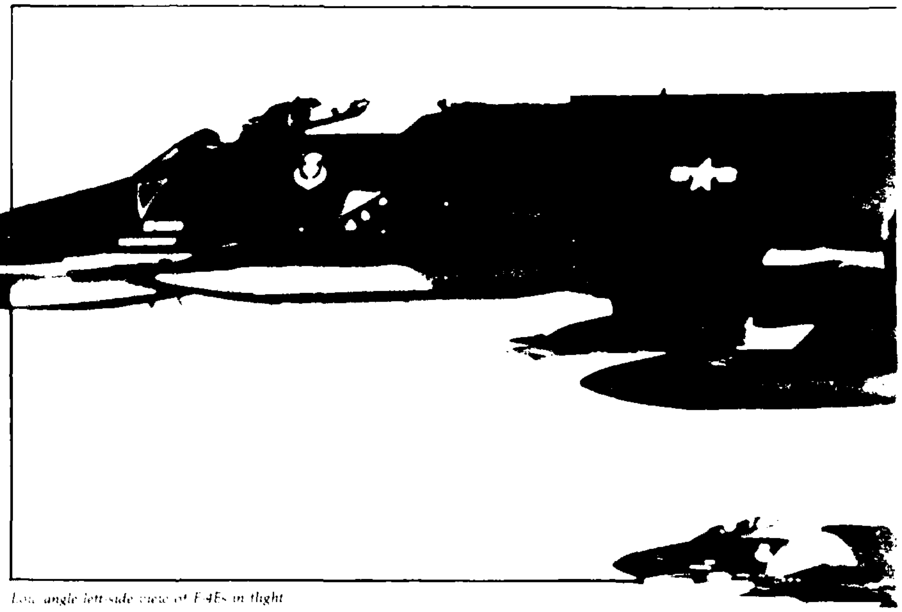
QUALITY

DEFENSE NEEDS MORE SYSTEMS ENGINEERING

Paul J. McIlvaine

The result of the current defense posture of the United States has been to place government systems management in a unique and critical position. The major thrust of this defense posture is for the United States to pursue a policy of qualitative superiority in defense systems that will overcome the quantitative advantage of any potential adversary; this is the opposite of the successful strategy pursued by the United States in World War II, which emphasized a quantitative advantage in arms.

To implement this current defense posture and maintain a qualitative edge in defense systems requires constant upgrade of defense systems to incorporate the latest technological advantage. A dilemma we face is that the increasing length and complexity of the defense acquisition cycle for new systems (which may require 12 years from requirement to initial fielding of a production system) with rapidly changing technology (in some cases, a new generation of technology every 2-6 years) result in the fielding of new systems with technology behind the "state of the art." In dealing with this dilemma, product improvements, modifications, engineering changes, service life extension programs, and the like have become the norm, (See Figure 1). One only need to compare money spent on new starts versus all forms of modifications to become convinced of this.



Low angle left-side view of F-4Es in flight

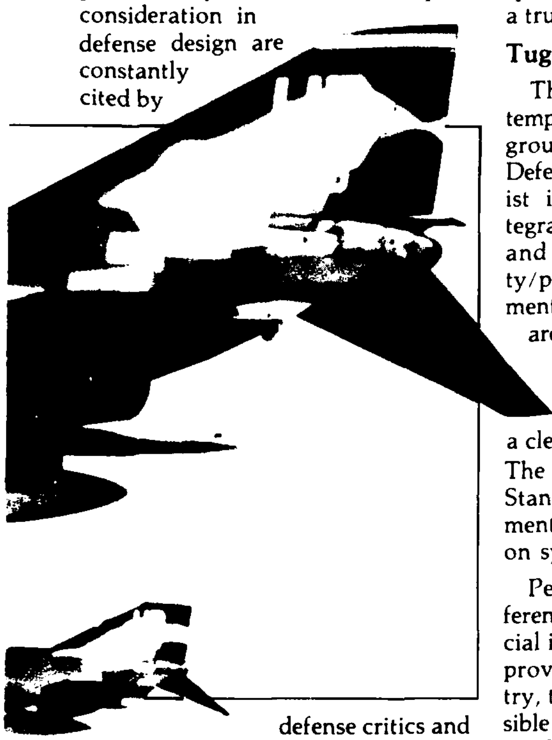
Long Lines

The difficulty in successfully executing a new start and other problems have resulted in defense systems leading service lives often extending 20-50 years. For example, some current F-4 aircraft have been in the inventory 22 years. The B-52 aircraft will see a service life in excess of 50 years. The USS New Jersey/USS Iowa will see similar lives. The M-60 Tank is expected to remain in the Army inventory past the year 2000. The bottom line is that the total cost to the government of a system during its full life (life-cycle cost) is being dominated by operation and support (logistics) costs and production costs (See Figure 2). Hence, logistics supportability and producibility considerations should permeate all aspects of systems management and dominate defense thinking. Ease of modification, to keep up with technology that changes at a greater rate than ever before, should be one of the top design requirements in virtually all major systems. It seems the one certainty in defense systems management is that things will change!

In light of modifications, engineering changes and the like, it is clear that "system acquisition management" is obsolete. The U. S. Air Force Destination 1999 Study pointed out that many modifications are generally as difficult as the original design problem, citing that it was as demanding an engineering task to modify the B-52 Force or the C-5 Wings as the engineering in many new development programs. In fact, a new system acquistion requires the technical activities of design, test, and manufacture before the system is deployed and subsequently operated and supported (used) for a period ranging up to 50 years. Similarly, a modification to an existing system requires the technical activities of design, test, and manufacture before the modification is installed and subsequently operated and supported.

Therefore, "system acquisition management" needs to be replaced with the term "system life-cycle management" to reflect current reality. Program management, likewise, is applicable to the five phases of the system life cycle: concept exploration, demonstration/validation, full-scale development (collectively referred to as development or RDT&E), production/deployment, and operation support.

This creates a need for disciplined, holistic systems engineering applied to defense systems during the entire life cycle. Although logistics and production cost account for approximately 90 percent of total life-cycle cost, virtually all major logistics supportability and producibility decisions are made by engineers (knowingly or unknowingly) during execution of the systems engineering process in the RDT&E phases of a defense program. Past problems in which supportability and producibility have not had adequate consideration in defense design are constantly cited by defense critics and have been dealt with via the designation of increasingly vocal advocates for specialty disciplines (ilities); these advocates are directed to apply constant pressure to influence design from their particular areas of specialization. Many of these specific disciplinary areas, shown in Figure 3, have developed their own power structures and directives. This may solve a short-term problem, but creates the danger of suboptimization if carried to an extreme over time.



Systems engineering is the discipline controlling the whole design process to achieve an optimum balance of *all* system elements (See Figure 4). It is the only discipline that can achieve a true system optimization through integration and balance among the various disciplines that are impacted by a systems design rather than the uncontrolled optimization of individual elements. Advocacy for disciplined, holistic, integrated systems engineering must have a voice greater than, or at least equal to, the voice expressed by each specialty element. Leadership to provide a clear understanding of system goals and methodologies is needed to meet the increasing performance, supportability, producibility, cost, and schedule demands being made for defense systems; also to provide focus, checks, and balance among many specific elements that combine to make a truly optimized total system design.

Tug of War

This tug of war is a significant contemporary problem in defense. Specific groups and specific Department of Defense (corporate level) directives exist in the test and evaluation, integrated logistics support, reliability and maintainability, producibility/production, configuration management, safety, technical data, and other areas; yet, no single defense (corporate level) directive exists on systems engineering. Suboptimization remains a clear and present danger in defense. The only current guidance is Military Standard 499 on engineering management, and Army Field Manual 770-78 on systems engineering.

Perhaps a closer look at the differences between defense and commercial industry systems engineering will provide insight. In commercial industry, the entrepreneur is largely responsible for the design, development, test, production, marketing and, to varying degrees, logistics support of the commercial system during its full life. As such, the life-cycle perspective permeates truly excellent commercial organizations and results in superior product knowledge. Forces of the marketplace impose considerable cost consciousnes and discipline on engineering. For example, if a commercial aircraft cannot be sold or profitably operated for more than $58 million per copy, then that (design to cost) constraint must dominate all aspects of engineering or there will be no viable product and, ultimately, no viable business enterprise. To make a clear over-generalization, cost tends to dominate commercial engineering.

Defense industry does not follow the same breakout of responsibility as does commercial industry.

In defense, the government specifies system requirements, oversees contractor design and manufactuning, shares different aspects of developmental and operational tests, and generally operates and supports the system with industry providing necessary material, spare parts, etc.

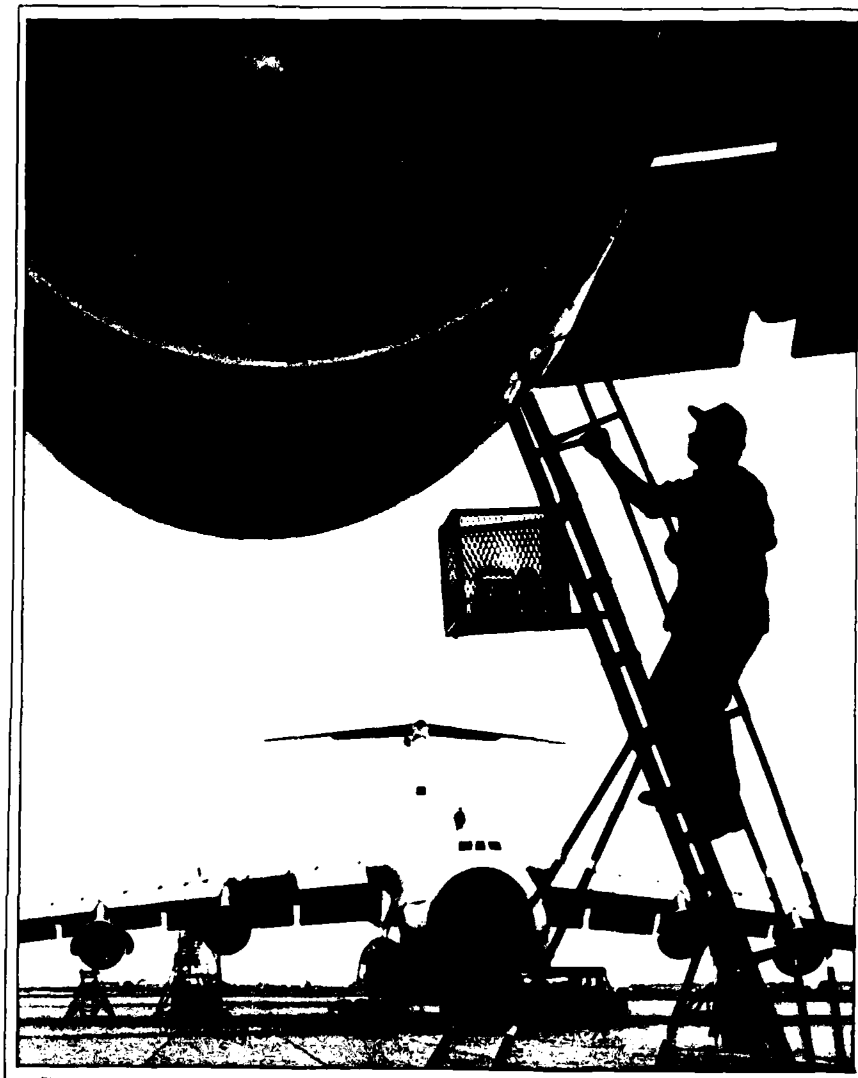
Defense industry reacts to government specifications, designs and manufactures the system, and generally has a secondary role in the ultimate operation and support of equipment. An arms-length relationship between government and defense industry is encouraged and mandated; however, this may preclude careful and systematic tradeoff of cost versus quality considerations at all times during development. This requires the government to discipline itself to specify what is required, but not how to design it. This requires the government to conduct an early requirements scrub to prioritize its need into mandatory, desirable, and nice-to-have requirements, in light of the cost implication of each requirement. This is difficult while maintaining an arms-length relationship, because the contractor often has better cost data. The fact remains that requirements are set early and are the first order determinants of life-cycle cost. Another overgeneralization: Performance tends to dominate defense engineering.

