AD-A285 566

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS None
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION / AVAILABILITY OF REPORT Distribution Unlimited
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Defense Systems Mgmt College 6b. OFFICE SYMBOL *(If applicable)* DSMC Press	7a. NAME OF MONITORING ORGANIZATION Same as 6a.
6c. ADDRESS *(City, State, and ZIP Code)* 9820 Belvoir Road Suite G38 Fort Belvoir, VA 22060-5565	7b. ADDRESS *(City, State, and ZIP Code)* Same as 6c.
8a. NAME OF FUNDING / SPONSORING ORGANIZATION Same as 6a. 8b. OFFICE SYMBOL *(If applicable)*	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS *(City, State, and ZIP Code)* Same as 6c.	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE *(Include Security Classification)*
Program Manager - Journal of the Defense Systems Mgmt College - Vol. XXIII, No. 4, DSMC 121

12. PERSONAL AUTHOR(S)
Numerous Authors

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT *(Year, Month, Day)*	15. PAGE COUNT
Journal	FROM ____ TO ____	July - August 1994	48

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*
FIELD	GROUP	SUB-GROUP	The Mobile Integrated Tactical Terminal; Ethics in Int'l Defense Acquisition Programs; Managing a Major Technical Program; Traveling Contact Team Assists Bulgaria

19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

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.

94-32385

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Sylvia Nance	22b. TELEPHONE *(Include Area Code)* 703-805-2743 22c. OFFICE SYMBOL OS-PR

DD Form 1473, JUN 86 — *Previous editions are obsolete.* — SECURITY CLASSIFICATION OF THIS PAGE

A Case Study in Rapid Development

PROGRAM MANAGER

Journal of the Defense Systems Management College

Vol. XXIII, No. 4, DSMC 121

Published by the

DEFENSE SYSTEMS
MANAGEMENT
COLLEGE
PRESS

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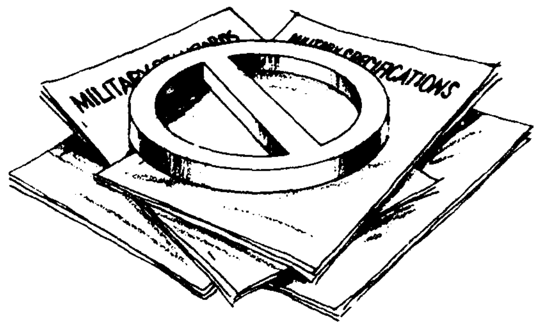
Program Manager (ISSN 0199-7114) is published bimonthly by the Defense Systems Management College Press.

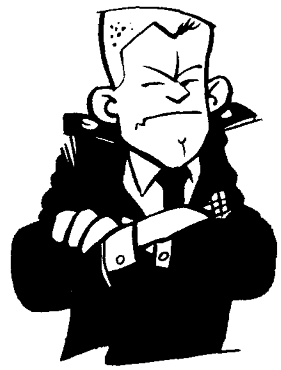
POSTMASTER: Send address changes to:
DEFENSE SYST MGMT COLG
ATTN DSMC PRESS
9820 BELVOIR ROAD
SUITE G38
FT BELVOIR VA 22060-5565.

To subscribe, government personnel should submit written requests (using their business address) to the above address.

Nongovernment employees and organizations may subscribe at $9.50 annually through the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Second class postage paid at Fort Belvoir, VA, and at additional entry offices.

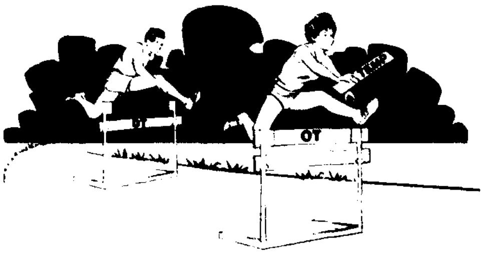
Manuscripts, Letters to the Editor, and other correspondence are welcome and should be addressed as above. Inquiries concerning proposed articles may be made by phone at (703) 805-2892/3056 or DSN 655-2892/3056.





Whenever feminine or masculine nouns or pronouns appear, other than with obvious reference to named individuals, they have been used for literary purposes and are meant in their generic sense.

COVER: Major Lillian A. Pfluke, USA, demonstrates the MITT System to General Gordon R. Sullivan, U.S. Army Chief of Staff, in June 1993. (Photo by Larry Shank, courtesy of the U.S. Army Laboratory Command)



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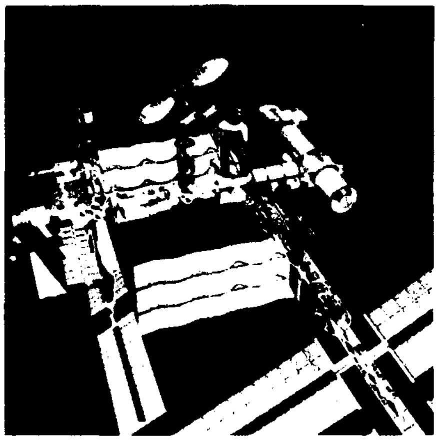

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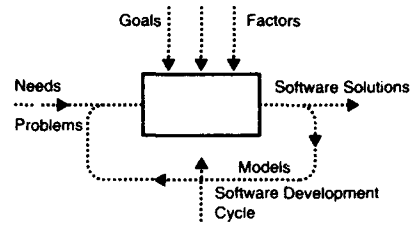

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THE MOBILE INTEGRATED TACTICAL TERMINAL (MITT)

A Case Study in Rapid Development

Major Lillian A. Pfluke, USA

The first Mobile Integrated Tactical Terminal (MITT), latest development effort by the Army Space Program Office (ASPO), was recently fielded to the 319th Military Intelligence Battalion at Fort Bragg, N.C., only 36 months after Concept Studies Approval (Milestone 0).

This rapid development was possible because we used *concurrency* throughout the acquisition process: we did more than one thing at a time, and we didn't wait to complete administrative requirements before proceeding with other phases of the program.

Also, we used an innovative approach to transition this program from a highly classified contracting and development process to a standard program development. This allowed the program to take advantage of both the highly technical, rapid and unique development process possible in the classified world and the standardized, supportable and reproducible development process possible in the acquisition world.

Major Pfluke is Systems Coordinator in the Department of the Army Research, Development and Acquisition (SARDA) for Patriot Missiles, the Pentagon. She was the MITT program manager from March 1990 through June 1993. She is a PMC 94-2 student.

Major Pfluke describes the MITT power system to BG John E. Longhouser, USA, then Assistant Deputy for Systems Management, Office of the Assistant Secretary of the Army (Research, Development and Acquisition).

While this is a unique program with unique circumstances, some of the procedures used and lessons learned are relevant to the acquisition community at large. In an era of shrinking budgets and rapidly moving technology, all program managers (PMs) must strive continuously to shorten the acquisition cycle; some of the experiences of the MITT program may apply to this need. This article describes how this successful acquisition took place so rapidly.

Background

The ASPO director is the PM of the Army "Tactical Exploitation of National Capabilities" (TENCAP) Program. The ASPO is not in the Army Program Executive Office (PEO) structure under the Assistant Secretary of the Army (Research, Development and Acquisition) but is a field operating agency of the Department of the

Photo by Larry Shank, courtesy of the U.S. Army Laboratory Command

Army Deputy Chief of Staff for Operations and Plans. As such, ASPO executes the TENCAP program as approved by the TENCAP general officers steering group, which is cochaired by the Army Deputy Chief of Staff for Operations and Assistant Secretary of the Army (Research, Development and Acquisition). The ASPO is the Army focal point for technical, fiscal and operational interactions with the national space community; and, as such, develops, tests, fields and sustains tactical systems for national and theater intelligence products.

In 1978, the ASPO fielded its first signals intelligence system, the Electronic Processing and Dissemination System, its first intelligence systems. Since then, 24 other TENCAP systems of various sizes, missions and complexity have been developed, fielded and are operating throughout the world at Army divisions, corps and echelons above corps. The systems are supported by contractor field-service representatives permanently on site with each piece of equipment. The computers in the original TENCAP systems are dated, the software is expensive to maintain, and the systems are operating at their maximum level with no growth potential.

The ASPO coordinates with key personnel in TENCAP cells at every command where TENCAP equipment is used to expedite actions appropriate to that command. This allows the ASPO to obtain a materiel requirement approved by the TENCAP General Officers Steering Group while formal documentation is still in the Training and Doctrine Command (TRADOC) pipeline. Thus, ASPO traditionally strives for "the 80-percent solution" during development, and relies on close contact with the user in the field and extensive preplanned product improvements to refine system capabilities. This allows the PM to write rather general specifications for the contractor, and then work closely with the contractor and the user during system development.

Pre-Milestone 0 Activities

From 1987-89, 16 different Mission Need Statements (MNSs) were generated at various divisions and schools expressing a requirement for TENCAP capability at lower levels on the battlefield. During the Gulf War, all five Tactical High Mobility Terminals were deployed, and three were sent forward with divisions for the first time. Tactical High Mobility Terminals are highly mobile systems that allow a single operator/analyst to receive, analyze, archive and disseminate signals intelligence and imagery intelligence products. Intended for use at the Corps Forward Command Post, these systems proved extremely successful at the division level, validating in wartime experience the need for such a system in divisions.

Even before the Gulf War, it was clear that a material solution was indicated to get more TENCAP capability on the battlefield. The Tactical High Mobility Terminal was the best system for use at division level, but expensive to reproduce because the government did not own the technical data package (the five systems in existence were prototypes and never intended for a more extensive fielding). Also, several of the systems were mounted on five trucks and the MNSs called for a smaller system. Finally, the systems were already pushing the limits of their intended processing capacity, and it seemed short-sighted to reproduce a system headed for obsolescence.

Thus, based on informally stated requirements from the field (a formal consolidated MNS was never written) and the clear need for a material solution, the TENCAP General Officers Steering Group directed on 6 July 1990 that ASPO pursue the prototype development of a smaller and updated Tactical High Mobility Terminal. Five prototypes would be built for test and evaluation. The PEO for Intelligence and Electronic Warfare would assist ASPO in documentation and development to ensure the technology used was consistent with the Intelligence and Electronic Warfare Systems open systems architecture. Milestone 0, Concept Studies Approval, was achieved.

Phase 0: Concept Exploration and Definition

The purpose of concept exploration and definition is to evaluate the feasibility of alternative concepts and determine the most promising solutions. Two separate evaluations for this system were: the software architecture and associated hardware suite, and the vehicle/shelter/trailer system configuration. The ASPO formed two teams of experts to address the problem.

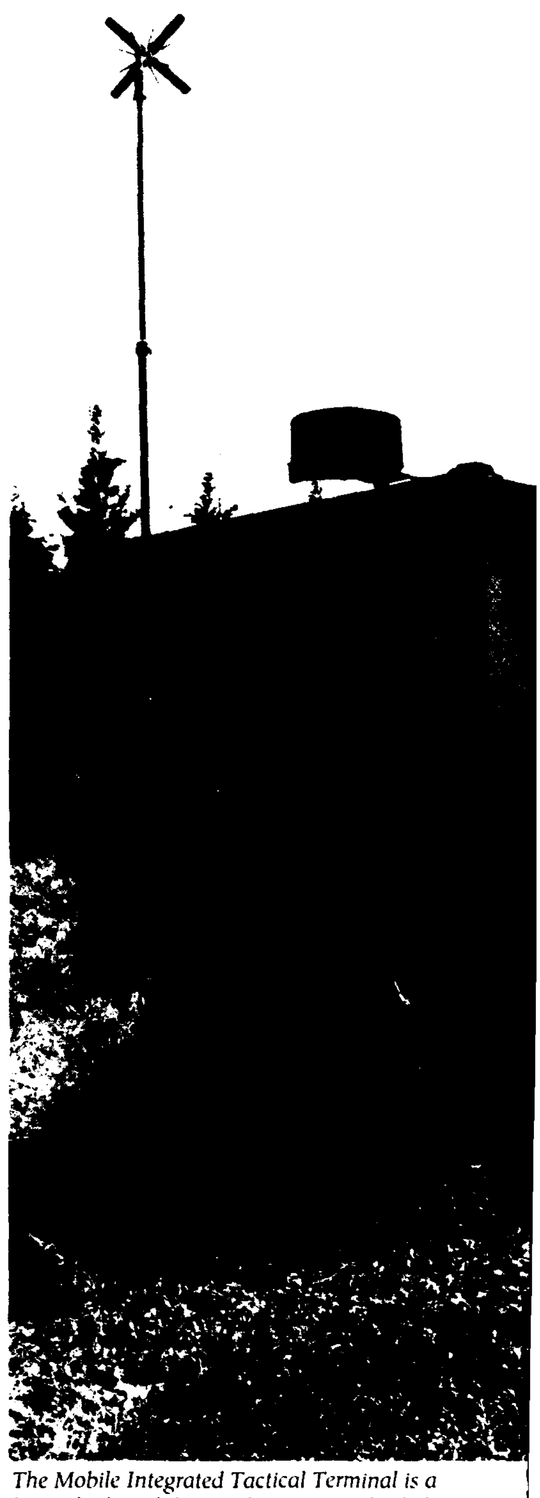
The software/hardware team of experts were from the program office, the contracting office, and the supporting Federal Contracts Research Center. Their study began on 8 August 1990, and included coordination visits with 16 different Department of Defense (DoD) agencies engaged in intelligence, electronic warfare, communications and computer technology. Their final product was a 15 November 1990 decision brief, recommending the hardware and software approaches to be pursued in the newly designated MITT.

Because of the Gulf War, the TENCAP General Officer's Steering Group did not meet in the December/January timeframe to give formal Concept Demonstration Approval (Milestone 1) for the software effort. The contracting process proceeded with an informal approval from the co-chairs of the group. As with all previous contracts for other TENCAP signals intelligence systems, cost-plus-award-fee contract was awarded to rehost Tactical High Mobility Terminal functionality onto a UNIX baseline. (This meant the MITT could execute all of the functions of the previous system but could use the most modern computer technology.) Authority to proceed was granted on 1 February 1991, and the contract was expected to be a 22-month effort.