There is a trend for greater cost consciousness in defense and reform of the system acquisition process. An Acquisition Streamlining Initiative was established in 1984 by the Deputy Secretary of Defense and institutionalized in 1986 by the formal publication of a corporate-level DOD Directive 5000.43 on acquisition streamlining. The initiative goal is to reduce the cost and/or time of system acquisition and life-cycle cost without degrading system effectiveness. The methodology to achieve this goal is allowing early industry involvement in recommending the most cost-effective solutions to defense requirements through:

—Specifying contract requirements in terms of results/objectives rather than how to design or how to manage

—Precluding premature application of design solutions, specifications, and standards

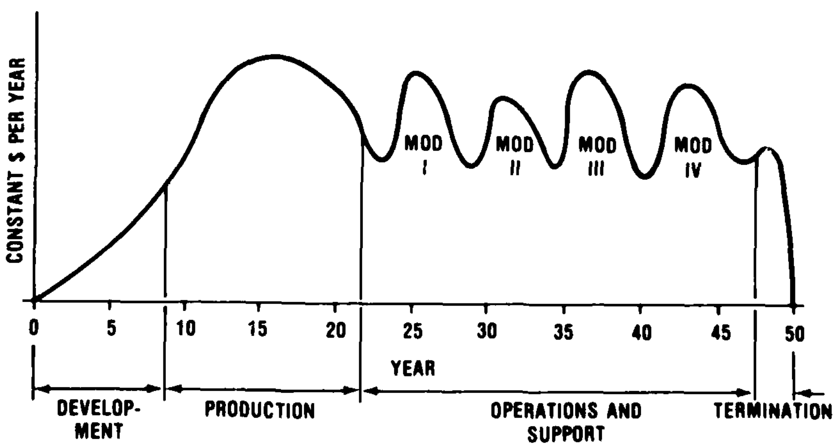
—Tailoring contract requirements to the unique circumstances of the pro-



--Photo courtesy of Lockheed

Ground crew performs post-flight check on C-5A Galaxy at Travis Air Force Base, California. The C-5 is the world's largest aircraft and the only one that can transport the military's largest and heaviest air cargo.

Figure 1. System Life-Cycle Expenditures



gram at hand, vice the boilerplate approach of the past

—Limiting tiering, the uncontrolled incorporation of government specifications and standards by reference.

Proper application of this streamlining initiative to defense should result in defense contractors having greater flexibility and freedom in design and design tradeoffs through streamlined requirements provided by the government. When coupled with other efforts in defense like warranties product performance agreements, the net result may be greater opportunity and greater risk for the defense industry as a whole.

Major Implications

Three major implications for defense rise from the Acquisition Streamlining Initiative:

—Defense Industry must be particularly strong in the systems engineering area. Cost effectiveness tradeoffs and analysis of major design alternatives need increased emphasis in the future. Contractors must develop solid methods to articulate these studies' results to the customer (government) that result in progress—not added controversy or distrust. Greater flexibility and freedom in design must be coupled with greater balance and integration of the individual contributions of the design team members. Adequate consideration of each engineering specialty discipline is even more important in the absence of past rigid specifications. This is an essential role of systems engineering.

—The Department of Defense must clearly establish greater advocacy for systems engineering. This must be greater than or equal to the level of advocacy that exists in defense for functional disciplines such as reliability, producibility, supportability, etc. Individuals in functional disciplines must trust that holistic systems engineering will adequately represent their interests and result in a reliable, producible, supported system that performs well in the intended operational environment at an affordable cost.

—A clear measure of the technical excellence and cost of a defense system must be coordinated and established for use in system acquisition programs if acquisition streamlining is to work.

Informed designed tradeoffs can only be made in light of an established and accepted goal between customer and developer. This goal must be clear and simple so that every team member can articulate it; and likewise it must reflect an optimum balance of all system elements. An excess of objectives permeate defense directives, confusing participants. For example:

—Operational suitability and operational effectiveness are defined by DOD as objectives of equal importance as management precepts.

—Improved readiness and sustainability are defined as primary objectives of the acquisition process.

—Defense systems should be cost effective and responsive to mission needs.

—A cost-effective balance must be achieved among research, development, production, and ownership cost of major systems, and systems effectiveness in terms of the mission to be performed.

—Cost is a parameter equal in importance to technical and supportability requirements and schedules.

—Engineers and managers shall achieve a proper balance in design to cost emphasis between acquisition and operation and support costs.

—Readiness goals and related design requirements shall receive emphases comparable to that applied to cost, schedule and performance objectives.

If defense industry is to be given greater flexibility and earlier involvement in design, the government must provide crystal-clear objectives to gain the maximum benefit from this strategy of acquisition streamlining. Does operational suitability plus operational effectiveness equal system effectiveness? Do technical and supportability requirements equal performance? Do readiness and sustainability objectives equal technical excellence? The answers must be clear if streamlining is to work.

Significant Changes

The 1981 Defense Acquisition Improvement Program, the 1985

Figure 2. Typical System Life-Cycle Cost

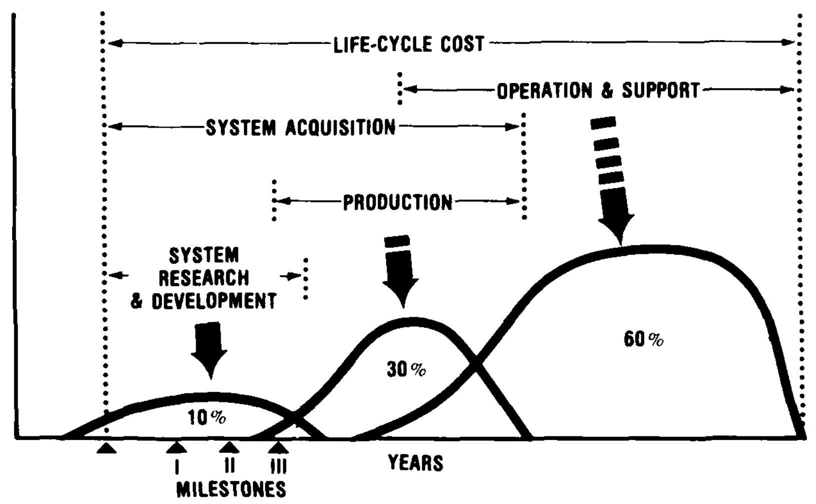
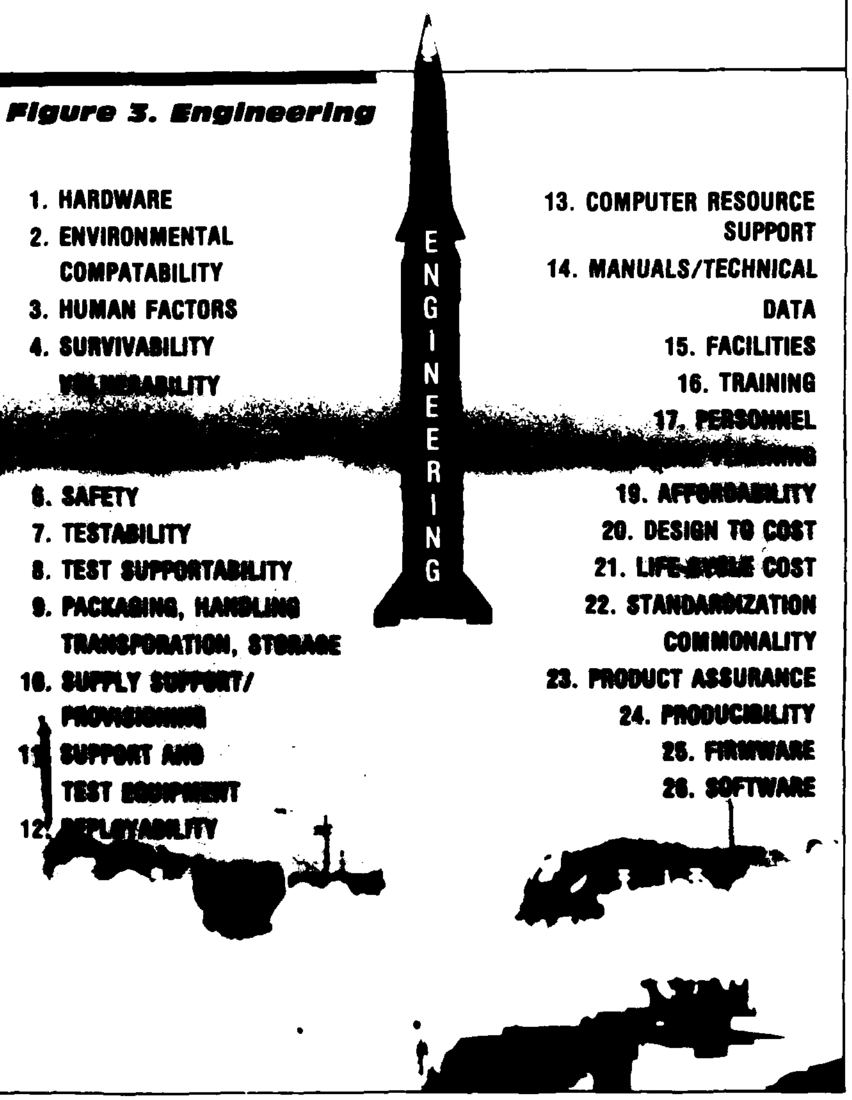


Figure 3. Engineering



U.S. Air Force Boeing B-52 bombers on the assembly line at the Boeing Aircraft Plant
—U.S. Air Force Photo

Any Department of Defense reorganization must be coupled with clearer definition, process, procedures, and advocacy for systems engineering which is at the heart of defense acquisition.

Goldwater-Nunn Report, the Packard Commission Report, and other studies advocate significant changes within the defense acquisition community. It is generally accepted that organizational change alone will not significantly alter the current mode of doing business. Any Department of Defense reorganization must be coupled with clearer definition, process, procedures, and advocacy for systems engineering, which is at the heart of defense acquisition. All effort in support of defense acquisition must focus on the system, or product, and the achievement of a balanced approach to the timely design of a capable, producible, supportable system at an affordable life-cycle cost. To do so requires people trained in the optimization of the total system through careful integration and trade-off of each of the major functional disciplines; i.e, true system engineers. True system engineering requires people whose expertise is integration and trade-off among different and often conflicting functional disciplines.