As the software contracting process was taking place, a second team of experts was formed to evaluate alternative concepts for the system. When the software/hardware experts had visited the Army Research Laboratory in Adelphi, Md., they were so impressed with the type of work in packaging VME-based computer systems in rugged tactical cases and vehicles being done there that it was decided that the Army Research Laboratory experience would be invaluable to the program. The Laboratory had extensive UNIX expertise and had written software packages that would pertain to the program. Four engineers from the Laboratory gained the appropriate security clearances to participate in the program and began work on the system design.

The system design team was two teams — the four Laboratory engineers and a complement of engineers from the defense contractor. The contractor team was expert in aerospace and satellite technology and had more than 20 years of experience in TENCAP systems. The team had people thoroughly familiar with the software package and a network of field service reps who dealt with TENCAP systems and TENCAP missions daily, worldwide. The team was accustomed to working with large vans, however, in special units with highly trained soldiers, and with minimal thought given to supportability or commonality with other Army systems because of their ongoing maintenance contract. Additionally, since they had enjoyed a long-term, sole-source relationship with ASPO, they were somewhat expensive.

The teams each designed the system independently. A series of iterative design concept meetings were then held to take the best ideas from each design. Also, the teams had a joint conference with the PEO for Intelligence and Electronic Warfare and several Intelligence and Electronic Warfare PMs at Vint Hill Farms, Va., to share ideas and ensure system compatibility and component commonality. The sessions fully utilized the respective expertise of the teams to come up with a concept which would not have been possible by either team alone. The PM's challenge was to help everyone set aside egos and suspicions and work together (a challenge that continued throughout the program).



The Mobile Integrated Tactical Terminal is a heavy high-mobility, multipurpose, wheeled vehicle (HMMWV) with shelter that contains two workstations and multiple communica-

U.S. Army photo

tions paths. It pulls a trailer-mounted 15kw generator. A second heavy HMMWV carries the crew and their cargo.

After this series of iterative system design concept meetings, the final product of the system design team was a 21 May 1991 decision brief recommending the system configuration. The concept was aggressive. The design depended on several key pieces of equipment not yet available, including the heavy variant of the HMMWV, miniaturized cryptographic equipment, the SUN SPARC 2E card (the smaller, more rugged computer card that would allow the system to use the most recent workstations available), and the 400-amp alternator for "under the hood" power. Successful completion of the total system depended on the timely fielding of these other systems. All of this equipment was late for a variety of reasons — the minicrypto still isn't available; and the PM executed some creative "workarounds" to keep development on schedule. The result of accepting this risk was that when the system was fielded, it reflected current technology, and was the first military system fielded with this equipment.

As work on the MITT Operational Requirements Document had begun at the Army Training and Doctrine Command and the initial draft was being staffed, we developed a revolutionary acquisition plan. The TENCAP signals intelligence systems, to date, had been contracted to the same contractor, because of that contractor's unique technical expertise. The systems had been intended as prototypes or low-density systems and, thus, were used in the field without complete military specification documentation, integrated logistic support (ILS) package, or comprehensive manuals. They were developed with minimal technical input from the program office (because of their extreme complexity, the program office often did not have the technical expertise to give precise guidance and make engineering decisions).

Since the MITT would bring TENCAP capability to the division for the first time and since the total number of MITTs was potentially more than 100 systems (at one point the MITT was to be the prototype for the Common Ground Station), this approach would no longer work. Instead, while the contractor was building the five approved prototypes, one additional system would be built at the Army Research Laboratory. This sixth system would allow the Army Research Laboratory to validate the contractor's engineering drawings and bring them up to level-three standards, and to make minor changes in the system (which would not affect form, fit and function) to enhance producibility. Moreover, the Army would develop a second source of TENCAP expertise to help reduce the cost of future systems, and the laboratory could produce an ILS package for the system.

The May 1991 TENCAP General Officer's Steering Group meeting was, in effect, a Concept Demonstration Approval (Milestone 1) decision, although the software contract was signed three months earlier, and the Operation Requirements Document was not complete. The software and hardware concept baselines were approved. The steering group withheld judgment on the final system configuration (whether to use a trailer or a second HMMWV, or both, to transport the generator and other equipment) pending further evaluations. The acquisition plan and concept for testing were approved. The program was underway; ten months had elapsed.

Phase 1: Demonstration and Validation

The purpose of the Demonstration and Validation phase is to design the system and demonstrate critical processes and technologies. The TENCAP General Officer Steering Group did not expect or require specific requirements be met for the program to move from Phase 1 to Phase 2. Consequently, the program made no clear delineation between demonstration and validation and engineering and manufacturing development. This allowed much work to be done concurrently, without preparing for a set of arbitrary milestones.

To save time, the software System Requirements Review and System Design Review were combined into a Requirements and Architecture Technical Interface Meeting. Although the software program was complex (more than 500,000 lines of code), it was primarily a rehosting of existing code onto UNIX. While not trivial, it was assumed that the requirements and structure were already fairly well-defined. Unfortunately, neither the contractor nor the program office had much UNIX experience, and a considerable learning curve had to be overcome in every phase of software development.

In retrospect and despite an eventual significant slip in the software development schedule, this consolidated approach was still a good idea. There was probably not enough UNIX expertise to do a such a thorough System Requirements Review and System Design Review to justify the time and expense involved. The final Software Requirements Specification was released on 31 July 1991.

A directed subcontract should have been submitted to an experienced UNIX software contractor or, at the very least, an intensive UNIX training program for the software team and the contractor's hiring of some UNIX experts. Some UNIX training was done up front, but the software team had other TENCAP commitments throughout the development which prohibited them from becoming proficient rapidly. Also, the level of program classification made rapid hiring of experts impossible.

Our contracting office issued a separate hardware request for proposal for the design and manufacture of five systems immediately after the Milestone 1 decision. The contractor briefed the proposal three months later, on 28 August 1991. The first inklings of the challenges of having two separate design teams work on the system became evident during fact finding, as the contractor, in some cases, reverted to less-risky solutions than had been proposed by the Army laboratory and endorsed by the program office.

Many of these differences were resolved early in the process; others persisted throughout the program. Understandably, the contractor leaned toward a design with known and available components to meet cost and schedule. The Army Research Laboratory wanted innovative solutions using the latest available technology. The PM was in constant arbitration.

The hardware contract was signed, and the contractor received authority to proceed in December 1991. Despite the fact that the design was not finalized, several long-lead-time purchases were initiated immediately. This resulted in the purchase of some excess parts as the design matured, but these parts were utilized for spares on other systems.

The hardware development did not include a formal Preliminary Design Review (PDR). Because of the numerous iterative design reviews held in the Concept Exploration phase and because the parts purchase process was well underway, the formal PDR seemed superfluous.

Phase 2: Engineering and Manufacturing Development

The purpose of the Engineering and Manufacturing Development phase is to mature and finalize the selected design, validate the manufacturing and production processes, and test and evaluate the system. The primary obstacle in this phase was getting the contractor (who was building five systems) to keep the Army Research Laboratory (which was building one system 3,000 miles away) informed and up-to-date on drawings, parts and design decisions. However, this teaming relationship was key in the PM's ability to influence the design, processes or testing.

Involving the Laboratory allowed the PM to have an independent set of engineers evaluate design and process decisions at every step, and helped keep the system design compatible with existing Army systems. Thus, despite the classification of the development, the system was not built in a vacuum, but was kept in step with mainstream Army components and developments. Additionally, sophisticated technologies developed by the contractor could be researched further and incorporated into other Army systems by the Laboratory.

Although the hardware design was still not final, the Critical Design Review (CDR) for hardware and software was held from 10-12 March 1992. The TENCAP General Officers Steering Group had approved the final configuration of two HMMWVs and a trailer, and most of the design was set. However, the system was overweight; the delivery schedule for some of the critical components were slipping; the software design was behind; and the Operational Requirements Document was not yet approved (approval came in June 1992).

The contractor's design style was similar to a "skunkworks." Engineers would design the system on paper, but technicians and engineers building the system were free to make changes and pursue "good ideas" as they were putting it together. Hence, the drawings often lagged behind the actual system design.

The Laboratory often was left out of the information loop and had to scramble to keep up. This frustration, coupled with constant challenges to contractor design decisions (to keep the system common with other Army systems — something in which the contractor had no experience) resulted in occasional hard feelings. For example, the contractor would design and manufacture simple hardware or brackets that were commercially available or even had National Stock Numbers assigned. The Laboratory would research and identify the best part commercially available and cause the contractor to change the design.

The PM's role of arbitrator and team builder was critical. However, the checks and balances imposed by the relationship between the contractor, the Laboratory, and the program office was invaluable to the successful completion of the program. In view of the contractor's skunkworks approach, the teaming relationship proved to be especially effective in validating the manufacturing and production processes used, and helped make the system reproducible at a reasonable cost.

Executing the software contract continued to be slow throughout this phase. The learning curve persisted in every phase of the project, and because of it the contractor had seriously underestimated the time (and, hence, cost) involved. The project was further complicated by the fact that the target system was not working until very late because of the leading technology hardware chosen. The software contract almost doubled in cost, and completion was eight months late. However, several critical components of the system design (the miniaturized cryptographic equipment, the heavy HMMWV, the 400-amp alternator) were also late, and would have delayed the system just as much.

The system was tested by the contractor with the program office and Laboratory present in May and June 1993. As would be expected, many bugs had to be eliminated, especially in the software and communications equipment. The system then was tested at Fort Bragg by the user in July. The gaining unit personnel were trained for 30 days by the contractor. Then, the U.S. Army Intelligence Center and School ran a test, using gaining unit personnel, contractor support, and again observed by the government team. The system was turned over to the 319th Military Intelligence Battalion in July 1993, 36 months after Milestone 0.

Phase 3: Production and Deployment

The purpose of the Production and Deployment phase is to produce and field the system, monitor the system performance, and support the fielded system. This phase went smoothly — the payoff for some earlier stresses.

The remaining four contractor systems were completed in rapid succession, months ahead of the original schedule. This resulted in tremendous cost savings and almost offset the software overrun. Fielding to Fort Bragg, Fort Campbell, Fort Stewart and Europe went smoothly and on schedule.

The Army Research Laboratory system was slower to finish (as expected) because of the additional work of modifying and upgrading the contractors documentation to standard and making minor changes to the system to enhance producibility. This proved to be a large task, and drawing inconsistencies continue to surface. The system was not intended to be fielded right away. The original plan was to keep this system at the Laboratory until the ILS package could be completed, formal testing of the vehicle and trailer could be accomplished at Aberdeen Proving Grounds, and for work on advanced technologies. However, the MITT was so impressive at a demonstration given to the senior Army leadership at the Pentagon in June that the fielding schedule was modified and accelerated, and the Laboratory system was fielded to Korea in January 1994.

For the first time, ASPO had fielded a standard system, with Army manuals, to Army divisions worldwide. More importantly, ASPO now had the technical data package and trained personnel to help bring down the cost of follow-on builds. A contract is being finalized at the Army Research Laboratory to build five MITTs with the development contractor.

Phase 4: Operations and Support

The Operations and Support phase supports the fielded system, monitors the system performance, identifies improvement opportunities, and modifies/upgrades, as required. Here, ASPO systems have always excelled. The ASPO tries to field the 80-percent solution, and then uses a robust preplanned product-improvement program to upgrade the system according to user feedback. A small community of users, supported by contractor field-service representatives, allows for excellent support, feedback and improvements. Semiannual users conferences are opportunities for training and close interface among personnel in the program office and the soldiers whom they support. The MITT was phased carefully into this program throughout its development, and some particularly vexing problems had already been presented to users for ideas and prioritizing.

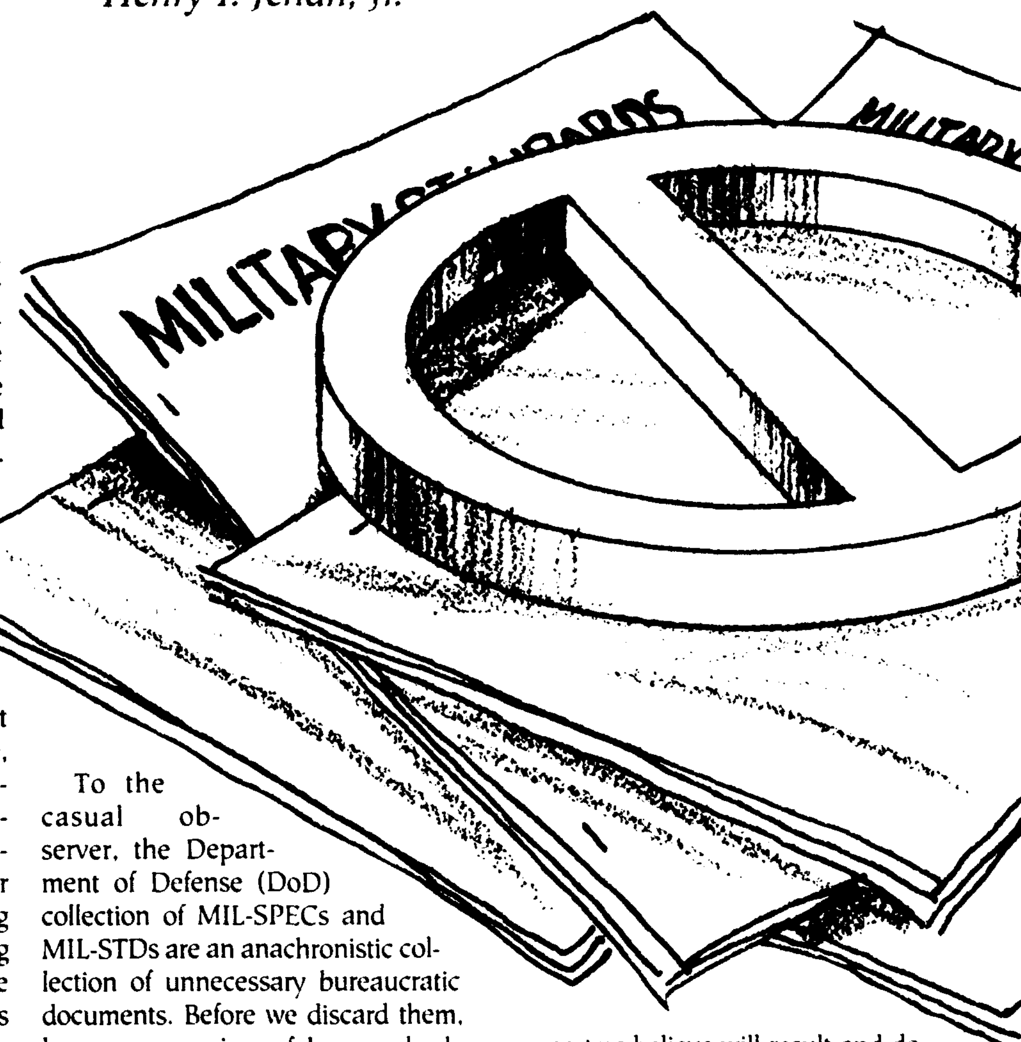
Conclusion

The use of innovative acquisition strategy was the key to the success of the MITT program. Involving an Army laboratory as an honest broker with an experienced defense contractor resulted in an impressive synergy of talent tempered by the checks and balances of divergent interests. The latest available technology was successfully integrated into a forward-thinking design. Concurrency in design, manufacture, testing, fielding and support hastened the process without compromising supportability or producibility. A flexible approach to the acquisition milestones allowed the program to progress rapidly without artificial barriers, while still fulfilling the essence of the process. Finally, a robust, preplanned, product-improvement program and frequent, direct interface with system operators allows the PM to be responsive to user requirements.