This starts with the accelerated identification, education, development, and retention of creative, competent, and motivated system engineers genuinely concerned with achieving a balance among technical excellence, cost, and schedule, and receiving peer pressure to achieve in each area. Career assignments in logistics, test, production, and value engineering, as well as design engineering, must be provided to allow one to gain necessary experience to develop the sound judgment essential for a system engineer. Many undergraduate engineering institutions, in their haste to instill the knowledge demanded by increasing specialization, inadvertently leave young engineers with the impression that their job is just to "make it work," and that they bear no responsibility for supportability or producibility, which are the major life-cycle cost drivers. Dr. Hisashi Shinto, president of Nippon Telegraph and Telephone, said many U.S. companies have ceased the practice of initially assigning young engineering graduates to the production line, where they would gain invaluable experience with

Figure 4. Definition of System Engineering

"The application of scientific and engineering efforts to (1) Transform an operational need into a description of a system configuration which best satisfies the operational need according to the measures of effectiveness: (2) Integrate related technical parameters and assure compatibility of all physical, functional and technical program interfaces in a manner which optimizes the total system definition and design: (3) Integrate the efforts of all engineering disciplines and specialties into the total engineering effort.——FM 770-78

the production process that could yield greater productivity in the production of quality products. Consequently, U.S. engineers of the current generation seem to attach themselves to computer keyboards in the office, not to robots on the shop floor.

Reorientation

Value engineering is an example of a discipline needing reorientation to be more effective in this country. Value engineering in the defense business has been classically looked upon as redesign of an existing system (to be more cost effective) after it has been designed and produced, usually an expensive time to change anything. The best time to change a design is before a design freeze. The first iteration that a design engineer goes through is usually to simply make the system work; this probably will never change. If the exigencies of an under-funded program or pressure for drawing release forces the designer to s here, then we have lost one of the most important cost-reduction opportunities in the system life cycle. A second, third, and even a fourth design iteration performed at this stage in the life cycle can make a system more producible, supportable, or less costly. Additional effort in this area may increase development cost and lengthen the schedule, but should significantly reduce production/operation and support cost. This, in addition to the classical view of value engineering, could provide major contributions to defense objectives. Clearly, we need greater advocacy in this area.

The United States of America has the technological capability to build reliable, supportable and producible systems that perform well and are reasonably priced. The most difficult challenge lies in making intelligent and deliberate choices through careful trade-offs that characterize the system engineering process. These choices and trade-offs are judgments made by people. These people must be given the opportunity of exposure to each key discipline that constitutes defense systems engineering. Likewise, defense industry must be challenged as never before. Consensus for defense in this country depends on it.■

■ *Mr. McIlvaine is Director of the Technical Management Department, Defense System Management College.*

DSMC Monograph: Designing Defense Systems

Product definition is the common thread in the system acquisition process. Creating the definition through the design process often involves resolution of ambiguous requirements and facing tough tradeoffs in performance, supportability, cost and schedule. Until now, design literature has focused primarily on individual functional approaches which have reached 26 at the Defense Systems Management College. To achieve a higher integration of design material the College has published a monograph, *Designing Defense Systems*, which is used as reference reading for specific and general "design for" classes and as a student aid in overall integration of system acquisition education.

This monograph describes contemporary tools, talent, issues, and techniques applicable to designing defense products. Objectives are to provide insight for managers concerned with the design functions. It provides designers with a better understanding of the scope, tools, and issues involved.

The first consideration is designing for the product's life cycle. This relates designing for performance to designing for quality, reliability and maintainability, production cost and special system requirements; e.g., system safety, human engineering, electromagnetic compatibility, contamination and corrosion control, survivability/vulnerability, hardware/software integration, and operation and support. These individual technical functional designs and interrelationships of performance, fitness for use during the life of the equipment, scheduled deliveries, and budget constraints are discussed. Also addressed are managing the design process, state-of-the art in design tools, talent, and computer aids for the task.

The material is based on publications by the author, Wilbur V. Arnold, and as co-author in *Program Manager*; also, readings and charts developed for the College Program Management Course by him and faculty members of the DSMC Technical Management Department. Researchers feel this work fills a void in design integration literature. A limited number of copies may be obtained by writing to:

Director of Publications (DRI-P)
Defense Systems Management College
Fort Belvoir, Virginia 22060-5426■

Guide Addresses Systems Engineering Techniques

The Defense Management College has released a second edition of its guide to acquisition management. The *Systems Engineering Management Guide* is an educational tool designed to acquaint the newcomer with systems engineering concepts and techniques, and to identify relevant directives and references.

The guide is one of a family of publications intended primarily for Department of Defense acquisition managers having some familiarity with its basic terms and definitions; it should assist government and industry personnel in executing management responsibilities relative to the acquisition suport of defense systems. It can be used as a desk reference for program and project management personnel. The publication concerns evolution of systems engineering and the systems engineering process, government acquisition policies, and the systems life cycle. It describes the systems engineering management plan, and engineering integration in the systems engineering process.

This comprehensive 368-page publication, *Systems Engineering Management Guide*, stock number 008-020-01099-5, is available for $17.00. Send prepayment to Dept. 36-VT, Superintendent of Documents, Washington, DC 20402-9325; to order with Visa, MasterCard or Choice, phone (202) 783-3238.■

MISSION CRITICAL COMPUTER RESOURCES

Major General Jerry Max Bunyard, USA
Assistant Deputy Chief of Staff for RD&A

Complexity of military weapons has increased steadily because of modern warfare's growing demands. These demands are being met by using mission critical computer resources. Today's Army is challenged with requirements for developing weapon systems relying on mission critical computer software. Computer software, which is becoming more complex, is germane to implement command, control, communication and intelligence (C^3I) processes for today's materiel systems. Due to software's critical nature, management must become more apprised of major software issues and must be able to assess software development progress, quality and cost throughout the software life cycle.

The review process by top management in the military services, under the new acquisition process, includes the project manager (PM), program executive officer (PEO) and service acquisition executive (SAE). These management levels must be informed properly through definitive schedules, specified milestones, measurable products and evaluation criteria. This is necessary if they are to make effective program level decisions for mission critical defense systems (MCDS)[1] that contain mission-critical computer resources (MCCR)[2]. We must ensure by some means that computer resources in Army's MCDS are planned, developed, acquired, tested, fielded and supported in a timely manner that also minimizes life-cycle costs. Currently, the Army does not have one general policy defining the software acquisition framework. Numerous regulations, pamphlets, technical bulletins and letters have been promulgated and cover most of the software life cycle.

Software evaluation *must* be addressed from the total life-cycle process with proper attention being given not only to evaluation during initial development, but to critical aspects of software during maintenance. At this time, software continues to be enhanced, modified, corrected and tested. This broader examination of the software life cycle will require proper emphasis on software documentation and support software, and on executable code and testing.

The DA Pamphlet 11-25 is being revised. It will help guide the project manager and top-level management during the review process of major Army systems containing mission-critical computer software. The Air Force Systems Command has promulgated a *Software Management Indicators* pamphlet (January '86) providing management indicators for acquisition managers and their counterparts in industry to gain insight into the software development process. Key feature of the Army-revised pamphlet will be a check list for a manager to follow, providing guidelines for major areas of emphasis needing to be properly addressed during the software development process.

Software reviews must consider a wide range of potential concerns to assess potential program risk. For example, candidate areas needing to be explored during review of full-scale development would include: cost estimation techniques, development methodology employed, measures of test completeness, audit of outstanding discrepancy reports, quality and detail of documentation, functional and physical configuration audit and design review results, and role/results of independent verification and validation (IV&V) activities. As each area is explored, guidelines must be summarized at a sufficiently high level consistent with the level of management responsible for the given review.

A major interface to this evaluation process should be the Life-Cycle Software Engineering (LCSE) Centers which have been established throughout the Army. For example, charters of the LCSE centers at MICOM and CECOM include: (1) IV&V support to the project offices while prime contractors are active; (2) maintaining selected fielded software; (3) provide centralized management of system's computer resources to include planning, acquisition, engineering, configuration management and assessment testing; and (4) technology consulting to the entire command for computer/software/standards areas. The LCSE centers can provide independent inputs to all levels of management reviews described above and should be intimately cognizant of the overall issues regarding life-cycle software support—from cradle to grave. The results of two primary areas of inspection should be available during the software life cycle, namely development and operational testing (DT/OT).

Both are key in the evaluation process provided by LCSE centers. If follow-on evaluations are done, this data also should be made available to LCSE centers.

Throughout the years, many discussions about the software life-cycle process have taken place and much work has been done by people in the Department of Defense. Of particular note was the outstanding work in 1979 by the Computer Software Management subgroup for the Joint Logistics commanders. Several of their thoughts and recommendations are contained in this paper; notwithstanding, much remains to be done. Principal focus of the revised DA Pamphlet 11-25 will concern elements germane to the review and decision-making process at the PM, PEO, and SAE management levels. Specific software issues and products to be reviewed for each major acquisition review milestone will be defined. A check list will be developed for management to provide guidelines to follow in the software management process. In order for the reader to have a layman's knowledge of the magnitude of this subject, a cursory view is provided of highlights of key elements of the software life cycle, and how it interfaces with the system life-cycle model.

Key Elements of Software Life Cycle

MATERIEL SYSTEM LIFE CYCLE. The Army process for conceiving, developing, acquiring, and fielding new items of equipment is formalized in a Life Cycle System Management Model (LCSMM) for Army systems, described in detail in DA Pamphlet 11-25. This cycle consists of four phases: concept exploration, demonstration and validation, full-scale development, and production and deployment.

Tailoring the LCSMM to specify program needs is encouraged. Tailoring an acquisition program provides flexibility to modify the standard acquisition process as a reactive necessity, and also to make proactive planning decisions which significantly alter, combine or eliminate phases in the process. A complete discussion on the tailoring process is in AR 70-1, 12 November '86, and Annex D of DOD-STD-2167.

When systems do not follow a normal system life cycle, the software activities, reviews, products, and baselines remain applicable and must be scheduled in the context of the tailored life cycle. The associated software development cycle, as described in DOD-STD-2167 (Jun '85), consists of six phases: software requirements analysis, preliminary design, detailed design, coding and unit testing, computer software component (CSC) integration and testing, and computer software configuration item (CSCI) testing. These activities lead to and are required during software support. Associated with each activity are corresponding software products and documentation representing work effort for that activity.

Whenever computer software is engineered, the corresponding activities, reviews, products and baselines are applicable. This set of activities may be repeated if the software is redeveloped, modified, refined or corrected during any phase of the system life cycle. Activities can occur sequentially, overlap in time, or proceed concurrently. In the last case, different portions of the software are engineered in parallel, each portion proceeding sequentially through the activities. The total software development cycle or a subset may be performed within each of the system life-cycle phases. Successive iterations of software development usually build upon the products of previous iterations. It is imperative that appropriate emphasis be placed on integrating the software development activity within the broader system acquisition framework and that software development is not treated as a discrete activity. The acquisition of computer software for a defense system must be an integral part of the system acquisition process.