MIL-SPECS AND MIL-STDS NO MORE?

DoD Changes Prioritizing Policy

Henry I. Jehan, Jr.



Acquisition reform is the topic of many conversations. Needed and long overdue, this may be the year in which we begin to see improvements. The proposed streamlined contracting procedures, elimination of restrictive legal and regulatory requirements, and a new focus on an integrated military/commercial industrial base all sound like positive changes to a system we agree is an overburdened, restrictive and often counterproductive bureaucracy.

One effort frequently championed by reformers is elimination of military specifications (MIL-SPECs) and military standards (MIL-STDs). Once a critical cornerstone in fielding an effective state-of-the-art logistically supportable fighting force, MIL-SPECs and MIL-STDs have become a system of some 35,000 documents. Many have questionable military need, such as MIL-SPECs for chocolate chip cookies and dog combs. Others define procedures long ago determined technically obsolete by the commercial sector. Still others define cascading and circular references from one document to another, often ending at the starting point.

Mr. Jehan is the Deputy Project Manager for Instrumentation, Targets and Threat Simulators at the Army Simulation, Training and Instrumentation Command (STRICOM), Orlando, Fla. He is a PMC 94-1 graduate.

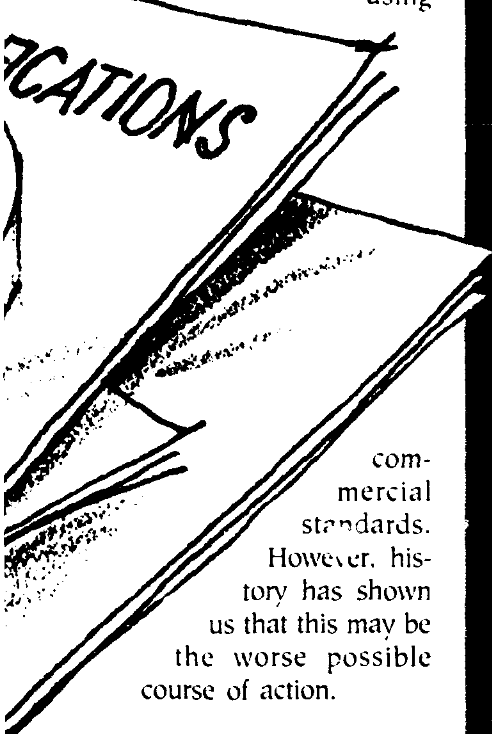
To the casual observer, the Department of Defense (DoD) collection of MIL-SPECs and MIL-STDs are an anachronistic collection of unnecessary bureaucratic documents. Before we discard them, however, a review of how and why they came into being may be in order.

These documents evolved to what they are because of bonafide requirements. Yet, the dialogue I have heard on acquisition reform has not included discussion of what will be lost if MIL-SPECs and MIL-STDs are eliminated. Rather, the discussion seems to center on a perceived cost savings that supporters believe will result and detractors say cannot be documented.

Cost Controversy

The cost controversy related to MIL-SPECs and MIL-STDs is based on reasonable estimates that they add as much as 30 or 40 percent to DoD acquisition costs. Presumably, by eliminating the MIL-SPECs and MIL-STDs, this cost will be a real dollar savings in a time of declining budgets. However, this argument fails to explain why specifications and standards exist. Not created for economic reasons, they exist because, as history has shown, they were required to reduce combat risk. Simply put, they represent dollars paid now to save lives later.

Some may contend that cost is not the only reason for eliminating MIL-SPECs and MIL-STDs. To many, bureaucracy issues, document deficiencies, and burden on industry are adequate justifications to advocate total elimination of the documents in favor of using



commercial standards. However, history has shown us that this may be the worse possible course of action.

The roots of the current system of specifications and standards lie in the supply fiascos of the Spanish-American War, and a need for good standard procedures for packaging and preserving supplies and material. From the problems experienced in the field and at sea, the MIL-SPECs and MIL-STDs system was born. Subsequently, industry adopted many of the specifications and standards, institutionalizing them into what have become the commercial procedures standards and specifications of today.

However, these adaptations of use by the commercial sector are developed to meet civilian needs, not the rigors of combat. During conflict, failures of commercial and improperly designed military materiel are not counted in monetary costs; they are bought with mission failures and loss of human life. Historically, this price

While eliminating them may produce short-term savings, history has shown that the long-term cost of not having MIL-SPECs and MIL-STDs is a price our nation has not been willing to accept.

has been more than our forefathers were willing to bear. Have our values changed so we can now afford such human cost? Based on recent experiences in Desert Storm, I would say not.

Reversing Priorities

Department of Defense leadership does not advocate total elimination of military standards and specifications. A policy memorandum of 29 June 1994, by Dr. William J. Perry, Secretary of Defense, states:

> Performance specifications shall be used when purchasing new systems, major modifications, upgrades to current systems, and nondevelopmental and commercial items, for programs in any acquisition category. If it is not practicable to use a performance specification, a non-government standard shall be used. Since there will be cases when military specifications are needed to define an exact design solution because there is no acceptable non-governmental standard or because the use of a performance specification or non-government standard is not cost effective, the use of military specifications and standards is authorized as a last resort, with an appropriate waiver.
>
> Waivers for the use of military *specifications and standards* must be approved by the Milestone Decision Authority (as defined in Part 2 of DoD Instruction 5000.2). In the case of acquisition category I D programs, waivers may be granted by the Component Acquisition Executive, or a designee. The Director, Naval Nuclear Propulsion shall determine the specifications and standards to be used for naval nuclear propulsion plants in accordance with Pub. L. 98-525 (42 U.S.C. § 7158 note).

In her comments at the April 26, 1994, Defense Acquisition Reform Symposium, Mrs. Colleen A. Preston, Deputy Under Secretary of Defense (Acquisition Reform), stated that the intent of DoD policy is to reverse the priority by which military and commercial standards and specifications are incorporated in procurement actions. Use of commercial practices, standards and specifications is prioritized ahead of military standards and specifications.

but use of MIL-SPECs and MIL-STDs is not eliminated completely.

It is incumbent on personnel in the Office of the Secretary of Defense, military services and defense agencies responsible for implementing this change in policy to ensure that implementation reduces bureaucracy across all aspects of our acquisition system, for both contractor and government. Decisions on which industry standards, commercial specifications, MIL-SPECs and MIL-STDs should be imposed on a program are critical factors in balancing the tradeoffs between cost, schedule and performance with direct battlefield consequences. Because they represent technical decisions, these factors are best evaluated by a knowledgeable program team and should be a decision reserved for the program manager (PM) with the approval of the Milestone Decision Authority.

Identifying when MIL-SPECs and MIL-STDs should be used instead of commercial practices, standards and specifications is only part of the specifications and standards problem that must be addressed in each procurement. In most discussions on eliminating MIL-SPECs and MIL-STDs, most examples come from the electronics industry. This industry has an almost daily change in technology and a reasonably solid set of industry specifications and standards. It contends that MIL-SPECs and MIL-STDs are obsolete, references obsolete practices and, to correct problems in existing contracts, would require an inordinate number of engineering change proposals at an unaffordable cost. Another common argument has been incorporation of a MIL-SPEC in a contract forces the contractor to give us less for more, because the commercial sector often has cheaper products that exceed the MIL-SPEC. Undoubtedly, Dr. Perry's direction gets to the core of these arguments. However, this new direction may not correct the perceived problems with the standards and specifications.

Historically, we have done a poor job of understanding and tailoring the MIL-SPECs and MIL-STDs incorporated into our contracts.

A bigger issue is how we as acquisition managers employ the standards and specifications.

Many MIL-SPEC and MIL-STD problems could have been corrected if a few changes had been made in how we incorporated them into our contracts. Typically, we included them by reference without a thorough understanding of their content. We incorporated them by default, frequently not making provision to change to updated versions during contract performance. And, we made them absolute standards, which not only established minimum requirements but often limited performance as well.

A New Way of Doing Business

The new policies regarding specifications and standards add an unprecedented level of importance to the PM's responsibility to understand the implications of the specifications and standards applicable to the contract. The MIL-SPECs and MIL-STDs represent a historical compilation of lessons learned, while commercial specifications, standards and procedures are not tailored to military requirements. As a result, the PM must understand the lessons learned captured in the MIL-SPECs and MIL-STDs; the implications of the commercial specifications, standards and procedures; and how these often incompatible worlds interface in the system being acquired.

Historically, we have done a poor job of understanding and tailoring the MIL-SPECs and MIL-STDs incorporated into our contracts. Now that the use of MIL-SPECs and MIL-STDs is the exception rather than the rule, we must give them the attention they deserved all along. If we must use MIL-SPECs or MIL-STDs, we must review and understand their content and intent to ensure they are appropriate and justified before we incorporate them into the contract. Additionally, if the MIL-SPEC or MIL-STD is technically obsolete, it should be updated or eliminated. To ensure this, the program office discovering the inadequacy must become responsible for initiating action to have the technically knowledgeable and responsible government organization make the needed corrections.

Summary

Military specifications and standards play a vital role in our acquisition process. While eliminating them may produce short-term savings, history has shown that the long-term cost of not having MIL-SPECs and MIL-STDs is a price our nation has not been willing to accept.

The change in DoD policy to reprioritize the use of commercial standards, procedures and specifications ahead of military standards and specifications is wise. However, those responsible for implementing this policy must ensure the PM is given maximum flexibility to trade off the type of specifications and standards used to optimize the program. In doing this, the PM must not lose sight of the long-term combat implications of the standards and specifications used, while pursuing innovative ways to reduce any unnecessary burden imposed on the contractor.

FROM OUR READERS

LETTER TO THE EDITOR

In the Jan-Feb 94 issue, the Commandant of the Defense Systems Management College, Brig Gen (Sel) Claude M. Bolton, Jr., [USAF] indicated a lack of understanding of Special Operations requirements by those in the acquisition arena. The USAF Special Operations School (USAFSOS), located at Hurlburt Field, Florida, could offer the first step in solving this problem. The mission of this school is to educate United States military and other personnel in the missions and functions of special operations in the evolving world threat. The school has existed under various names since 1967. The Ribbon-cutting Ceremony for our new 28,700-square-foot educational facility is scheduled for July 1994. This state-of-the-art facility will have two large auditoriums, four classrooms, and the latest in instructional technology.

The USAFSOS curriculum has grown from a single course of instruction with 300 graduates per year to 15 different courses presented 72 times per year with 4,000 graduates. Courses of instruction are divided under two main headings—Regional Affairs and Special Operations. Regional Affairs courses include orientation courses on Latin America, the Middle East, Africa, and the Asia-Pacific areas. Classes on cross cultural communications and antiterrorism also come under this heading. Special Operations courses are more mission oriented and include topics such as an introduction to Special Operations, joint planning, revolutionary warfare, psychological operations, crisis response, and foreign internal defense. Most classes include a joint student population made up of approximately 56 percent Air Force, 19 percent Army, 12 percent civilian, 7 percent Navy, and 5 percent from the Marines. This joint environment and a school policy of nonattribution promote a forum for an open exchange of ideas and experiences. Many courses are presented at the Secret and Top Secret levels. Courses often feature area experts including ambassadors, college professors, and general officers.

Off-site tutorials are also available and can be tailored to special needs. We have a team that takes the Introduction to Special Operations Course on the road to units in the CONUS, as well as Kadena Air Base and Mildenhall, England. This two-day course addresses the evolution of Air Force Special Operations, JUST CAUSE and DESERT STORM, and the basic missions and capabilities of Special Operations units. A classified case study of Desert One is also included in this course which targets the audience with little knowledge of the Special Operations arena.

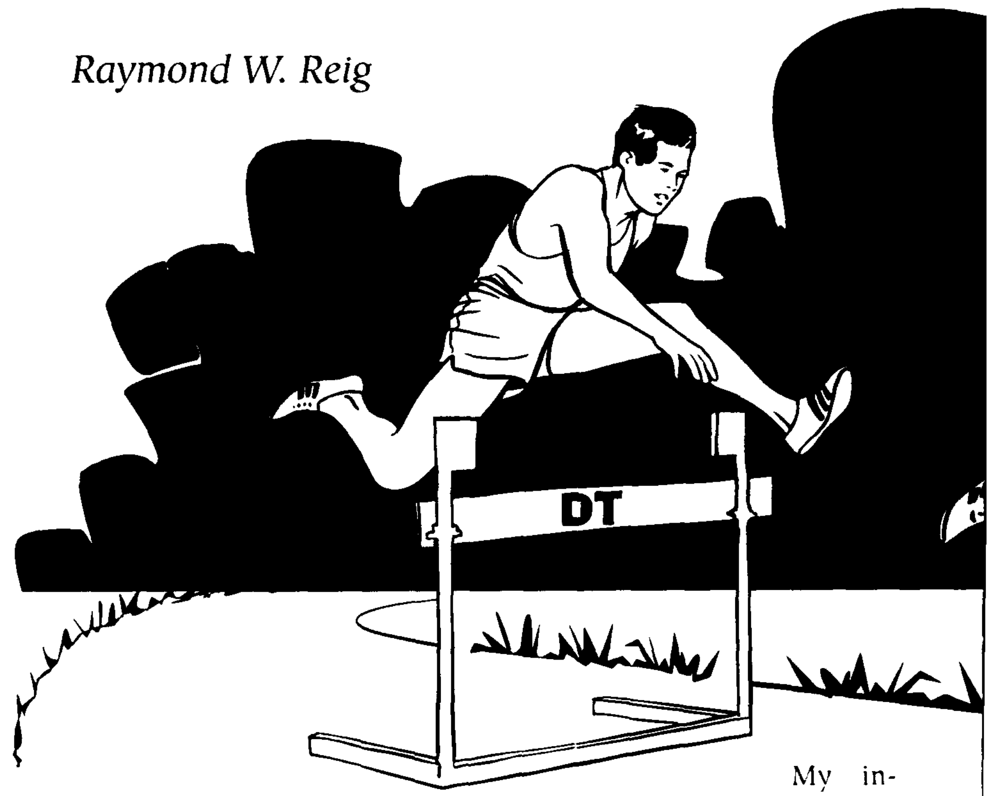
All too often, Special Operations units are viewed as performing their own unique mission with little interface with the conventional world. The truth is that Special Operators actually support the conventional war. Because of this common misconception, we in the Special Operations business are constantly working to bridge the gap between our forces and the conventional units. We hope to continue this bridge-building process by opening the lines of communication between USAFSOS and the Defense Systems Management College.

Continuous changes on the battlefield and the evolution of new missions demand new and improved equipment for Special Operations forces. Just as the operator benefits by understanding how to function in the joint arena, those in the acquisition process will undoubtedly benefit by understanding the growing demands being placed on those in Special Operations. We at the USAF Special Operations School welcome opportunities to interact with those in the acquisition process. Persons interested in attending one of our courses should contact the Registrar at DSN 579-4731 or commercial (904) 884-4731.

Colonel Terry R. Silvester, USAF
Commandant
USAF Special Operations School
Hurlburt Field, Florida

INSUFFICIENTLY ROBUST DT&E MEANS TROUBLES AHEAD FOR OT&E

Raymond W. Reig



In the fall of 1993, the General Accounting Office issued a report critical of how the Department of Defense (DoD) was managing the acquisition and development of software-intensive systems.[1] At about the same time, the Under Secretary of Defense (Acquisition and Technology) (USD(A&T)) asked his staff how come systems pass developmental testing (DT), and fail operational testing (OT). He then named five systems that were electronic warfare (EW) and command, control, communication, computer, and Intelligence (C^4I) systems. These systems are, of course, software intensive; thus, the actions are addressing the same issue.

An intensive three- to four-month study effort was initiated to answer the USD(A&T) question involving several organizations and considerable number of personnel in the test and other acquisition disciplines. The Defense Systems Management College Test and Evaluation Department participated in research aimed at answering the question. Conclusions were presented through management and considered with many other inputs into the final report. This report was forwarded to the USD(A&T) on 25 February 1994, and contained the following primary findings:[2]

— The requirements generation and management process led to unrealistic operational requirements.

— Program Developmental Test and Evaluation (DT&E) was not sufficiently robust for confident entrance into Operational Test and Evaluation (OT&E).

— System boundaries were not defined sufficiently.

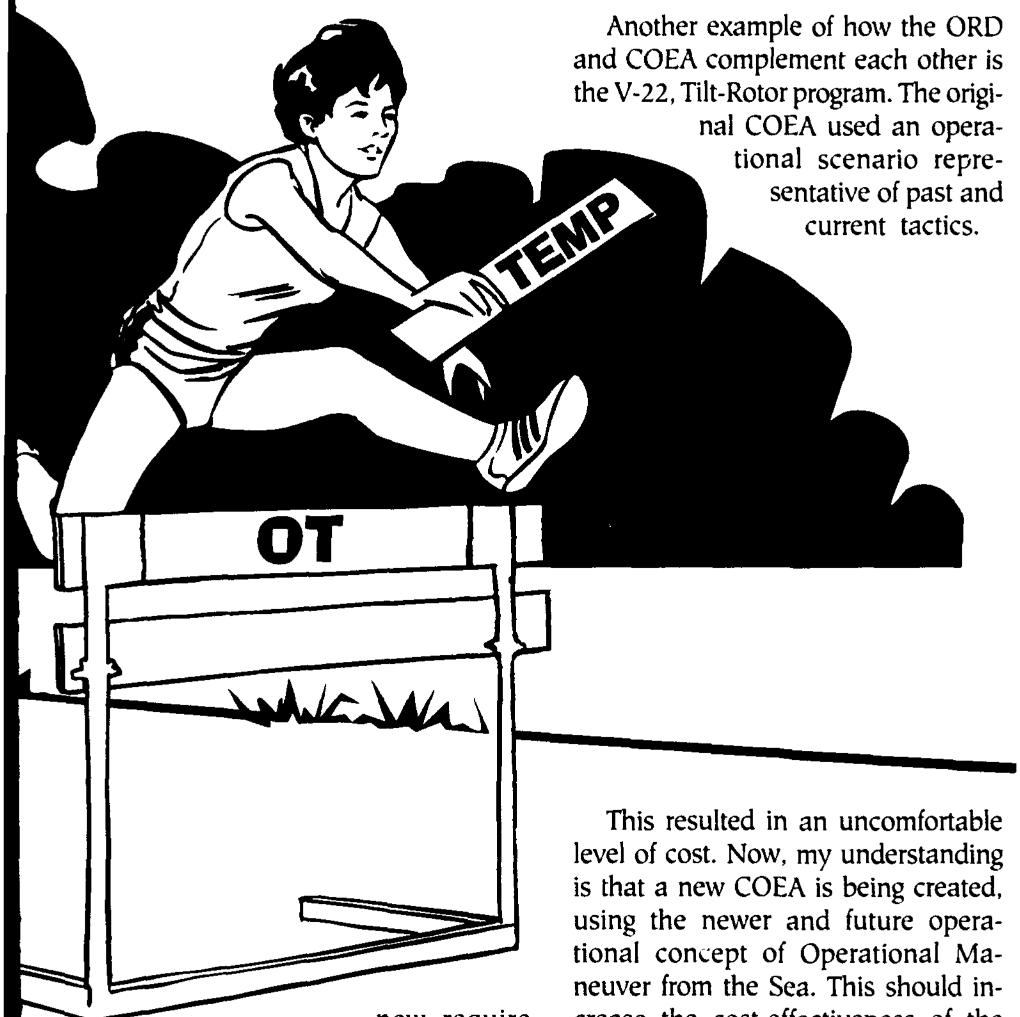
My involvement with this study effort, combined with other experiences in weapon systems acquisition, have resulted in "personal findings," as follows:

Personal Findings

1. The requirements generation and justification documents — the Operational Requirements Document (ORD) and the Cost and Operational Effectiveness Analysis (COEA) — tend to be used as advocacy documents leading to optimistic expectations, which are rarely achieved. Research into the acquisition history of 24 DoD programs shows an average cost overrun in the Engineering and Manufac-

Professor Reig is on the faculty of the Test and Evaluation Department at the Defense Systems Management College. His more than 35 years of experience spans military, government and private aerospace industry.

turing Development (EMD) phase of the programs to be 45 percent, and the schedule overrun to be 63 percent.[3] A natural bias seems to be at work here. After all, no one proposes a new system "just a little better" than the existing system. So the pressure builds for the super system that will stand head and shoulders above the existing system. This usually requires state-of-the-art solutions and results in notching up the risk. That could take the form of adding one more requirement to the existing hard-core new requirements, thus leading to the one super system that can accomplish the entire requirement. In simpler times, this was called goldplating and engineers were accused of doing it.



Concurrently, the COEA is accomplished and "confirms" that to meet all requirements the system in mind is most cost-effective. The COEA that comes to mind included a major Pre-Planned Product Improvement (P^3I) consisting at the time of a one- or two-sentence description of the modification, and the specific threat it would defeat. Regardless of the fragile input data, the COEA concluded that the basic system with the P^3I was the preferred approach. Independent cost analysis concluded insufficient data existed to determine the reasonableness of funding profiles of the basic program, to say nothing about the P^3I program.

Another example of how the ORD and COEA complement each other is the V-22, Tilt-Rotor program. The original COEA used an operational scenario representative of past and current tactics.

This resulted in an uncomfortable level of cost. Now, my understanding is that a new COEA is being created, using the newer and future operational concept of Operational Maneuver from the Sea. This should increase the cost-effectiveness of the system and may correct a prior fault, but it shows also how the ORD and COEA tend to self-confirm each other. Lastly, the DoD 5000 series acquisition guidance makes the user responsible for creating both the ORD and the COEA. This single responsibility for the requirement, as well as the justification of the selected solution, is rare in the practice of business.

2. Developing successful software-intensive systems is difficult, because more hardware experience and skills are available in industry and government than software experience and skill. This is particularly true in older, senior personnel who started their careers in the 1950s and 1960s — the "hardware generations." Back then, in large engineering departments working on many programs, one centralized compartmented area existed, where we engineers would bring software requirements to the counter, and were told when to return for the software program to integrate into the hardware at a final manufacturing step. When we returned, we usually were told the program wasn't ready, when to return again, and how much more funding to bring. (An over-simplification, but not by much.)

DT is considered a "low hurdle" (easy), while OT is considered a "high hurdle" (harder). This is especially true for software-intensive systems.

Much progress has been made in software development since then, much of it codified in MIL-STDs

2167A and 2168. But, hardware engineers who used to bring their requirements to the counter have not received much additional training. Many of those still in the business are faced with making decisions on software-intensive systems. This results in managers not skilled in the subject area deciding major program design parameters. However, on balance, they come with a healthy skepticism of software plans, based on their frequent return trips to the software counter.

3. Avionics software-intensive systems are even more difficult to develop successfully, because airborne equipment usually has severe state-of-the-art requirements involving weight, volume and cooling air. One manifestation of this is low volume manufacturing yields of densely packaged electronics. The same card, made in the engineering lab for proof of principle tests on the prototype, did not reveal this manufacturing problem. This led to optimistic production *schedules*.

Also, unhampered by fact, it is my opinion that avionics software-intensive systems have more interfaces than stabile ground systems. Shortcomings are more apt to be discovered in OT end-to-end testing than in prior *in situ* DT testing. For example, a standard radio designed to operate in many aircraft types may perform differently in different platforms because of the type and placement of the antennae in the various platforms, particularly in fighter aircraft vs. transport aircraft.

4. The EW and C^4I avionics software-intensive systems are the most difficult to develop successfully. In addition to the constraints previously discussed, these systems usually require stringent special personnel security clearances, over and above those required for other military development projects.

In the late 1960s and early 1970s, the "software generations" were just graduating with the prerequisite skills desperately needed but, to a certain percentage, using their skills for the military was anathema. Any involved in college student protests probably would not be granted the required clearance. Besides, the alternative was employment in Silicon Valley and elsewhere with modern working conditions and attractive pay. It seemed more inviting than working at a green or gray steel desk in an engineering bullpen at some defense contractor or government laboratory.

Also, the EW and C^4I systems were being designed to defeat a threat that was not static, not under our control, or perhaps not even known to us. In the 8-10 years it takes to design, develop and produce our system, if the threat has increased, our production-ready system may have limitations. This comes close to being a law of physics and the only solution I can think of is a P^3I or evolutionary acquisition approach.

5. Perhaps because of the aforementioned aspects, software-intensive systems receive extramanagerial inputs, above and beyond the program manager's control. Examples listed here are all from one program, but these and others do occur with some frequency. In this program, the Service Secretary abruptly requires unplanned-for testing, and adjusts the budget insufficiently. Another Service withdraws from this joint program, and Congress limits the use of production funds. Contracting directs the procurement of a critical subsystem from a specific source, and later caps the government program costs at a figure substantially below actual costs. Most recently, the Service has been directed to conduct no more OT until a Director of Operational Test and Evaluation, has been appointed.

6. In systems of this type a movement seems to exist toward "creative terminology" which confounds the established program evaluation metrics. I believe most people who have been in the defense industry for any period of time have a good, homogeneous interpretation of the terms Low Rate Initial Production (LRIP), Operation Evaluation (OPEVAL), Full Rate Production, and Initial Operational Capability (IOC). Generally, they are familiar with the requirements of each, and many of these requirements are contained within the DoD 5000 series documentation. Recently, some programs approaching these milestones, but not quite able to meet the requirements thereof, have used alternative terminology. Hence, an LRIP phase becomes a PV (product verification) phase, or an OPEVAL becomes an "Operational Effectiveness Test" or a "Verification of Correction of Deficiencies Test." The IOC, in some cases, has been replaced by Limited Operational Capability (LOC). Many people would know how to evaluate an OPEVAL, or judge readiness for an LRIP phase, but no guidance is found on how to evaluate, or what to expect from, these newer terms.

Then the question remains regarding wording used within a TEMP or test report. One sentence from a test result used in a program TEMP stated "For the tests performed the system operated as required." Is this good or bad? Another variation of the same idea is to list a large number of limitations of scope on the testing performed, and then provide a generalized evaluation which makes the results of limited usefulness. Currently a program is considering declaring IOC before Milestone III, upon delivery of the first LRIP article. Clearly, this is a different interpretation of the IOC than that of a few years ago.