SOFTWARE DEVELOPMENT CYCLE. As explained above, the software development cycle has six separate phases. This discussion gives a brief description of the purpose and results of each. Figure 1 shows the software development cycle and its relationship with the system phases plus associated reviews, audits, documentation, configuration management, and test and evaluation.

—*Software Requirements Analysis*. The purpose of this phase is to define and analyze completely the requirements of the software. Preceding this phase, the functional software baseline will have been established through a system software requirements definition and finalized during a Systems Requirements Review. These requirements include functions the software is required to accomplish as part of the system, segment, or prime item. Additionally, functional interfaces and necessary design constraints are defined. Results are documented and approved requirements for the software. This establishes the allocated configuration identification or the allocated baseline of the system.

—*Preliminary Design*. The purpose is to develop a design approach including mathematical models, functional flows, and data flows. During this phase, various design approaches are considered, analysis and trade-off studies are performed, and design approaches are selected. The result is a documented and approved top-level design of the software. This phase establishes the developmental configuration baseline for the software.

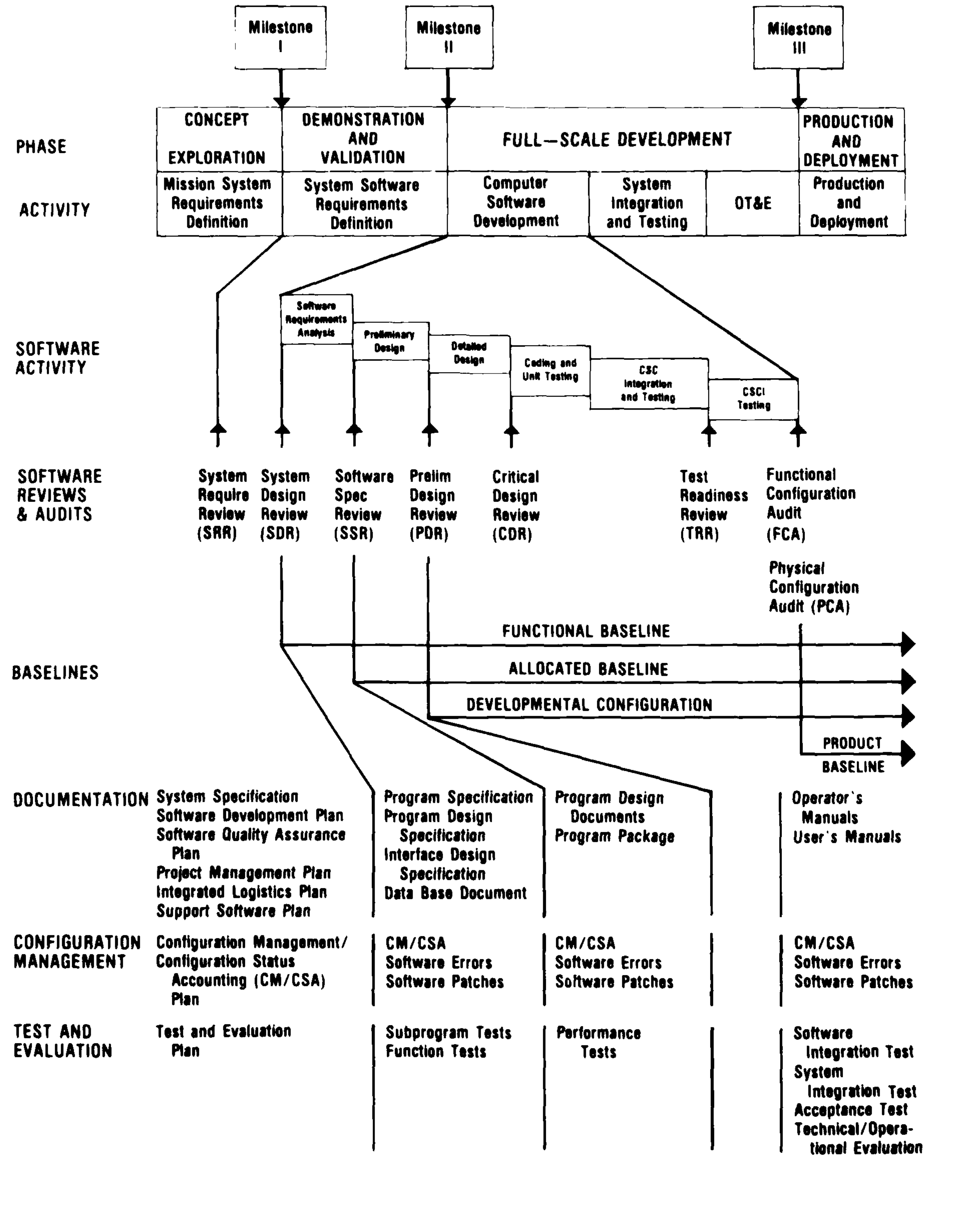
—*Detailed Design*. This phase refines the design approach so that each top-level computer software component (TLCSC) is decomposed into a complete structure of lower-level computer software components (LLCSC) and units. The detailed design approach is provided in detailed design documents and reviewed against the requirements and top-level design before initiating the coding phase.

—*Coding and Unit Testing*. The purpose is to code and test each unit of code described in the detailed design documentation. Each unit of code is reviewed for compliance with the corresponding detailed design description and applicable coding standards before establishing internal control of the unit and releasing it for integration.

—*Computer Software Component (CSC) Integration and Testing*. The purpose is to integrate and test aggregates of coded units. These tests are based on documented integration test plans, test descriptions, and test procedures. The test results, test plans, descriptions, and procedures for testing the fully implemented software are reviewed before the next phase of testing.

—*Computer Software Configuration Item (CSCI) Testing*. The purpose is to

Figure 1. Software Development Cycle



test the fully implemented computer software configuration item. The test will concentrate on showing that the software satisfies its specified requirements. Test results should be reviewed to determine whether the software satisfies its specified requirements. The product baseline configuration is a result of this phase.

DOCUMENTATION. Documentation should be obtained in a timely manner to ensure successful development, operation and support of the computer resources throughout the system life cycle. Procurement and contractual documents should explicitly establish Department of Defense rights to all computer resources required to develop, operate, simulate, test and support the system. This includes computer hardware, computer software, and documentation required for system maintenance and modification.

CONFIGURATION MANAGEMENT. The Computer Resource Management Plan (CRMP) should identify configuration management responsibilities and procedures that will ensure configuration control of computer resource baselines throughout the system life cycle. Computer hardware and software should be identified, specified, and managed as configuration items. The mechanism for controlling computer hardware and software changes is the documentation for each configuration item, and it is the responsibility of the system configuration manager to ensure that this documentation is accurate and current. Software configuration management establishes the discipline for software design. This discipline is executed by completion of the following:

—Identifying the documents and computer programs to be controlled

—Establishing baselines and change control

—Providing status accounting of baselines

—Auditing for compliance to customer requirements

—Ensuring an orderly process of filing/storage of documents and computer programs.

SOFTWARE QUALITY EVALUATIONS. Software quality should be managed as a major consideration during all phases of the system life cycle. The development activity has the responsibility to establish a software quality program (SQP) and to manage the SQP as a part of the mission critical defense systems. The Life Cycle Software Engineering (LCSE) centers should participate in the SQP from the outset. It is envisioned that the LCSE centers would perform the software engineering and evaluations. The LCSE centers may contract for independent verification and validation (IV&V) to do those technical tasks the LCSE centers would normally do if they had requisite technical manpower in-house. These tasks would include such things as design verification, product development traceability, technical review of prime contractors' development activities, and validation of test results through analysis, separate testing, and contractor test monitoring. The LCSE center and the associated IV&V contractor should be independent of the developing agency. The value of this method stems from the true objectivity that can be derived by an independent group.

SOFTWARE ACCEPTANCE CRITERIA. Unlike hardware, successful development of software cannot be based on passing a definitive test at the end of development. Experience has shown that the end-item acceptance approach to software is disastrous. Acceptance based on this approach provides no warning of an unsatisfactory product until a point is reached where recovery becomes exceedingly expensive in terms of cost and schedule. Therefore, it is concluded that various software acceptance criteria must be applied at well-defined points of the development phase of the software life cycle. These acceptance criteria must be applied at meaningful milestones in the cycle and must not be allowed to be ignored for reasons of expediency. The project manager should have definitve acceptance criteria to ensure that the delivered operational software works. Also, this would: (1) allow the extent of acceptable development progress to be quantitatively measured, (2) improve visibility into the developmental status of software throughout the developmental cycle, (3) provide a better basis for software acquisition managers and software developers to agree on job completion criteria, and (4) provide a basis to express in a better way the quality of delivered software. Therefore, it is concluded that software acceptance criteria should be developed as a check list for use at all approval disapproval events wtihin the software acquisition cycle.

POST-DEVELOPMENT SOFTWARE SUPPORT. A Life-Cycle Software Engineering (LCSE) center should be designated for each mission critical defense system (MCDS) and should manage and control the software support for assigned MCDS. The LCSE center should perform tradeoff analyses to determine level and method of software support. Resources determined necessary to establish support capabilities include facilities, personnel, data, documentation, and training. The LCSE centers should establish organic technical (computer and system) and managerial expertise for the pre-deployment efforts and post-deployment support of computer resources. This expertise should be within or under the direct control of the LCSE centers, independent of any system prime contractor or computer software development agency or sub-contractor.

Conclusions

At present the Army does not have one general policy defining a software acquisition framework. Numerous regulations, pamphlets, technical buletins and letters have been promulgated covering most subsets of the software life-cycle process. However, neither the project manager program executive officer nor the service acquisition executive can turn to any one policy document to determine what constitutes the life-cycle software acquisition management process. To remedy this deficiency, DA Pamphlet 11-25, *Life Cycle System Management Model for Army Systems*, is being updated to include the entire software life cycle. This policy framework should provide the foundation for formulating and revising software acquisition.

Currently, no formal guide exists to help the project manager and top-level management during the review process of mission critical defense systems that contain mission-critical computer resources. However, in conjunction with a change to AR 70-1 and 70-10, a separate appendix to DA Pamphlet 11-25 is being developed to assist different management levels during review milestones, to be supplemented by management oversight authority tailored to each mission critical defense systems. A key feature will be a check list whereby a manager can provide guidelines for major areas of emphasis needing to be addressed during the software development process; included will be overall software acceptance criteria, which must be applied at meaningful milestones in the cycle and must not be ignored for reasons of expediency. The operational tester should be a participant in the development of these criteria. The program manager, in conjunction with the operational tester, should develop definitive acceptance criteria to ensure delivering operational software that works and has the appropriate documentation and configuration management to support the software after deployment. Guidelines will be summarized at a sufficiently high level consistent with the level of management responsible for the review.

By updating DA Pamphlet 11-25 and the incorporation of software development policy and guidelines, managers at all levels will, for the first time, have one source document to assist in their materiel systems review and decision-making process. ■

Cited References

1. A Mission Critical Defense System (MCDS) is any system that includes, as a part of, or totally comprises a mission critical computer resource or an embedded computer resource (ECR).