7. In my opinion, subject to objective confirmation, it seems that few test articles have been used in the EMD phase, relative to the total planned production quantity. In the ongoing research into the EMD phase of recent weapon systems acquisitions, an average of 1.8 percent of the total planned production quantity or

28 percent of the total LRIP quantity was acquired with research, development, test and evaluation funds and presumably used for testing. Of the five programs used as examples in USD(A&T) questions, the average number of LRIP articles used for testing was 1.3 percent of the total planned production quantity.[4]

Recommendations

The price for commenting on a process is to recommend actions to ameliorate the situation. Mine are as follows:

1. If someone could solve the software development problem, half of our systems acquisition problems would be solved. Our usual approach is to reorganize or change the acquisition policy. I suggest a complementary approach whereby, for the next five years, a mandatory special software acquisition management course could be held for all senior managers involved in DoD acquisition. The target audience would be the still-active *hardware-generation managers*. Waivers would be available for the software proficient, and younger managers who want more software training would be welcome. After five years the problem should be self-correcting, and the special course could be terminated.

The Air Force Bold Stroke course is an excellent example. This is a one-week course designed for general officers, and its objective is to increase the awareness of these senior managers to software acquisition pitfalls. This course, originally designed by DSMC for the Air Force Systems Command, is now presented by the Professional Development Institute.

2. Distinguish between a "broken" acquisition system and a poorly executed program. In the 24 systems reviewed, 18 were tightly grouped somewhat over the original EMD cost and schedule estimates, and six were significantly outside the range. I would say the current acquisition system provides results similar to the results of 18 of these programs, and six of these programs were poorly executed. The reasons for poor execution are many and diverse, and probably caused as much by conditions outside the program office as those within.

3. Instill discipline in the established acquisition system. The current official guidance governing DoD acquisition, the 5000 series documentation, was issued in February 1991. Merely reading and knowing the 5000 series intimately would not suffice three years later. The conclusions of a dozen or more OSD memos, immediately directive in nature, indicate that the subject matter will be incorporated into the next Directives update. To date, this has not happened.

The Directives state the Test and Evaluation Master Plan is limited to 30 pages, plus annexes. Providing the data currently required by OSD reviewers and others within 30 pages is not possible. Much of the additional required data is valuable, and perhaps the answer, in this instance, is to review the page limitation. Creative terminology, discussed previously, falls into this category of system discipline.

4. Consider the then-current practices when *post-facto* criticizing a program's performance. I believe the A-12 Administrative Inquiry contains an eloquent exposition of this point.[5]

The above thoughts were generated by my involvement in recent research efforts associated with acquisition, and by longer-standing experience. I hope it agrees generally with your own thoughts, and you find it worthwhile. The Test and Evaluation Department research is ongoing and other resulting data will be published in subsequent articles.

The Air Force Bold Stroke course is a one-week course designed for general officers, and its objective is to increase the awarencss of these senior managers to software acquisition pitfalls.

Endnotes

1. "Test and Evaluation: DoD Has Been Slow in Improving Testing of Software Intensive Systems," 28 September 1993. (GAO/NSIAD-93-198). Washington, D.C., General Accounting Office.

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MANAGING A MAJOR TECHNICAL PROGRAM

Comparisons in Dealing with Changes

Dr. Raymond B. Gavert

Although it is not a military system, the Space Station Freedom Program (SSFP) provides some interesting technical and management comparisons in dealing with the changes of a major technical program.

The space station program is a major technical effort involving funding of approximately $2 billion yearly. Scheduled for completion around the year 2000, the program is global and includes international partners from Japan, Canada and the European Space Agency. It also includes work with Russia. The closest comparison to a military program office would be that of a joint program office with participation of allied forces.

This article will make some comparisons of the National Aeronautics and Space Administration (NASA) SSFP with two major military devel-

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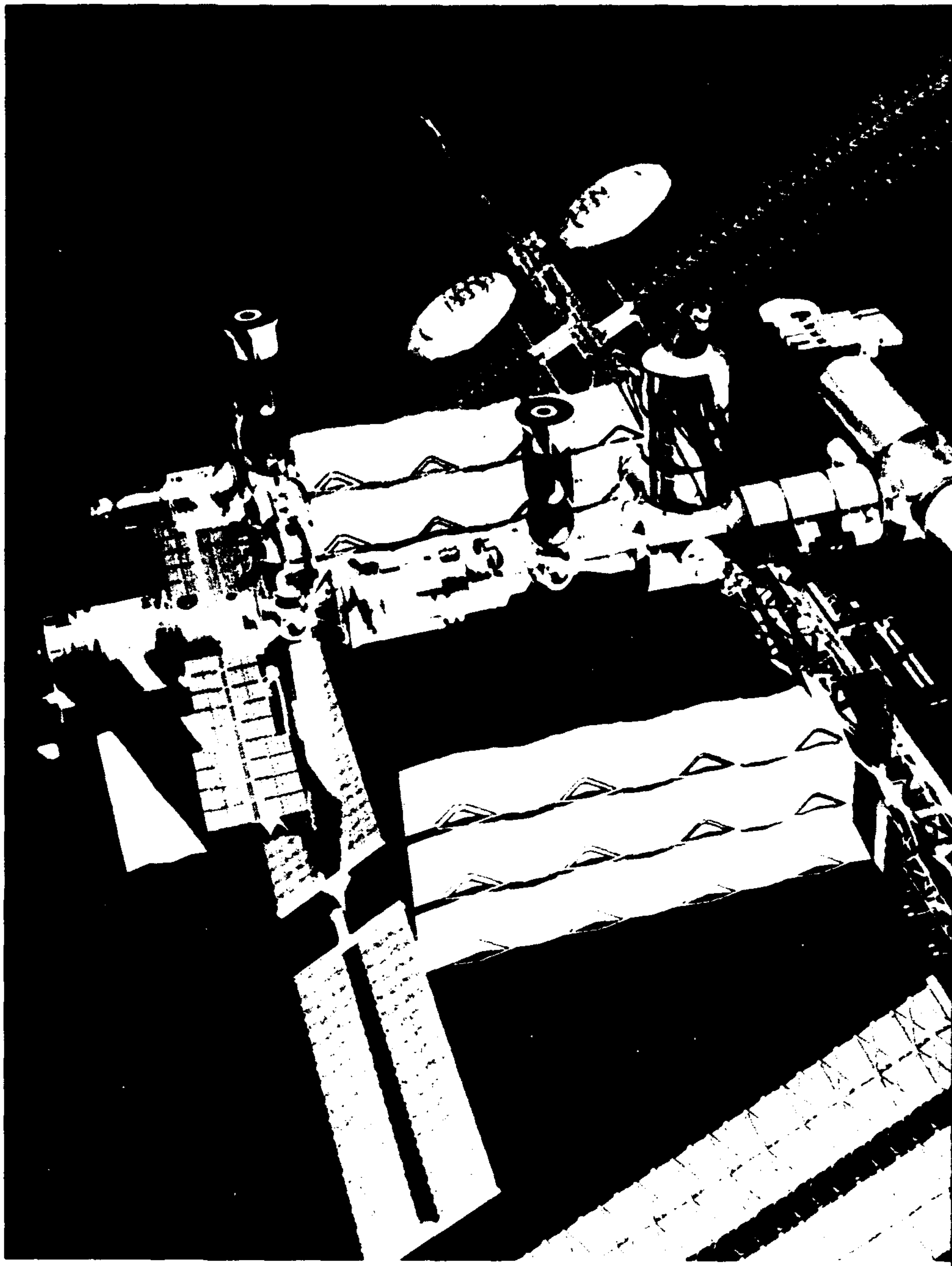
The author thanks Dr. Franz A. P. Frisch, Professor of Acquisition Management, Research, Consulting and Information Division, Defense Systems Management College, for his valuable support and suggestions in the development of this article.



Space Station: U.S./International partners preliminary design concept.

opment activities; i.e., submarine construction and the work of the Strategic Defensive Initiative (SDI). General comparisons are made between the military and NASA program life cycles. Comparisons are shown in software management in the NASA SSFP with military software management. Life-cycle organizational change comparisons are made.

The configuration of Space Station Freedom (SSF) has changed many times during its development cycle.

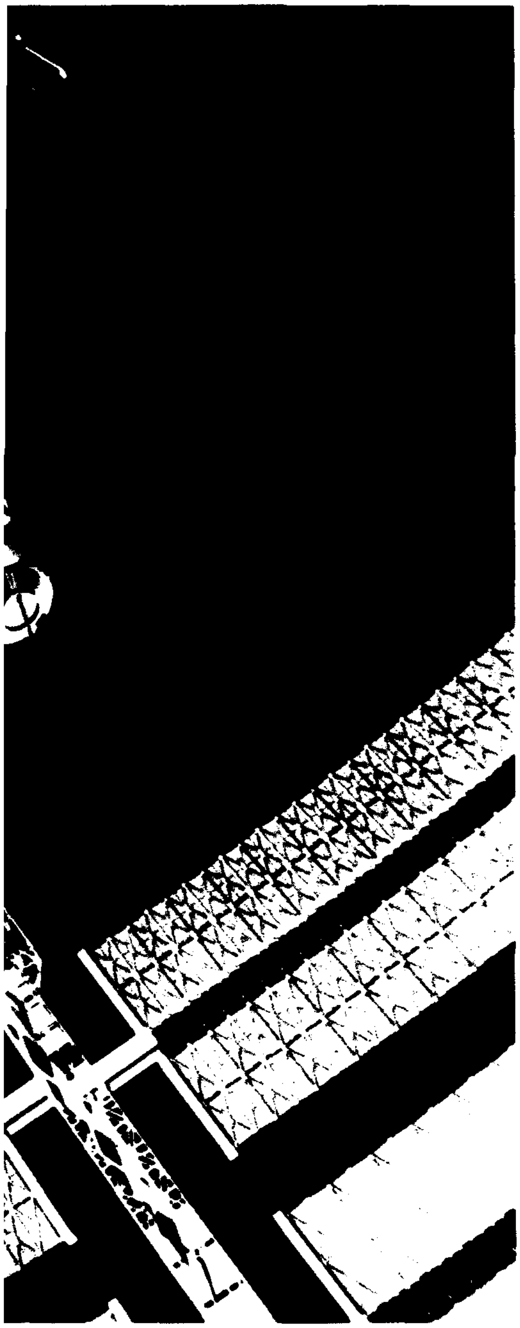


Photo courtesy of NASA

The version in the photograph is a restructured design concept. Like military programs, constant pressures to cut costs exist. Even with major restructuring to save money the space station has general features still including: a Truss for mounting station elements; a U.S. laboratory module; a habitation module; an airlock enabling transfer of crew and equipment between pressurized and unpressurized areas; major subsystems for providing power, thermal control, data handling, environment control and life support; Canadian rail-mounted mobile transporter; pressurized and unpressurized logistics supply elements; a Japanese experiment module, and a European Space Agency attached pressurized module for laboratory work.

Like the military, adversaries suddenly can become friends. With the collapse of the Cold War, negotiations are now underway to use the Russian Soyuz spacecraft as a "lifeboat" for emergency crew return. Plans also continue for considering further changes that involve greater cooperation with the Russian Space Station Mir program.

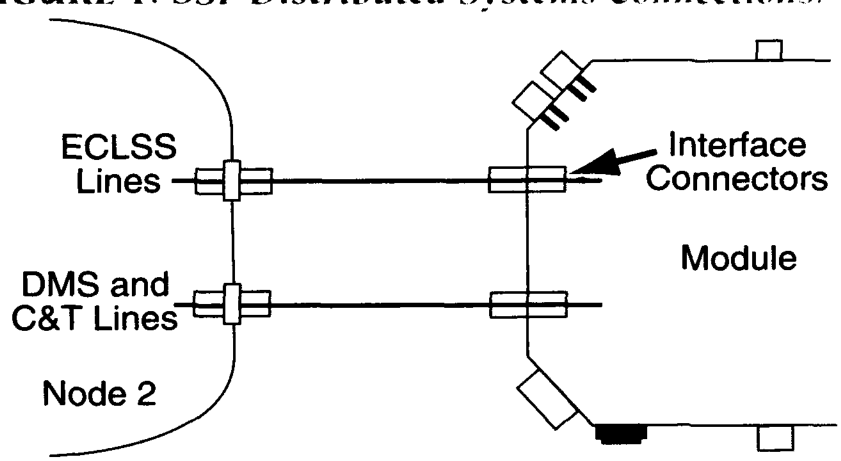
Comparison with Submarine Construction

Commander S.M. Jarrett in his Naval War College paper, "The Application of Submarine Experience and Technology to the Space Environment," pointed out that the submarine force of the United States has operated in a closed environment for almost 80 years. Further, he stated that submarine patrols simulate space travel more closely than any other type of operation.[1]

Developing and constructing a submarine, however, differs from developing and constructing the SSF. For example, the SSF Environmental Control and Life Support System (ECLSS) has atmosphere control and supply, nitrogen support, pressurized element temperature and humidity control, atmosphere revitalization, and fire detection and repression. Designed to be a distributed system, the equipment will be assembled in space during several shuttle flights. Figure 1 shows an example of the ECLSS distributed systems lines and other distributed system lines that need to be connected in space between a node and module sent up on different flights.

In submarine development and construction, the life-support systems are designed to be assembled at a naval shipyard with all the conveniences of a permanent facility. Although the ECLSS system has had some shuttle carryover in technology, it has been designed as a completely new system. By comparison, in a submarine program, changes to a system are more gradual. A new class of submarine might be built, for example, with no major changes in the life-support system.

FIGURE 1. SSF Distributed Systems Connections.



Although differences exist between development and construction for operations in space vs. underwater, Commander Jarrett, in his thesis, discusses opportunities for sharing technologies. This type of cooperation can benefit both the NASA and military program managers (PMs).

Comparison with the SDI Program

The SDI (renamed the Ballistic Missile Defense Organization), a major military program, has seen many changes. Even with the current emphasis on ground defense systems, the program involves on-orbit spacecraft and is useful for making comparisons with the SSFP. Like the SSFP, the SDI has an annual budget in billions of dollars and involves many government organizations and contractors.

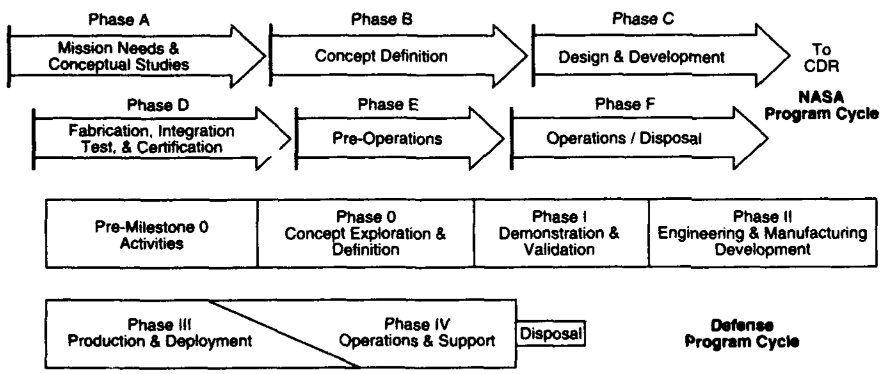
The SDI military mission has been to develop a defense against nuclear missile attack. Space-based satellites in the defense system are used to spot launches, track targets, prioritize and control kills. The weapons for kills may be space or ground based. Although astronauts may be military and the experiments may be of use to military research, the space station is not a part of any weapons system.

The space station program will have men permanently stationed in space. On the other hand, the SDI program does not involve permanent presence in space to operate the system. Space Station Freedom has a long-term mission in space of 15 years or more. The SDI has a long-term commitment to protect our nation's assets from missile attack, but it would not necessarily have to have the same spacecraft in orbit for long periods of time. Should an SDI element have a long-term presence in space, it can learn from the space station's designs and operating experiences in on-orbit maintenance involving robotics and manned extravehicular activities.

Both being major billion dollar programs, the space station program and the SDI have been in the public eye constantly and open to public attack. Throughout the program life cycle, critics present other systems and ways to spend the money, and may time their attack to just before congressional hearings. The PM may not have much time to respond to a headline in the morning newspaper when hearings begin the same or following day. Generally, the PM must be aware of these critics in advance in order to best defend his program decisions. Sometimes public debate may be necessary. Program officers must make no out-of-place remarks or those that can be misinterpreted.

Major programs like SSF and the SDI seek technical and programmatic advice from many consultants and outside experts. Generally, these people come under two categories — those under PM control and independent experts chosen by others at higher levels including the President and Congress. Those in the first category can be a big help in resolving problems where the existing organizational staff is deficient in capabilities saving time, money and improving quality. Those in the second category often require the PM to divert precious manpower into gathering information for the experts.

FIGURE 2. Comparison of the NASA Program Cycle with the Defense Program Cycle



A negative report by the experts can hurt the PM's career. In addition, the results of independent studies limit the PM's decision-making flexibility. In one case in the space station program, the outside consultants were not pleased with the reception their study received by the program management. To strengthen their point, the consultants released their views to the New York Times. This forced the program to move in the direction desired by the consultants.

Lobbying the Congress is not an option of a NASA or military PM, even though Congress with its larger support staffs, tends to be moving beyond establishing policy and funding legislative work to directing program office actions. Program contractors can lobby the Congress. For example, a contractor might place an advertisement strategically in the Washington Post just before a congressional hearing. Even unions can help the PM promote his program. In both cases, however, the PM has no control over what they say or their priorities. The PM's best defense for his program is a good presentation at the congressional hearings and to be trusted.

Comparison of Program Life-Cycle Phases

The military program life cycle and the NASA life cycle have different terms and groupings for the program phases as shown in Figure 2. The military groups the program life cycle into: the Pre-Milestone 0 Activities, Concept Exploration and Definition, Demonstration and Validation, Engineering and Manufacturing Development, Production and Deployment, Operations and Support and, finally, Disposal. The phases apply to all types of weapon systems from helicopters to ships, tanks and satellites.

The NASA program life cycle is geared ultimately to launching something into space and retrieving information from the space activities. The NASA program phases are termed: Phase A, Mission Needs and Conceptual Studies; Phase B, Concept Definition and Preliminary Design; Phase C, Design and Development, leading to Critical Design Review; Phase D, Fabrication, Integration, Test and Certification; Phase E, Pre-Operations, including deployment and performance validation; Phase F, Operations and Disposal, including sustaining engineering and phase out. The program is currently in Phase C with partial work being done in Phase D.

In both NASA and the military program cycles, change flexibility becomes more confining as the program cycle progresses, because decisions made continually reduce options and alternatives. This is true particularly as hardware production begins and software is in advanced testing. Like the military, NASA must respond to threats and opportunities as the life cycle unfolds. Military programs usually are impacted by changing threats from external military powers. The NASA threats tend to be related to things like funding indecision. For example, if a heavy lift vehicle is not funded for SSFP use, more shuttle flights will be needed to get the total number of payloads into space. Software phases differ somewhat from the phases just described, as the following section will explain.

Software Management Comparisons

The System Software Development Standard (DoD-STD-2167A) applies directly to military software development. In NASA, DoD-STD-2167A provides supporting and background information but is not a requirements document. The NASA Software Management and Assurance Program (SMAP), out of the Office of Safety, Reliability, Maintainability and Quality Assurance, has created standards documentation called the "Information System Life-Cycle and Documentation Standards." The SSFP has used these standards including many of the NASA Data Item Descriptions in its management planning and requirements development.

A distinction between military and NASA management in software and hardware development is that in NASA consensus of management is a more dominant influence than following a strict set of regulations. The military rotating assignments create a greater need for following formal directives and standards. In NASA, employees remain for long time periods and have considerable influence in new-program decision making. In the case of the SSFP, experiences of shuttle program personnel have had a strong impact on SSFP software requirements and management practices.

One example of the influences of previous experiences is the SSFP Flight Systems Software Requirements (FSSRs). Unlike DoD-STD-2167A, which sets requirements by individual Computer Software Configuration Items (CSCIs), the FSSRs set requirements by systems which may have several CSCIs. What is gained by a systems perspective, however, is offset by the greater difficulty in judging the maturity of requirements compared to evaluating individual CSCIs.

Many of the contractors that work software development for the SSFP have experience based on military software systems. They tend to follow the military standards like DoD-STD-2167A whenever they can, thereby providing another source of influence on NASA procedures.

Working Avionics Problems

The SSFP software development management, software engineering and software test and evaluation responsibilities fall under the same groups that work avionics problems. For example, the largest software effort in SSFP is the Data Management System (DMS) which is organizationally placed under Avionics Systems. Before restructuring to reduce costs, the DMS, including applications software, had more than one million lines of code required to integrate, test, verify and maintain the system. The DMS uses 1,553 data bus architecture. For example, the system controls sensors and effectors in pointing an antenna, through the use of Multiplexer Demultiplexers (MDMs).

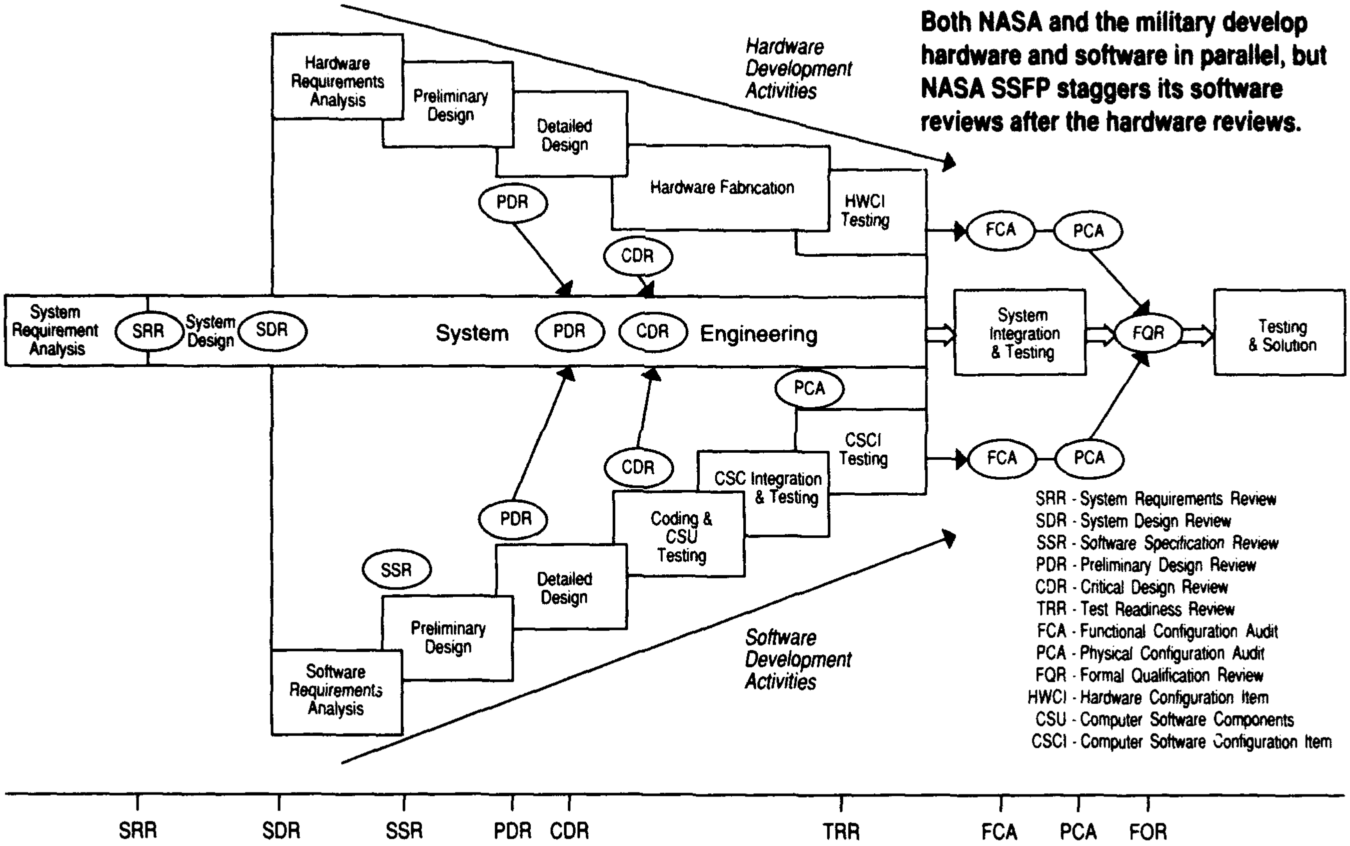
Organizationally, SSFP Avionics includes the DMS, Communications and Tracking System (C&T) and Guidance, Navigation and Control (GN&C). Other systems such as the Electrical Power System (EPS), and the Environment Control Life Support System (ECLSS), for example, are not in Avionics Systems but require software controls. These systems rely on the software community for software engineering and testing support. Because they are in different organizations, more integration is required than where the system is directly in avionics.

Software Configuration Management (CM) in the SSFP does not follow DoD-STD-2167A. Requirements for CM are patterned after the space shuttle program. Software change control and hardware change control follow traditional CM procedures of establishing configuration identification, configuration control, status accounting and verification.

Baseline distinctions like functional, allocated and product are not followed rigorously. The main Software Change Control Board for the SSFP has been located physically at the NASA center having the most software expertise. This board has had

FIGURE 3. Software/Hardware Development[2]

Both NASA and the military develop hardware and software in parallel, but NASA SSFP staggers its software reviews after the hardware reviews.



baselining authority. However, if a software issue is sufficiently controversial, particularly in terms of cost impacts, the Change Request will be brought up to the Space Station Control Board — the main board for all changes.

Requirements for software quality assurance generally include the essentials of DoD-STD-2167A, although some differences exist. For example, in the software product assurance evaluation of nondevelopmental software (NDS), the military and SSFP both want evidence that the NDS works, that it is under configuration management, and that data rights are consistent with the contract. The DoD-STD-2167A goes further, requiring government approval to use NDS; otherwise, their documentation requirements apply.

Figure 3 shows an example of system development reviews for software/hardware development in the military. The diagram is from DoD-STD-2167A with the addition of a systems engineering timeline.[2] The NASA and military software and hardware are developed in parallel. The diagram shows military hardware and software being integrated at major milestones such as Preliminary Design Review (PDR) and Critical Design Review (CDR).

In the SSFP case, the software major reviews are staggered later than the hardware major reviews. This allows the software developers to see the hardware detail before they finalize their codes. This makes sense in terms of system safety. Software alone is not safe or unsafe. However, if there are some wrong assumptions made in writing the codes about the operations of the hardware, safety could be affected.

In the SSF Man Tended Capability CDR, for example, software people were well represented and they made status presentations. The software, however, was not baselined at that time. Thus, the software people were able to evaluate carefully the hardware with which they would be working before they baselined the software. Eventually, hardware and software must be tested together in both NASA and military systems, similar to the right side of the diagram.

Life-Cycle Organizational Change Comparisons

In the military and in NASA major programs, the expectation is that organizational changes will occur as the program shifts to new phases. Organization changes can help create, in a better way, products expected from the succeeding phases.

The SSFP organizational history goes back to the early 1980s. In the conceptual stage (Phase A) the organization began as a small task force, which funded studies on attributes, architectural options and international participation. Similar to the military, a working group was established to set mission requirements. In the mid-1980s, the President introduced the space station program to the nation including the intent for international participation.

Phase B began with an organizational pattern that differs from a DoD approach. Definition studies were directed not by a central organization but by four NASA centers. Results of the work of eight definition contractors were worked into Requests for Proposals (RFPs) which were issued and controlled by the four NASA centers. In Phase B, NASA Headquarters, working with the State Department, established Memoranda of Understanding with Canada, Japan and the European Space Agency.

Phase C organization was influenced by the Challenger accident. A post-Challenger investigation recommended that better control could be achieved by having the program office near NASA Headquarters in Washington, D.C. Thus, a formal program office structure was established as shown in Figure 4. A three-tier program office included Level I and Level II offices located in the Washington, D.C., area and Level III Offices located at the NASA centers.