2. The term Mission Critical Computer Resources (MCCR) includes those computer resources identified in Section 908 of the FY 1982 Defense Authorization Bill (Warner-Nunn Amendment). It includes resources involving intelligence activities, involving cryptological activities, involving command and control, involving equipment that is an integral part of a weapon or weapon system, or critical to the direct fulfillment of military or intelligence missions.

Training with Industry Program

The Training with Industry program provides training to Army officers in industrial procedures not available through the military service school or civilian university systems.

The objectives of the program are to:

—Provide a nucleus of officers trained in managerial techniques and the relationship of specific industries to related functions in the Army.

—Enhance the capability of officers to perform Army special program activities.

—Serve as a source of information concerning innovations in industrial management practices and techniques.

—Teach officers how major defense contractors and other firms do business, and have them use the information to the Army's advantage upon return.

Officers participating in TWI are assigned to civilian industries for 1 year of training. A 3-year utilization tour in a position that requires interaction with civilian industry follows training.

SOURCE: *Army Personnel Bulletin* November-December, 1986, p.3.

Army officers annually enter Training with Industry in the following functional areas:

15T Aviation Logistics
25 Communications-Electronics
31 Physical Security
44 Finance
46 Public Affairs
49 Operations Research/Systems Analysis
51 Research and Development; Test and Evaluation
53 Systems Automation
91 Ordnance
92 Quartermaster
95 Transportation
97 Procurement

Training with Industry has been used primarily for procurement, logistics and research and development fields. For 1986-87, there are 335 approved TWI positions.

Of these, 80 percent belong to the Army Materiel Command and the Officer of the Deputy Chief of Staff for Logistics. Most are in functional areas 51, 95 and 97.

Signal-related positions take 12 percent, and 6 percent are in public affairs. The remaining 2 percent reside at the Office of the Deputy Chief of Staff for Personnel, Comptroller and the Military Police School.

In recent years, the ODCSPER community has shown increased interest and participation in the Training With Industry program. This has centered primarily in the marketing and advertising arena.

Officers interested in applying for TWI must have academic records, educational tests and other indicators that reflect an aptitude for further schooling. Applicants also must have military performance records that demonstrate the potential for highly successful careers.

No tuition costs are associated with the Training With Industry program. Officers receive full pay and allowances and are authorized permanent-change-of-station moves. Participants do not receive academic degrees as a result of their training.

Interested officers may submit applications, with their personal resumes, at any time using DA Form 1618-R, Application for Detail as Officer Student at a Civilian Education Institution or at Training With Industry. Refer to AR 621-1, paragraph 3-4, for information on application preparation and submission.

(DAPC-OPB-D; AV 221-3140, Commercial 202-325-3140)

Establishing the Defense Systems Management College in 1971 acknowledged the importance of training system acquisition managers. People now recognize the necessity for a trained and experienced cadre of acquisition managers, the complexity of weapon systems, and the process for acquiring them. In 1974, DOD Directive 5000.23, *System Acquisition Management Careers*, charged the military services to develop and maintain system acquisition career fields. Recently, the Congress focused attention on requirements to manage acquisition programs when the fiscal 1985 Defense Authorization Act mandated that:

> The Secretary of each military department prescribe regulations establishing requirements for the education, training and experience of any person assigned to duty as the program manager of a major defense acquisition program.
>
> Prescribed regulations should require that before being assigned to duty as a program manager, that person:
>
> 1. Must have attended the program management course at the Defense Systems Management College or a comparable program management course at another institution.
>
> 2. Must have at least eight years of experience in the acquisition, support, and maintenance of weapons systems, at least two of which were performed while assigned to a procurement command.

The DODD 5000.23 has been revised by a joint service/Defense Logistics Agency work group to implement this legislation and to clarify experience and training prerequisites for all program managers and deputy program managers. The revision has been staffed and coordinated throughout DOD and was approved by the Office of the Deputy Secretary of Defense in December 1986.

Each military service, as charged by DODD 5000.23, has a framework of requirements for military and civilian acquisition managers. The structure of career programs varies among the military services. This article describes the

ALL DOD

CAREERS IN SYSTEMS ACQUISITION MANAGEMENT

Sandra S. Rittenhouse

military services' system acquisition management career programs and gives points of contact on each program.

Military Managers

The Army program for developing military acquisition managers, including program managers, is the Materiel Acquisition Management (MAM) program. The objective is to develop selected commissioned officers (captain to colonel) to exercise centralized management of acquisition functions like research, development, testing, initial procurement, production and integrated logistic support for designated weapon systems or equipment. The MAM operates within the Army Officer Personnel Management System (OPMS), which provides framework for officer career development. Officers entering the Army are assigned to a branch like infantry, signal, or ordnance. Officers also may choose a functional area for which they quality; i.e., grouping skills requiring specific education and experience. Examples of acquisition-related functional areas are research and development, procurement, comptroller, and systems automation. After choosing a functional area, officers usually alternate between assignments in that area and their branch, or may request assignments in specific functional areas for the remainder of their careers.

Requirements

To qualify for MAM, an officer must be in Grades O-3 to O-6, have completed at least 5½ years of active federal commissioned service, have 6 years of active federal commissioned service remaining when applying, have a baccalaureate degree and military schooling appropriate to the grade and length of service, and be assigned in an acquisition-related functional area.

Entry into the MAM program is competitive; a central selection board selects by specialty and grade according to projected Army requirements. Selected officers are awarded a 6T Skill Identifier earmarking them for future acquisition assignments.

Three Phases

The first phase of MAM is user-support development. It begins when an officer enters active duty and lasts about 6 years. During this phase, each officer develops in his/her branch specialization. This phase provides user-support experience with the type of systems or equipment that officers may develop or acquire later.

Second, the development phase begins after officers are accepted and covers approximately the sixth to sixteenth years of service. Usually, captains attend the 9-week MAM training course at the Army Logistics Management Center early followed by their first acquisition assignments. Normally, progression is then a branch assignment, attendance at the Defense Systems Management College Program Management Course, and a second acquisition assignment.

The MAM assignments include the Army Materiel Command and could be in a program management office, research and development laboratory or center, or headquarters; the Training and Doctrine Command in a system user or operational tester position; or at Headquarters, Department of the Army.

Third, the certified phase occurs at approximately the sixteenth year to the end of the officer's service. When selected for promotion to lieutenant colonels, officers are evaluated by a central selection board for certification as materiel acquisition managers. For MAM requirements and for certification, an officer must complete two acquisition assignments and the MAM and Defense System Management College training courses. Certified acquisition managers are considered for selection as program managers for major systems, and as managers of other acquisition programs of significant responsibility.

The MAM point of contact is:
Headquarters
U.S. Army Materiel Command
AMCPE-MM (LTC Oliver)
5001 Eisenhower Avenue
Alexandria, VA 22333-0001
Telephone: (703) 274-5076
Autovon: 284-5076.

LOGAMP for Civilians

The U.S. Army Logistics and Acquisition Management Program (LOGAMP) provides structured and controlled developmental assignments and formal course training for civilians to meet the need for a work force to develop, field, and support Army materiel. The objective is to develop civilians for multifunctional management positions. The U.S. Army Materiel Command conducts the program for the Army. The LOGAMP is the prototype for Army Civilian Training, Education and Development Systems (ACTEDS), which seeks to ensure that minimum essential technical, managerial and professional training is systematically accomplished for civilians like it is in MAM.

Applicants qualify for LOGAMP as follows:

—Be Department of Army employees eligible for registration in supply management, materiel maintenance management, contracting and acquisition, quality and reliability assurance, engineers and scientists (non-construction), or transportation management.

—Have one performance rating above "fully successful" during the two rating periods before applying.

For MAM requirements and for certification, an officer must complete two acquisition assignments and the MAM and Defense Systems Management College training courses.

—Sign a mobility/participation agreement.

—Be endorsed by the activity, and Major Command commander.

Three Parts of LOGAMP

Covering the GS-5 to GS-12 grades, the first part gives people in career programs listed above broader experience in logistics or acquisition. It emphasizes an individual development plan to identify formal training courses and, in some cases, rotational assignments. The LOGAMP applicants at this level are competitively rated and selected by the DA LOGAMP Committee.

Second, the program includes GS-13 through GS-15 employees who obtain experience in a specialty other than the primary career program; e.g., quality assurance experience and a maintenance management primary career program. The goal is to learn other specialties instead of becoming an expert in the primary career field. Participants in this second phase of LOGAMP are competitively selected by the DA LOGAMP Committee after evaluation by an Army panel of subject-matter experts. Evaluating candidates includes assessing ability to analyze, plan and control, manage resources, and interact and assess knowledge of materiel acquisition/logistics. The training program at this level concerns formal and on-the-job training within and outside the Department of the Army. Training spans a minimum of 24 months and includes at least 8 weeks of formal training—4 weeks secondary specialty, 2 weeks primary career field, and 2 weeks management/executive development. It encompasses a 4-month rotational assignment in a secondary LOGAMP specialty and an optional rotational assignment or detail at the executive, policy, or staff level.

Third, graduates are eligible for GM-13 through SES positions designated as multifunctional key logistics/acquisition management positions.

The LOGAMP point of contact is:
Headquarters
U.S. Army Materiel Command
ATTN: AMCPE-CC-C (Mrs. Nancy Flynn)
5001 Eisenhower Avenue
Alexandria, VA 22333-0001
Commercial: (703) 274-5021
Autovon 284-5021.