The organization was made large in order to provide the design detail needed for CDR. Overall, 2,300 civil servants worked directly or matrixed to the program. These included 292 NASA contractors and 117 international partner contractors. The prime contractors still reported to the NASA centers through the Level III organizations. Figure 5 shows only three prime contractors, since early in Phase C Work Package III was abolished.

The Level I organization, a small office, worked overall policies with NASA Headquarters, coordinated with the Congress, and provided overall program direction. The Level II organization had approximately 250 civil servants supported by an integrating contractor with approximately 850 people. Top-level baseline requirements control was worked by Level II. Organizational elements included: program engineering, utilization and operations, management integration, international programs, integration, safety and product assurance and program control. The international partners had their main integration offices located at Level II.

Early in Phase C, top NASA management began looking ahead to the organization needed for succeeding phases. Development and fabrication contracts eventually were scheduled to be tapered off and replaced by contracts for operation and utilization of the space station, and a new organization would be needed. The new activities were expected to be NASA center oriented involving payload planning, logistics, launch operations and station operations.

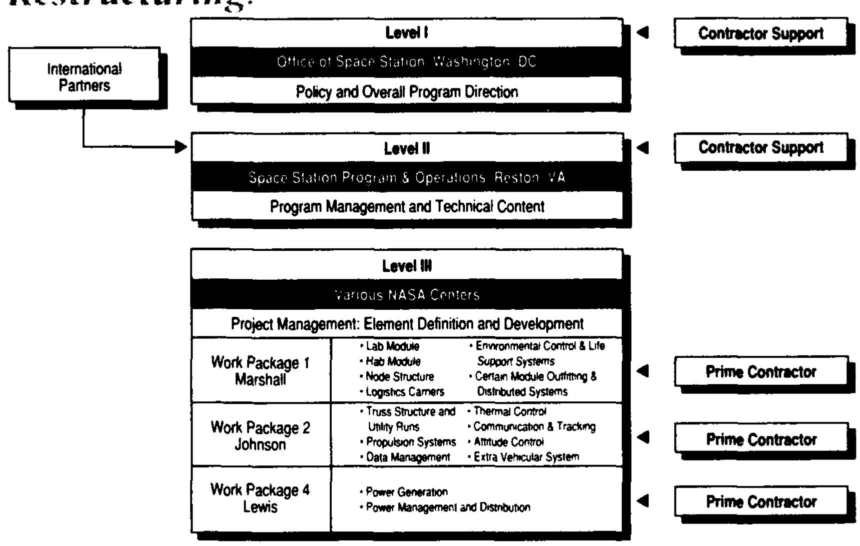
The feeling was that a large Washington-based program office was not needed for these activities. A smaller office located on one of the centers, with people focused more on utilization and operations, was anticipated. The situation might be somewhat analogous to the Air Force approach in the past to moving a program from a development command to a logistics command. When and where was not established.

The NASA, like the military, is subject to budget pressures, administration changes, reactions to cost overruns, and world politics. These factors made the SSFP a target of technical and organization change before Phase C was completed. The uprooting included technical and management changes. Technically, some parts of the program; i.e., structure and mass properties analysis, had to revert back to an earlier stage in the development phase. In some cases, crossing back into the conceptual phase might be necessary.

For the most part, the change philosophy is to use existing technology as much as possible. This includes not only the SSF technology but also the existing DoD technology, and Russian Space Station Mir. For example, propulsion, navigation guidance, and control for the restructured space station might come from a satellite bus built for a DoD program or may come from the Russian "space tug" Salyut FGB.

Compared with the old Phase C organization in Figure 5, the proposed restructured organization does not have Levels I, II and III. These offices merge into a single program office located at the Johnson Space Center which becomes the lead center. One

FIGURE 4. SSFP Phase C Organization Prior to Restructuring.



of the original three prime contractors is now the prime integrating contractor. This contractor is responsible for making design changes; finishing up the CDRs; managing Phase D involving fabrication, integration, test and certification; and assisting in the preparations for Phases E and F. The new NASA organization emphasizes preoperations activities such as launches, stage assemblies, logistics, science and on-orbit operations.

The difference between the military and NASA at this point is that, in the military, the receiving organization might have the right to refuse transition of a development program. In this case, the new receiving organization takes on an incomplete design package with the intent of streamlining the entire activity.

The streamlining effort is seeking greater management efficiencies. The PM, for example, will have greater budget authority and control over contracts by managing out of one program office. His key managers will report to him and not to the center directors as in the past. The new management approach includes multidisciplinary integrated product teams, which have been used successfully in the military. The idea is to bring together players responsible for a given product or area. For example, design engineering, manufacturing, operations, safety, science and utilization would be on a team that has budget, schedule and technical area of responsibility. The teams will include NASA and contractor personnel.

The new program office is expected to have a core of 300 NASA personnel and be supported by approximately 700 matrixed personnel.

Summary

The SSFP is a major national technical program that provides some interesting technical and management comparisons with major military systems. For instance, the submarine has technical similarities in environmental control for long duration missions that have benefitted the SSFP in information exchanges. The management of a submarine program differs from a space station program. Submarines are developed and built by modifying previous designs. Construction is done in a shipyard on earth, whereas SSF is a completely new design assembled in space with pieces arriving over a period of several launches.

The SDI has some interesting technical exchange opportunities in the areas of maintenance in space using robotics and manned extravehicular activities. Some striking similarities exist between the SDI and SSFP in managing a major program with a large budget.

The PM is in a public scrutiny "fishbowl," and under pressure from groups wanting to take the money away or receive a bigger piece of the program. The PM must engage in public debate with caution and without lobbying. He must be able to utilize consultants and outside experts effectively, and recognize the difference between those who will be on his side and those who might harm him or his program. He must recognize and deal effectively with those who have special interests and those whose political strength may be greater than their capabilities to carry out the program. Finally, he must provide Congress and the President with clear status information and be trustworthy.

The program life-cycle phases of NASA and the military closely resemble one another. The NASA life cycle is tailored ultimately to launching something into space, whereas the military life cycle is geared to a variety of weapon systems and products.

In SSFP software development, DoD-STD-2167A provides supporting and background information but program requirements are based on NASA experience. The NASA and the military develop hardware and software in parallel, but SSFP staggers its software reviews after the hardware reviews.

Organizational changes are a necessary part to keep a program in trim and to effectively meet new problems that emerge in the changing program phases. The space station organization in the Conceptual Studies Phase (A), like in the military, was small.

In the Definition Phase (B), the space station organization became larger but, unlike the military, it was decentralized with different NASA centers directing the definition contracts.

In the Development Phase (C), like the military, a much larger organization had to be established to meet the design detail that ultimately had to be produced before being manufactured. Unlike the military, a decentralized pattern of organization continued with a three-tier program management structure put into place.

The SSFP is being restructured with a new program management organization that is more centralized and has product team concepts used by the military.

The SSFP has a new name, International Space Station Alpha, and a new configuration. The comparisons made herein, however, are useful since, by understanding how major programs change and evolve, better programs can be built in the future.

Endnotes

1. Jarrett, Stephen M., CDR, USN. The Application of Submarine Experience and Technology to the Space Environment, Naval War College, Newport, R.I., March 1992.

2. Courtesy of the Defense Systems Management College.

DSMC PRESS PUBLISHES TR 1-94

The DSMC Press has published a new technical report (TR), *The Impact of the Under Secretary of Defense for Acquisition on Defense Science and Technology, An Organizational Culture Study*, by Robert A. Warren. Dr. Warren is a Professor in the Systems Engineering Management Department, Defense Systems Management College.

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AGGRESSIVE AND ENTHUSIASTIC SOFTWARE ENGINEERING

No Longer "Just Writing Code"

LTC Larry G. Baker, USA

The brochure distributed by The United States Army Information Systems Software Development Center - Washington (SDC-W) states that SDC-W has been the leader for the past 30 years in planning, designing, testing, implementing and maintaining the Standard Army Management Information Systems (STAMIS).[1]

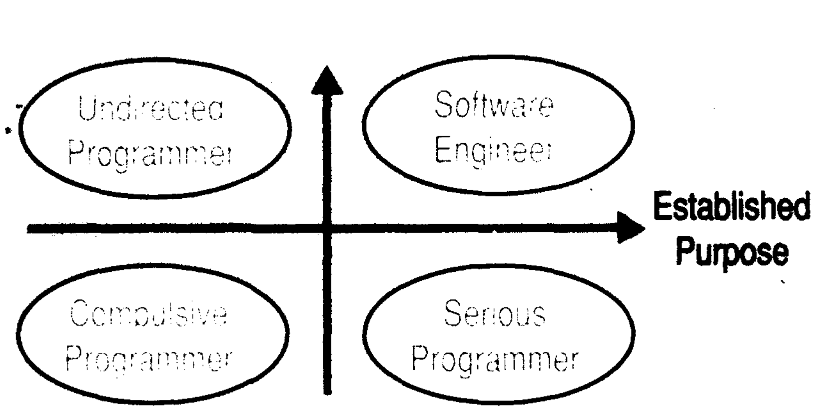
However, at times, in many large organizations responsible for the development of computer software, the emphasis mistakenly is placed on the implementing stage of software development. This is an understandable mistake because this is the phase of software development when a tangible product (software code) is produced, and this is the commodity desired by the customer. However, this mistake can be costly in light of the fact that more than 70 percent of the software cost is for software maintenance (correcting the initial software code).

The answer to the problem of "just writing code" is an aggressive and enthusiastic application of software engineering.

What Is Software Engineering?

A software engineer is one who applies a disciplined engineering approach to software development. The software engineer must be concerned with more than the software solution to the project. Most often, the engineering side of the software engineer is forgotten, and this can be costly in terms of dollars and time. Understanding engineering is more important than understanding coding. That is, software engineers are engineers first and builders of software second; they apply engineering concepts to their work.[2]

FIGURE 1. Awareness of Real-World Factors



Lieutenant Colonel Baker is Chief, SBIS/ISM Division, U.S. Army Software Development Center-Washington, Information Systems Software Command, Fort Belvoir, Va. He is a PMC 94-1 graduate.

The software engineering concept is a fairly new discipline. In the early times of software development, the code was fairly simple, and could be handled easily by one or two people. As the size and complexity of the software projects grew, the people who developed the earlier projects were involved again on these more complex projects because they were successful with the initial programs. This software development style led to the current cliché of the "software crisis." The fundamental cause of the software crisis is that massive, software-intensive systems have become unmanageably complex.[3]

In addition to the complexity of software development efforts, the needs and problems users present are becoming increasingly more perplexing. To ensure the software solutions that are developed are useful to the customer, software developers must be aware of user requirements and real-world factors. David Marca classified as either compulsive or serious programmers the original software developers who performed software development as programs became more complex.

According to Marca, four different types of programmers exist. Programmers lacking purpose and awareness of real-world factors can be classified as compulsive programmers. Programmers aware of real-world factors but with no goals are undirected in their work. Programmers with a clearly established purpose are serious programmers; they approach the computer intending to obtain useful results. But, serious programmers are not software engineers if they are not aware of real-world factors. Figure 1 summarizes these programming personalities.[4]

The deficiency of not knowing the real-world factors causes the serious programmer to create software that fails to meet customer demands. The principles of software engineering attempt to bridge this difficult gap in building well-engineered software. This ability to identify and assess practical, real-world factors are key to software development. Separating software engineers from other programmers is their ability to make decisions with practical issues in mind during all software development phases.[5]

The software engineer must take user needs and problems and apply various goals (discussed later in this article) and real-world factors to produce a software solution for the user. To produce the correct software solution, the software engineer must use an iterative process with software development cycle to ensure the programmer's final solution is what the user really wants. Only by applying software engineering concepts and goals can the final product be useful to the end user. Figure 2 summarizes inputs and outputs for the software engineer.[6]

The reliability factor for software must be initiated early in its development, which begins with understanding user needs.

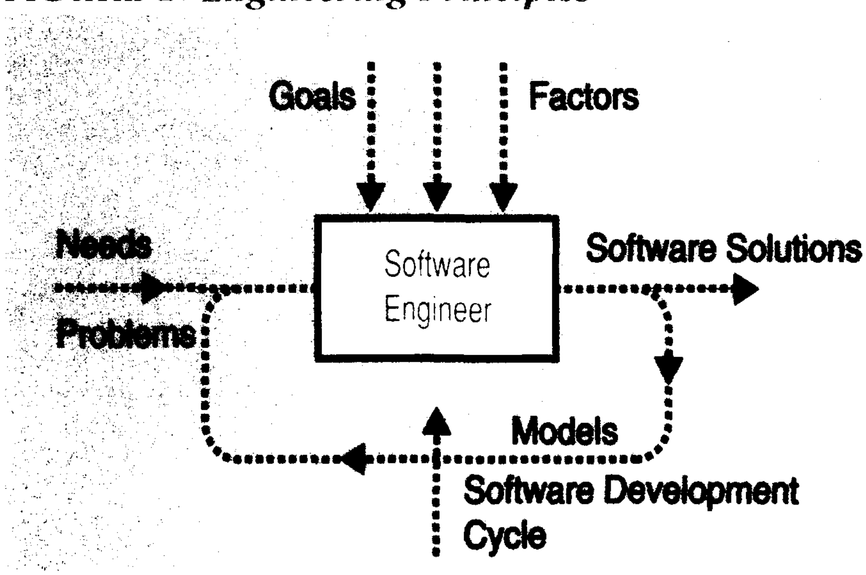
Software Engineering Goals and Purposes

Software engineers must have established purposes and goals when developing software. Purposes and goals are the key ingredients separating programmers from software engineers. In general, the six engineering goals or purposes that must be met to ensure the successful development of a computer software project are: timeliness, efficiency, reliability, simplicity, modifiability and cost-effectiveness.[7]

The software must be done in a timely manner to ensure that the system being developed is not obsolete prior to fielding. Also, if the software development time/cycle as shown in Figure 2 is too long, then user requirements will change to meet the new environment in which they are working. At times, the efficiency requirement is overemphasized. It is an important goal, but only in the context of the system being developed. If the emphasis is to save one nanosecond of CPU time, this efficiency will not be realized by the user, even in a real-time system. Often, this efficiency can be postponed until later in the software development cycle when the entire system is more mature and a better decision can be made regarding software efficiency.