U.S. Air Force

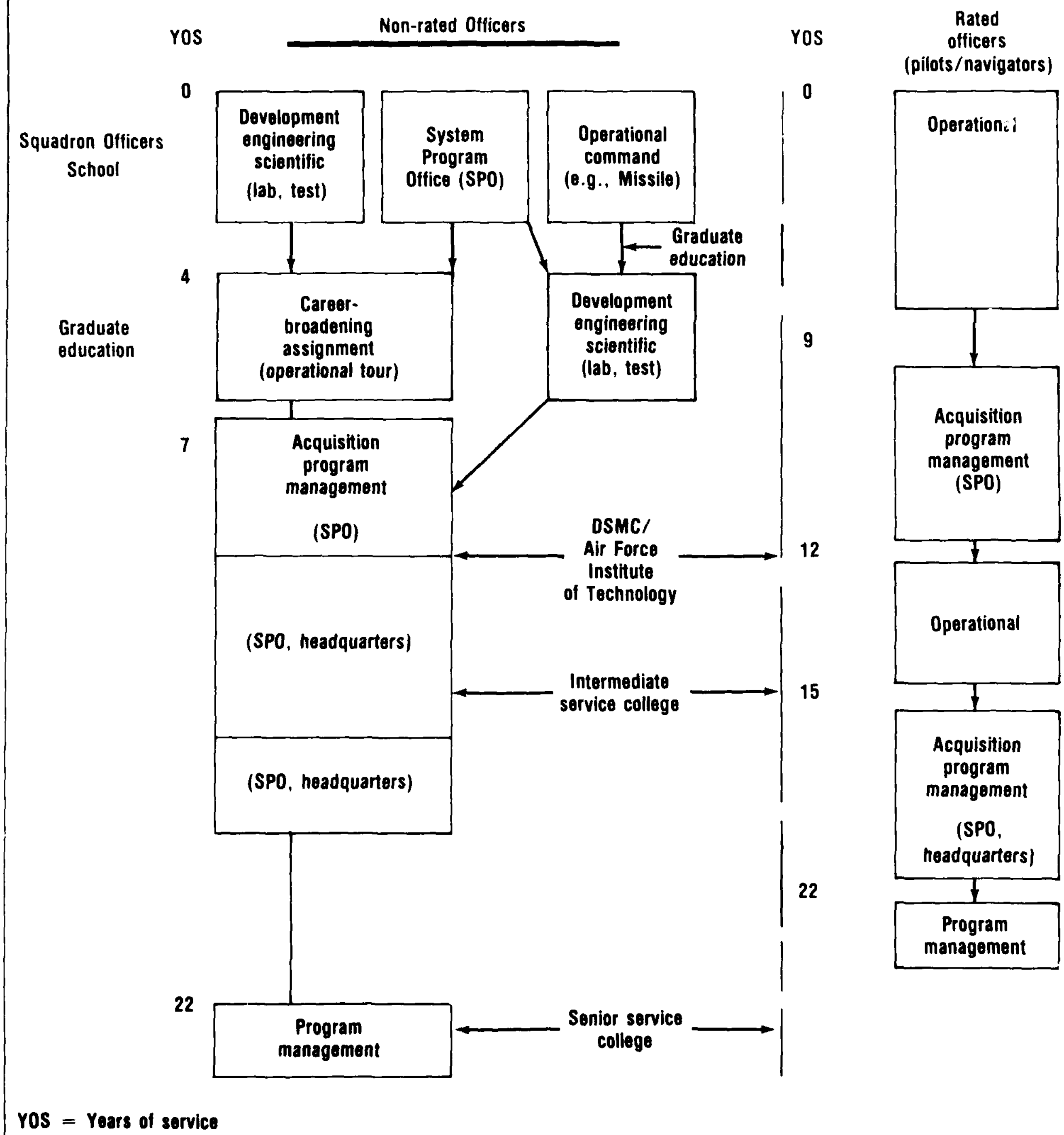
The U.S. Air Force has specialized career fields for acquisition managers encompassing command, staff and management activities in the acquisition life-cycle. These include research and development, test, evaluation reliability and maintainability, financial and configuration management, procurement, production, logistical support and site activation.

Most acquisition personnel are in the Acquisition Program Management Utilization Field (AFSC 27XX). Two levels are shown below.

—The AFSC 2724, acquisition project officer (lieutenant through major), assists in planning and managing systems, subsystems or equipment acquisition programs throughout the acquisition life cycle, performs project officer functions in engineering, data management, configuration management, and program control.

—The AFSC 2716, acquisition program manager (major through colonel), plans and manages acquisition programs of other-than-major systems or subsystems throughout the acquisition life cycle; performs managerial

Figure 1. Air Force Career Development Path for Program Managers



and supervisory tasks associated with functions like program control, configuration management, test and deployment, engineering and integrated logistic support; accomplishes staff review and action; and coordinates with appropriate functional organizations and executive levels.

Officers often transfer into the 27XX utilization field from scientific (26XX) and development engineering utilization (28XX).

Another logical transition is from the 27XX career field to program manager (system program director) utilization (29XX). The latter covers executive management for *major* system acquisition programs for all phases of the acquisition life cycle; duties include formulating system objectives and policies, organizing and directing the program office, and coordinating the system program with using and supporting commands. Because all program management field (29XX) officer authorizations are at the lieutenant colonel or colonel grades, career progression usually starts at about the 17-year point.

Each field requires a bachelor's degree, preferably in engineering, science, mathematics or business. A master's degree and completing the Training with Industry Program are desirable. Required training includes completing the Program Management Course at Defense Systems Management College or Air Force Institute of Technology courses in basic, advanced, and supervisory systems acquisition management.

Career paths leading to program manager of a major system are shown in Figure 1. The acquisition management career path for rated officers (pilots and navigators) is different from that of non-rated officers. A non-rated officer usually starts as an aquisition project officer in a technical (engineering or science) career field and progresses into the acquisition program manager level between the seventh and eleventh year of service. Normally, while in the acquisition career field (usually for the rest of Air Force service), officers will have two assignments in different systems project offices and one at a headquarters; i.e., Air Force Systems Command, Air Staff or Department of Defense. Also, officers may have an operational assignment and/or participate in the Education with Industry Program and attend the Defense Systems Management College Program Management Course and/or systems acquisition management courses at the Air Force Institute of Technology.

Typically, rated officers spend their first 9 years in flying duties and rotate into 3-year assignments in acquisition. Then they return to flying for 3-4 years. After about 15-16 years of service, officers usually return to acquisition for the rest of their careers. Selectees transfer into the 29XX utilization field.

An officer in the acquisition career field can be considered for selection as program manager of a major system starting at approximately the seventeenth year of service. Selections are made by the Commander of Air Force Systems Command based on recommendations from its product divisions.

The acquisition management career path for rated officers is different from that of non-rated officers.

Officers qualify for consideration when they have an undergraduate degree in a technical, scientific, or management field and 8 years of experience in acquisition including completion of the Defense Systems Management College Program Management Course and a minimum of 2 years as a systems project office manager.

The point of contact for career field 27 is:

HQ, AFSC/MPROS
ATTN: Captain Glynn Firmin
Andrews AFB, MD 20334-5000
Telephone: (301) 981-6528
Autovon: 858-6528

Civilians

The Air Force Systems Command established the Systems Acquisition Career Management Program (SACMPC) as a development program for cross-training personnel from positions in systems acquisition functional fields to meet current and future program management staffing needs. The Systems Command allows each product division to develop specific means to accomplish program objectives.

The Aeronautical Systems Division (ASD) at Wright-Patterson Air Force Base is one product division using this development program extensively. It is designed for civilian employees at the GS-12 level whose past performances, experiences, education and training demonstrate potential to become executive-level acquisition managers. Participants receive training and individual development to manage system acquisitions at a high level of competency.

The ASD SACMPC appointments result from a competitive selection process using an assessment center as a major evaluation tool. Normally, the selection process is conducted every 2 years. Individuals selected are assigned to SACMPC manpower pool positions. These career development positions are used to move SACMPC participants in and out of assignments without encumbering permanent acquisition management positions.

The ASD program is structured so that participants can obtain skills and experience in functional areas supporting program management. The individual rotates through assignments in engineering, test and evaluation, configuration and data, logistics, manufacturing, contracts, and program control. Participants attend formal training courses, like functional courses at the Air Force Institute of Technology and the Program Management Course at the Defense Systems Management College.

The final developmental assignment is a project manager role where the individual gets program management hands-on experience and a final assessment. The individual is eligible for key project/program management positions after successfully completing a probationary period in this final assignment.

The SACMPC requires continuous interaction among program participants and advisors. Participants are guided individually by senior civilian or military counselors, functional advisors, and the product division SACMPC career program manager. A formal development program is prepared for each individual as a framework for the nominal 30-month program.

The SACMPC success is demonstrated by the fact that many participants are in key program management positions. Although post-SACMPC promotions are in accordance with established merit promotion procedures, many "graduates" are selected to fill pivotal acquisition management positions as the most qualified with experience and training from this career-

Figure 2. Specialties Included in the WSAM and MP Programs

Unrestricted Line

Surface warfare
Aviation
Submarine warfare

Subspecialties

Material logistics support management
Acquisition management
Operational logistics
Applied math
Operational analysis
Antisubmarine warfare
Command and control
Electronic warfare
Geophysics
Oceanography
Naval systems engineering
Weapon systems engineering
Aeronautical systems engineering
Communications
Computer technology
Masters of Business Administration

Additional qualification designator
Weapon systems acquisition management (WW1)

Restricted Line

Engineering duty
Aeronautical engineering duty
Aviation maintenance duty

Staff Corps

Supply Corps
Civil Engineering Corps

broadening program. The SACMPC motivates and increases participants' potential and qualifies them for executive-level acquisition management positions.

Points of contact are:
HQ AFSC/MPK
ATTN: Ken Puhaly
Andrews AFB, MD 20334
Telephone: (202) 981-5941
Autovon: 858-5941

HQ, ASD/AVC
ATTN: John Pandzik
Wright-Patterson AFB, OH 45433
Telephone: (513) 255-2100
Autovon: 785-2100

Navy WSAM and MP

The Navy has two complementary programs for developing acquisition/program managers. The Weapons System Acquisition Management (WSAM) program was instituted in 1975 to identify acquisition jobs and to identify, develop and track the lieutenant through captain levels with experience and education related to acquisition. The Materiel Professional (MP) program was instituted in 1985, designating approximately 28 percent of Navy flag-rank billets as MP positions and establishing procedures for commander/captain selection into the program. It supercedes the function of the WSAM program at the senior-officer level program. Both programs are based on the philosophy that acquisition/program managers need skills from many specialized fields; technical and financial planning, contracting, engineering development, operational system development, production and procurement.

—**The WSAM Program.** The Navy WSAM Selection Board chooses officers annually for the program. To qualify, officers must have one of the specialties listed in Figure 2; graduate education in a technical or business field or completion of the Nuclear Power School, the Test Pilot School, the Industrial College of the Armed Forces, or the Defense Systems Management College; and a 2-year tour in an acquisition position. Generally an officer enters the program as a lieutenant commander or commander. Normally, those selected are given an additional qualifications designation (AQD) of WS1 (WSAM selectee).

The WSAM Selection Board evaluates officers already in WSAM and designates them as proven managers. To qualify as a proven managers (designated AQD WW1), officers must have another 2-year tour in acquisition over and above WS requirements.

The WSAMs occupy positions classified into three categories: WW1 positions requiring a proven manager; WPI positions for which a proven manager is preferred; and WR1 positions—training positions for manager selectees or officers interested in qualifying for WSAM.

The WSAM program and its positions cover unrestricted line officers in warfighting specialties such as surface warfare, aviation warfare, and submarine warfare; restricted line officers in engineering duty and aeronautical engineering duty specialties; and staff corps in the supply corps.

Unrestricted line officers spend about 13-14 years of their first 20 years at sea. This time must include some specialized warfare training. Lieutenant commanders and commanders serve in acquisition positions. Restricted line officers spend a portion of their first 10 years at sea, transfer into engineering duty and spend most of the rest of their careers in acquisition assignment and engineering assignments. Figure 2 shows career paths to program manager for unrestricted and restricted line officers.

Supply corps officers alternate between sea and shore assignments and spend 6-8 years out of 20 at sea. They are assigned primarily to financial management and contracting rather than technical positions in acquisition.

—**The MP Program.** The MP Program provides a pool from which program managers of major systems and commanding officers of acquisition field activities and laboratories are selected. Materiel professional officers are selected from the unrestricted line, the restricted line and the staff corps. Procedures for selecting officers for the program differ for the unrestricted line and the restricted line/staff corps. Unrestricted line officers are evaluated by a standing board after they have been screened for command assignments at the commander level. The board considers officers in the surface warfare, submarine warfare, or aviation specialties who have the subspecialties shown in Figure 2 are WSAM proven managers (WW1)—volunteers for the program. Officers are evaluated using standards based on education, experience, and potential; there are no minimum educational or experience requirements. A list of candidates is submitted to the materiel professional standing selection board. The standing board selects candidates and forwards its list to the Secretary of the Navy for approval. Those selected are invited to become materiel professionals; entry is voluntary.

Officers in the restricted line and staff corps specialties shown in Figure 2 are evaluated by the standing selection board after promotion to captain. Those selected and approved by the

Secretary of the Navy are designated materiel professionals.

Materiel professional officers compete for promotion within their respective line and staff corps communities. Equitable consideration for flag rank is ensured by precepts (instructions) to the promotion boards. These precepts identify materiel professional skill needs and any personnel shortages. In 1986, approximately 38 flag rank positions were reserved for materiel professionals in the unrestricted line, 28 in the restricted line, and 35 in the staff corps.

The WSAM/MP point of contact is:

Naval Military Personnel Center
ATTN; Captain (Sel) Steve Kupka
Code N 447
Washington, DC 20360
Telephone: (202) 694-5631
Autovon: 224-5631

The standing board selects candidates and forwards its list to the Secretary of the Navy for approval. Those selected are invited to become materiel professionals; entry is voluntary.

Navy CMPP

Instruction in 1985 by the Secretary of the Navy established the MP career program for military officers and mandated a civilian weapons systems manager program. Within the Department of the Navy, the Naval Air Systems Command (NAVAIR) has designed and developed an acquisition management program for its civilian employees. This new career development effort, the Civilian Materiel Professional Program (CMPP), parallels the military materiel professional career program and complements existing NAVAIR career-development programs.

The CMPP four elements are position identification, selection, certification and training and development.

Like the military MP career program, key acquisition management positions have been identified. The 80 civilian positions identified comprise about 30 percent of the Senior Executive Service and GM-15 positions at the headquarters and are civilian counterparts of the identified military MP billets. Senior management at NAVAIR have reviewed the qualifications of the incumbents of these positions for certification into the acquisition management cadre.

Selection into the new CMPP is through the Command's existing Senior Executive Management Development Program (SEMDP). Members of the SEMDP at the GM-14/15 level may apply for the CMPP. Selection, made by a board of senior managers, is based on individual experience, performance, education, and training and development. If selected into the CMPP, individuals will modify career-development plans to include the training, development and experience required for certification.

Certified acquisition managers come from three sources. First is the pool of qualified executives and managers who occupy identified key acquisition positions. Second will be graduates from the newly established CMPP. The third includes individuals who petition the CMPP Board for certification.

The NAVAIR certification includes:

—A 3-12 month stint in acquisition related specialties such as logistics, engineering, contracting, test and evaluation, financial management, resource management and program management. This experience can be accomplished in a field activity, laboratory, industry, systems command or other Navy or DOD related activity.

—The following management development curriculum areas or equivalent:

—Program Manager Course

—Leadership and Career Development (40 hours)

—Management Practices (80 hours)

—Public Policy and National Security (40 hours)

—Federal Personnel Policy (80 hours)

—Graduate degrees, preferred.

Individuals selected for the CMPP will remain in current positions and schedule training and development as outlined in individual development plans (IDPs). The CMPP IDP will include requirements outlined above and other activities determined by the CMPP selectee, supervisor, and senior advisor or mentor. Individuals will stay in the CMPP for 2-5 years.

Another development associated with the CMPP and NAVAIR overall career development efforts is a curriculum that identifies acquisition competencies and related training and experience. The curriculum provides employees a framework of career-enhancing acquisition activities from early career to CMPP selection.

The CMPP is fully operational at NAVAIR Headquarters and implementation in NAVAIR field activities is under way. The NAVAIR Commander will fill future key acquisition management vacancies with individuals certified through this process or individuals with equivalent experience.

Other Navy Systems Commands are designing CMPPs for the autumn of 1987.

The CMPP point of contact is:

Director, Naval Aviation Executive Institute
Naval Air Systems Command
ATTN: Margaret Hutchinson
Air 71C
Washington, D.C. 20361-7102
Telephone: (202) 692-0392
Autovon: 222-0392 ■

■ *Mrs. Rittenhouse is a Professor in the Policy and Organization Management Department at the Defense Systems Management College.*

A SURVEY

COMMERCIAL COMPETITIVE BUYING

Dr. Robert F. Williams
Dr. V. Sagar Bakhshi

Competition is a cornerstone of the capitalist system. In 1776, Adam Smith discussed the importance of the "invisible hand," the working of the marketplace of competing buyers and sellers who pursue their own interests, in driving the economies of U.S. society. Economic texts today continue to emphasize the theory of competition in various forms. Advantages commonly cited are the development of more enterprise, more stable employment, removal of inefficient firms, and freedom from monopoly and cartel control.

Commercial buyers know the value of competition in individual purchases. They find that competitive pressures can reduce costs, induce technological breakthroughs and innovation, increase control of the seller, improve quality in the product, and reduce need for buyer vigilance. Having multiple sources allows more freedom in buying decisions, reduces dependence on individual firms, and gives access to geographical sectors in the country.

Commercial buyers also know competition is a means to buying economies and is not an end unto itself. In some situations, competition may not be a good idea. Judgment must be used in the decision to compete.

The National Association of Purchasing Management (NAPM) is a champion of competition purchasing; in its quest to improve purchasing, it conducted a survey of members in conjunction with the Army Procurement Research Office [1] to find the nature of competition today. The Department of Defense is interested because the Packard Commission recommended it do more commercial-type competition.[2] In this article, we will describe that survey and what results reveal about commercial buyers' competing methods.

Competition Questionnaire

The questionnaire gave an overview of competitive buying behavior. The classification section asked for general information on the kind of buying firm responding; for instance, what was bought and the main product line. There were questions on competition policy in the firm; competitive behavior to include what factors affecting the competition decision and competitive approaches were used; lastly, how much the respondent's firm competed.

Of the 500 NAPM members surveyed, 105 (21%) responded. Phone calls were made to those giving names for additional and corroborative information; i.e., a subsample of 31 firms were asked if they bought existing, modified, or new products. The industrial sample came from a wide variety of industries; approximately 2/3 specialized in goods, 1/3 in services; 60% were large businesses, and 40% were in small businesses. In the telephoned subsample 65% bought mostly off-the-shelf items, 6% mostly modified items, and 29% bought new products. The firms said 69% of sales were to commercial organizations and 31% to federal and other organizations.

Analysis of variance and t-tests were used to find differences among responses.

Buying Behavior

Buying organizations had varied competitive buying behaviors. Table 1 shows the buyer is the usual decision-maker on whether or not to compete. Far behind are teams of individuals and some management level.

Table 1. Competition Decision-makers

Buyer	56%
Supervisor	8%
VP/Director	11%
Team	17%
Other	8%

Most organizations (70%) have a policy or procedure on competition, including things like dollar thresholds for who makes the competition decision. Forty percent of the sample had such a threshold; average size of the threshold to send a competition decision forward is just more than $15,000.

Leading factors affecting the competition decision are potential savings, quality of available firms, dollar value, good existing customer relations, time available, complexity of item, location of suppliers, past performance, and services delivered. In Figure 1 you can see the responses are uniform among sample groupings. Manufacturing firms appear to feel dollar savings are more important than do services firms in the competitive decision. It is apparent that firms without competition policy think the availability of time and the complexity of the item are more important than do those with a policy.

Table 2 summarizes competitive approaches used in industry. The most popular is competing early buys, widely selecting a pool of reliable sources, and then competing among them in subsequent buys. Almost as common-

Figure 1. Effects of Different Factors on Competition

FACTOR	TYPE INDUSTRY			TYPE BUSINESS		SALES MIX				COMPETITION THRESHOLD		COMPETITION POLICY		ALL
	Mfg. Industry	Svc. Industry	Other Industry	Small Business	Large Business	Fed. Sales	Comm. Sales	Other Sales	Mixed Sales	No Threshold	Threshold	Policy	No Policy	
Time Available	3.2	3.3	3.5	3.6	3.3	3.0	3.4	3.7	3.2	3.5	3.2	3.2*	3.8★	3.5
Complexity of Item	3.1	3.1	3.3	3.4	3.2	3.4	3.3	3.5	3.5	3.4	3.1	3.1*	3.7★	3.4
Dollar Value of Item	3.6	3.2	3.7	3.7	3.5	3.2	3.6	3.8	3.8	3.4	3.8	3.6	3.7	3.7
Potential Competitive Savings	3.9*	3.0★	3.9*	3.7	3.8	3.8	3.8	3.6	4.0	3.6	4.0	3.8	3.7	3.9
Quality of Available Firms	3.6	3.4	4.0	3.6	3.9	4.0	3.8	3.9	4.8	3.7	4.0	3.9	3.8	3.9
Uniform Commercial Code	2.5	2.3	2.6	2.6	2.4	1.8	2.4	2.4	3.2	2.4	2.6	2.7	2.2	2.7
Quality of Available Specifications	3.2	3.4	3.4	3.3	3.4	2.4	3.4	3.8	3.8	3.3	3.4	3.4	3.3	3.5
Good Existing Supplier Relations	3.5	3.2	3.8	3.8	3.5	3.0	3.7	3.5	4.0	3.7	3.5	3.5	3.7	3.7
Poor Existing Supplier Relations	3.0	3.1	3.2	3.1	3.2	2.2	3.2	3.1	3.8	3.1	3.2	3.2	3.1	3.2

(Rating Scale: 1 = Never Affects, 2 = Seldom, 3 = Sometimes, 4 = Often, 5 = Always)
Group marked by symbol "★" is different from group(s) marked by symbol "*" at .05 significance level.

ly used is simply competing if beneficial. Other approaches commonly mentioned are competing per company guidelines and going consistently to a source originally chosen competitively. Services firms use this last approach more than manufacturing firms. As one would surmise, firms without competition thresholds tend to use the general rule of competing when beneficial; those with a competition policy tend to use company guidelines more than those who do not. Although certain cell sizes were small, the data suggests there are differences in kind of item bought (existing vs. new) that warrant more study. Overall, however, groupings are fairly consistent in using these approaches.

Table 2. Competitive Buying Approaches

Compete Every Buy	16.2%
Compete Subsequent Buys	15.2%
Pick Source-Buy Direct	24.8%
Pick Source-Compete	43.8%
Pick Pool-Select One	11.4%
Compete If Beneficial	41.9%
Per Company Guidelines	26.7%
Never Compete	2.9%
Other	2.9%

Firms were universal in believing they competed about the right amount (72%) or too little (28%); that is, nobody said they competed too much.

Degree of Competition

One of the study's primary objectives was to find how much buyers competed. Figure 2 shows the extent of industrial competition; the sample estimated they competed 58% of their dollars and 56% of their actions. The only significant difference among groupings was that firms with a competition policy competed more dollars than those who did not (65% to 44%). Again, small cell size in some areas may have suppressed findings; for example, the product of some organizations appears to affect the amount of competition undertaken.

Conclusions

The picture of industrial competitive buying practice in the United States now begins to emerge. The competitive buying decision is usually in the hands of the individual buyer and occasionally is sent to a buying center or higher management, depending on merit. Most firms have a policy on competition and those that do compete higher-dollar items more often, apparently because of the articulated guidance. Moreover, many firms have a threshold (about $15,000 on average) that helps the buyer decide when to send the decision forward to others. Buyers maintain that dollar value is often a consideration in the competition decision.

Buyers compete primarily to save money, particularly buyers in manufacturing firms, although other reasons (e.g., to motivate existing suppliers and to broaden supplier base) were suggested. A buyer must be assured, however, that there are firms capable of handling the complexity of the item; that the specifications are adequate; and that enough time is available. It was suggested that a buyer may not compete if existing supplier relations are good. Again, those firms without a competition policy seem to behave differently and express more concern about time and item complexity in decisions.

Figure 2. How Much the Different Groups Compete

GROUPS	ACTIONS	DOLLARS
MANUFACTURING INDUSTRY	55.0%	59.8%
SERVICE INDUSTRY	55.3%	57.0%
OTHER INDUSTRY	56.5%	57.8%
SMALL BUSINESS	49.2%	50.6%
LARGE BUSINESS	60.3%	62.7%
MAJORITY FEDERAL SALES	70.0%	66.0%
MAJORITY COMMERCIAL SALES	56.3%	60.5%
MAJORITY OTHER SALES	50.8%	42.8%
MIXTURE OF SALES	52.5%	35.0%
BUYER DECIDES TO COMPETE	53.6%	56.5%
SUPERVISOR DECIDES TO COMPETE	56.9%	60.0%
VP OR DIRECTOR DECIDES TO COMPETE	55.8%	65.8%
TEAM DECIDES TO COMPETE	56.7%	56.3%
OTHER (UNDEFINED) DECIDES TO COMPETE	70.6%	61.9%
DO HAVE COMPETITION THRESHOLD	57.7%	64.9%
DOES NOT HAVE COMPETITION THRESHOLD	55.0%	53.7%
COMPANY POLICY ON COMPETITION	58.8%	64.6%*
NO COMPANY POLICY ON COMPETITION	51.0%	43.5%#
ALL	55.9%	58.2%

Group marked by symbol "*" is different from group(s) marked by symbol "#" at .05 significance level.

Few buyers compete every purchase. The most common strategy is to compete early buys widely, select reliable sources and compete among them in later buys. Typically, industry develops a pool of good suppliers and protects them. Another common strategy is to select competitively a good source and then go directly to that source on subsequent buys; services organizations seem to favor this approach. As a general rule, buyers compete when it is beneficial and when company guidelines dictate. Those without policy in the area tend to employ more general decision rules.

Industry competes more than half of its dollars and actions, although one suspects measurement of what constitutes competition may vary the exact figure considerably. For example: Do we count a directed buy to a source originally selected as a competition? The degree of competition is fairly consistent for all kinds of firms, but with large variance. Industry is fairly content with the current level of competition. In any event, competition is not always the law of the land, at least in industrial buying.

This study was a general survey intended to find the overall dimensions of industrial competitive buying. It suggests other efforts for further investigation. Narrower reviews of different commodity buyers (e.g., electronics) can give useful insights into more specific behaviors, such as information searches. Of particular value would be a contrast of the behavior of buyers specializing in existing, modified, or new items. A contrast between industrial and government buyers might suggest new direction for buying policy in both communities. As we said, new work can now use a more rigorous definition of competition to gain confidence in inferences on competitive behavior. ■

■ *Dr. Williams is Director and Dr. Bakhshi is an Operations Research Analyst, U.S. Army Procurement Research Office, Fort Lee, Va.*

Footnotes

1. Williams, Robert F. and Bakhshi, V. Sagar, *"Industrial Competitive Buying,"* Research Paper P-22, Army Procurement Research Office, June 1986.

2. Packard, David, *A Quest for Excellence:* Final Report to the President, (and Appendix), President's Blue Ribbon Commission on Defense Management, June 1986.

$4 Million Network

The U.S. Army Troop Support Command's Belvoir RD&E Center has awarded a $4 million contract to install, maintain and operate a broadband Local Area Network (LAN). LAN is a coaxial cable TV-based data communications network to provide high capacity communications services to every office, desk and information device at the Center's 240-acre main area at Fort Belvoir, Va. By June 1987, a pilot network will be available for operational acceptance and demonstration. The full net will be installed by April 1988.

The backbone for the system is a high quality, high band width (900mhz) dual coaxial cable TV (CATV). One or more radio frequency outlets will be installed in each office attaching a multiport Ungerman-Bass network interface unit to the cable. The head-end of the network includes a network control center with battery backup in the Computer Center. Amplifiers will be mounted inside buildings, on pedestals at the roadside or on phone poles.

The Network will allow terminal-to-host, PC-to-host, and PC-to-PC interconnections. It will handle the special IBM PC protocols and will carry other ethernet channels (usually restricted by length) and will gateway between other networks and channels, handling the protocol conversion. ■

People on the Move

Chapla

Hallman

Littlejohn

Richard

Young

Daniel Chapla is a Professor of acquisition management in the Policy and Organization Management Department. He came to DSMC from the Industrial College of the Armed Forces where he was an instructor of management. A retired U.S. Marine Corps lieutenant colonel, Mr. Chapla received a B.S. degree in engineering from the U.S. Naval Academy, and an M.B.A. degree from Bryant College.

Commander, SW, Denis S. Hallman, USN, is a Professor of financial management in the Business Management Department. Before joining the DSMC faculty, he served as Detachment Chief, Navy Section, U.S. Military Training Mission, Jubail, Saudi Arabia. Commander Hallman received a B.S. degree in engineering from the U.S. Naval Academy, and an M.B.A. degree from the Unversity of Mississippi.

Major Ian B. Littlejohn, USAF, is a Professor of management in the Policy and Organization Management Department. His last assignment was at Wright-Patterson Air Force Base, Ohio, with the Integrated Electronic Warfare System (INEWS). A graduate of PMC 83-1, Major Littlejohn received a B.S. degree from Rensselaer Polytechnic Institute.

Gary L. Richard, a Professor of financial management in the Business Management Department, began his corporate finance career as a financial/budget analyst in the automotive industry, and joined Martin-Marietta, Orlando, Fla., as a budget analyst. More recently, Mr. Richard has been president of his consulting firm. He holds a B.S. degree in accounting from Wayne State University.

Lieutenant Colonel Lee R. Young, Jr., USAF, is a Professor of systems acquisition management, Policy and Organization Management Department. He formerly served as the Deputy Director of NAVSTAR User Equipment, and Program Manager for Air Force Integration, Global Positioning System program. Lieutenant Colonel Young holds a B.S.E.E. degree from George Washington University, and an M.B.A. degree from Wright State University.

Losses

Dr. Paul O. Ballou, Jr., Business Management Department, a promotion, to Director of Acquisition, Defense Mapping Agency, Tysons Corner, Va.

Radean Kerns, DSMC's first Protocol Officer, Office of the Commandant, to the Community Activities and Family Support Division, ODCSPER, Hoffman Building. She has been promoted and will be working with an Army Management Team.

Lieutenant Colonel Thomas E. Peoples, USA, Special Assistant for the Contractural Program, Department of Research and Information, retired after 20½ years of military service.

Gains

Tammy Cantrell, Business Management Department.

Marianne Hammond, Department of College Operations and Services.

Kendra Haugen, Office of the Commandant.

Tina Richards, Business Management Department.

Alumna

Dr. Henry J. Winkler, a graduate of PMC 78-1, has been named operations vice president for Training and Control, Honeywell Systems Division, West Covina, Calif. He will be responsible for management guidance and direction of the division's six operating departments which include engineering, manufacturing, procurement product assurance, information services and advanced systems. Before joining Honeywell in 1986, Dr. Winkler worked at Hughes Aircraft Co. for 12 years.

Dr. Jay Billings Receives Honor

Dr. Jay C. Billings, Director of the Defense Systems Management College Southern Region, Redstone Arsenal, Huntsville, Ala., has been named a Fellow by the National Contract Management Association Board of Directors. This recognizes his significant and outstanding contributions to the field of contract management and to the Association.

Formerly a faculty member in the Business Management Department at the Defense Systems Management College, Fort Belvoir, Va., Dr. Billings served previously in the Office of Federal Procurement Policy and contributed to the uniform procurement system proposal, and to federal procurement training and career development programs. ■

**"Sail on, O Ship of State!
Sail on, O Union, strong and great!
Humanity with all its fears,
With all the hopes of future years,
Is hanging breathless on thy fate!"**

—Henry Wadsworth Longfellow

DSMC POSITION VACANCIES

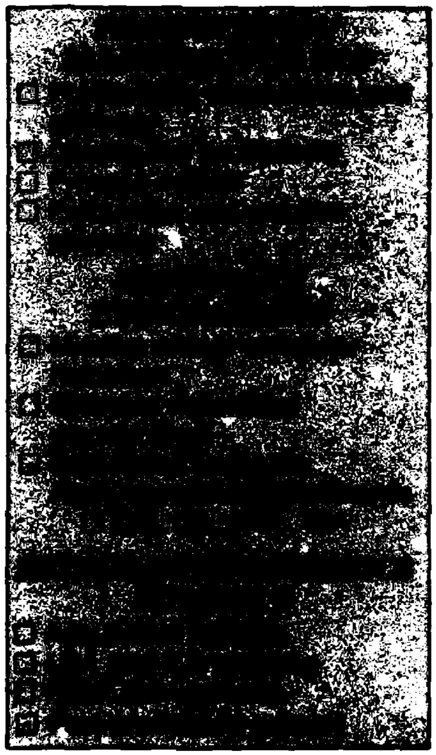
WE HAVE SOME EMPTY SHOES TO FILL

PROFESSORS OF MANAGEMENT ENGINEERING

This is an excellent opportunity to make a valuable contribution to the efficiency of defense systems acquisition at all levels.

Middle managers from the Army, Navy, Air Force, Marine Corps, Civil Service and private industry attend courses at the Defense Systems Management College to improve their effectiveness in defense systems acquisition. As a professor at the College, you will instruct, do research and consult within the Department of Defense (DOD) as a member of our Technical Management Department.

Salary range for these GS-14 excepted Civil Service positions is $45,763 to $59,488. Teaching ability, a baccalaureate degree in engineering or engineering management and at least 3 years of professional experience are required.



Military officers (05/05) may also be assigned through their detailer.

Understanding fundamental principles in one or more of the areas listed and their relationship with system engineering and DOD life-cycle management is required.

Interested civilians from government or industry should call Debbie Johnson (703) 664-3118 or AV 354-3118 or send a resume or SF-171 Personal Qualification Form to:

DSMC
ATTN: DCOS-CP
Bldg 202
Fort Belvoir, VA
22060-5426

Interested military officers should call LCDR Vicki Sanderson at (703) 664-1175 or AV 354-1175, before talking to their detailer.

AN EQUAL OPPORTUNITY EMPLOYER

PROGRAM MANAGER

SECOND CLASS MAIL
POSTAGE AND FEES PAID
DEPARTMENT OF THE ARMY
ISSN 0199-7114

DEPARTMENT OF DEFENSE

PROGRAM MANAGER
DEFENSE SYSTEMS MANAGEMENT COLLEGE
FORT BELVOIR, VIRGINIA 22060-5426