Reliability is a crucial goal for the software engineer. The software must be developed so it will respond correctly to the user's needs and problems. The reliability factor for software must be initiated early in its development, which begins with understanding user needs. A serious problem with reliability occurred in one of the first versions of the Ballistic Missile Early Warning System (BMEWS). The initial version of this critical software detected the rising of the moon as an moving object over the horizon and, according to the software algorithms, the moon was identified as an unknown, hostile target.[8] The software performed exactly as requested; the problem was, as the

FIGURE 2. Engineering Principles



user described, in not identifying correctly the criteria for designating a "target" as hostile or friendly.

The user must be kept in the development loop to ensure the software under development is meeting his needs. Two of the primary goals of software engineering — simplicity and modifiability — are attributed to the user and his ability to use the software. Ease of use is a vital characteristic for any software; therefore, the user interface to the software must be designed carefully. The user is not interested in the internal workings of the software; however, user interface can be one of the most critical factors in determining the overall success of the system.

This view of the overall software package is backwards to the typical software developer who looks primarily at the software from the internal workings outward to the user interface. As the user becomes more adept at using the system, he will begin to want other software enhancements or changes to make his job even easier. The software engineer must be aware of this phenomena and develop software that will be easy to modify in the future. This will help reduce the software maintenance cost, which can be two-to-three times more expensive than the original cost of developing the software.

The user is not interested in the internal workings of the software; however, user interface can be one of the most critical factors in determining the overall success of the system.

Government Standards

Help and assistance is available for the software engineer in developing software that meets government standards. The most important government standard for providing guidelines for software engineering is DoD Standard 2167A, "Defense System Software Development," the principal guide for developing software to government standards. This document describes software-specific requirements of system engineering, shows how software fits into the "big picture," and provides detailed escriptions of all documents (Data Item Descriptions) that must be produced by the software engineering team.

The DoD-STD-2167A also emphasizes activities to be performed during software engineering, with the activities oriented more toward managing the software-development effort throughout the development cycle, as opposed to technical approaches to software engineering.[9]

Summary

No longer can we in DoD develop software in the absence of the stimuli from the user and other real-world factors. Computer programmers cannot isolate themselves from the users, and develop software from an isolated point of view. Only by applying the software-engineering principles can we hope to stop or at least slow the "software crisis." Only by enforcing a disciplined engineering approach on the software development can future computer systems be developed that will meet end-user needs. Only by using software engineering can we eliminate the concept of the "black art or wizardry of software development."

If we are to develop better software (of quality, on time, under budget), we must expand our horizons from the narrow view of software programmers (writing code) to a more expanded view of the software engineer. We must follow a disciplined engineering approach to develop software. This approach is software engineering.

Endnotes

1. COL C.B. Mitchell, "Making Quality Software Happen," Software Development Center - Washington 1993: p. 2.
2. David Marca, *Applying Software Engineering Principles* (Boston: Little, Brown and Company, 1984) p. 3.
3. Grady Booch, *Software Engineering with Ada* (Menlo Park: The Benjamin-Cummings Publishing Company, 1987) p. 28.
4. Marca, p. 6.
5. Marca, p. 4.
6. Marca, p. 2.
7. Booch, p. 29.
8. Marca, p. 12.
9. William H. Reotzheim, *Developing Software to Government Standards* (Englewood Cliffs: Prentice Hall, 1991) p. 161.

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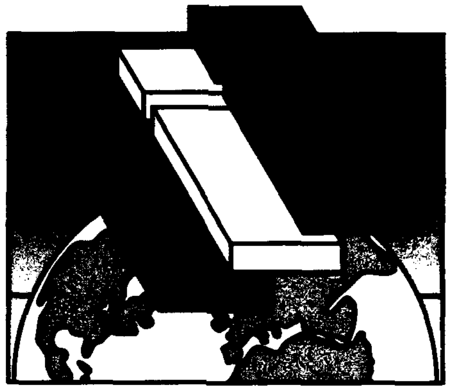

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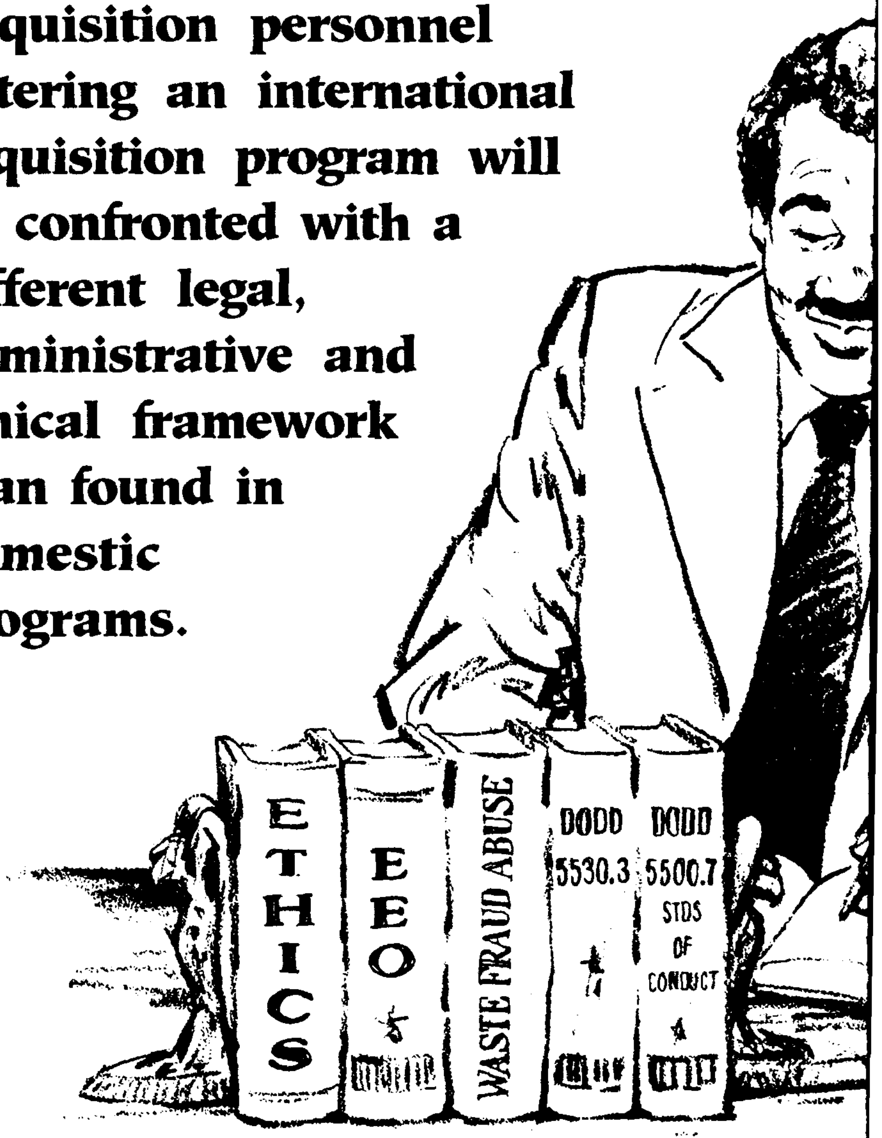
NCMA

Acquisition personnel entering an international acquisition program will be confronted with a different legal, administrative and ethical framework than found in domestic programs.



Legal and Administrative Framework

The Constitution of the United States (Article I, Section 9, Clause (8)) explicitly prohibits federal officials from accepting any office, title, gift or compensation from a foreign ruler or government without congressional consent. Virtually every activity of a federal official conducted with foreign representatives must be authorized by appropriate legal and administrative authority (directives, instructions, regulations and policy memoranda). Table 1 shows some of the broad activities associated with international acquisition programs, and a general reference. These are listed in the most probable order in which they would be encountered in the evolution of an international acquisition program.

General Principles of Ethical Conduct

"Ethical Conduct for Department of Defense Personnel," as contained in an Under Secretary of Defense (Acquisition) Memorandum of September 26, 1991, provides no specific guidance on ethical conduct of defense acquisition personnel in international situations. Presumably, the basic ethical principles of *integrity, honesty* and *fairness* should apply. However, we should be aware that these principles may have different meaning in other cultures. This make our definitions not better or worse, only *different*.

For example, take the first principle of integrity. In many cultures, especially those which are religion-based, the end does justify the means. The second principle of honesty can be misinterpreted. Certain cultures, especially in the Far East, place such a high emphasis on politeness and avoiding offense, that normal American candidness could be found offensive. The third principle of fairness may be the most difficult ethical principle to uphold in the international environment. Fair play is culturally American, and evolved primarily out of English culture. It has no meaning in many cultures. Fairness, compromise, and split-the-difference are very American. Compromise can be considered as a sign of weakness in some cultures. Split-the-difference may really mean that you are now halfway closer to the correct solution in the foreigner's point of view. One thing is certain — the American will be the most conscious of the ethical considerations in the program in a virtual checklist mentality.[12]

Specific Principles of Ethical Conduct

I conducted a thorough review of the 14 "Principles of Ethical Conduct for Government Officers and Employees" from Executive Order 12674 (April 12, 1989) for potential international implications. Nothing in the 14 principles applied specifically to international acquisition programs; however, many of the principles should be highlighted for special international implications. Significantly, more than half of the 14 ethical principles have international implications. Those principles follow with a general discussion of the international implications. To the reader, I point out that this is a discussion of where issues are likely to arise, not final legal solutions to every possible contingency. The

TABLE 1. Activities Associated with International Acquisition Programs

Broad Activities	Legal and Administrative Authorities
Social Events and Receptions	DoD Directive 5500.7[1]
Visits	Country Clearance Procedures[2]
	Data Exchange Agreement[3]
	Memorandum of Agreement[4]
Exchange of Technical Information	DoD Instruction 2015.4[5]
	DoD Directive 2000.9 - draft[6]
	DoD Directive 5230.11[7]
Negotiation	DoD Directive 5530.3[8]
Cooperative Acquisition	General R&D Authority[9]
	Quayle Authority[10]
	Cooperative R&D Authority[11]

remaining principles with no distinguishing international implications are shown for sake of completeness in Table 2.

— *"Public service is a public trust, requiring employees to place loyalty to the Constitution, the laws, and ethical principles above private gain."*

Loyalty to the Constitution, and specifically Article I, Section 9, Clause (8), prohibits federal officials from accepting any office, title, gift or compensation from foreign rulers or governments, unless authorized by the Congress.

— *"An employee shall not, except pursuant to such reasonable exceptions as are provided by regulation, solicit or accept any gift or other item of monetary value from any person or entity seeking official action from, doing business with, or conducting activities regulated by the employee's agency, or whose interests may be substantially affected by the performance or nonperformance of the employee's duties."*

Gifts from foreign governments are treated differently than gifts from contractors. Unsolicited, promotional items of nominal value (not exceeding $20 per item, or $50 per company per calendar year) are generally acceptable from a contractor, domestic or foreign. An unsolicited gift from a foreign government valued at less than $200 is generally acceptable in accordance with the DoD directive on gifts from foreign governments.[13] If the gift is greater than $200 in value, an attempt should be made to decline accepting it. However, if this would result in offense or embarrassment, or adversely affect U.S. foreign relations, the gift may be accepted *on behalf of* the government. Special rules apply in this instance, but in general terms, one may surrender the gift to your agency for disposal or official use, or the recipient may purchase it at the appraised value plus appraisal costs.[14] The key word with regard to gifts is

The key word with regard to gifts is "accept" vs. "solicit," the latter always being unethical and illegal.

"accept" vs. "solicit," the latter always being unethical and illegal. Consult with your agency's legal office in this instance, or wherever a question concerning a breach of ethical conduct might exist.

— *"Employees shall make no unauthorized commitments or promises of any kind purporting to bind the Government."*

Commitments binding the U.S. Government are subject to strict controls and much contemporary legal debate. Control of international acquisition program commitments is exercised by the Office of the Secretary of Defense under DoD Directive 5530.3 on international agreements. One must obtain proper legal authority to both negotiate and conclude an international acquisition program agreement. This agreement is normally called a Memorandum of Agreement (MOA), or Memorandum of Understanding (MOU), and is required by law for all cooperative acquisition programs. The controls of the Office of the Secretary of Defense on the MOA/MOU process extend to determinations of appropriate legal authority to conduct the program, financial authority to obligate funds for the program, security policy authority to exchange information, and host of other complex considerations. Furthermore, a requirement for these agreements is consultation with the Departments of Commerce and State, as well as congressional notification.

— *"Employees shall act impartially and not give preferential treatment to any private organization or individual."*

Table 2. Specific Principles of Ethical Conduct Having No Apparent Implications in International Acquisition Programs

- "Employees shall not hold financial interests that conflict with the conscientious performance of duty."
- "Employees shall not engage in financial transactions using nonpublic government information or allow the improper use of such information to further private interest."
- "Employees shall put forth honest effort in the performance of their duties."
- "Employees shall not use public office for private gain."
- "Employees shall satisfy in good faith their obligations as citizens, including all just financial obligations, especially those — such as Federal, State, or local taxes — that are imposed by law."
- "Employees shall endeavor to avoid any actions creating the appearance that they are violating the law or the ethical standards promulgated pursuant to this order."

This principle requires elaboration, as it most often seems to work in the reverse with international acquisitions. Certain types of preferential treatment for domestic contractors is encouraged by the Federal Acquisition Regulations to meet national objectives of protecting or enhancing domestic sources for defense products. Examples of this type of legal preferential treatment are the Buy American Act, the Berry Amendment on food and clothing, the Stratton Amendment on large caliber gun tubes, and Required Sources for Jeweled Bearings. However, under certain situations, the Secretary of Defense may require subcontracts be awarded to particular allied nation subcontractors in furtherance of cooperative projects, and may waive most of the restrictive provisions of U.S. law.[15]

— *"Employees shall protect and conserve Federal property and shall not use it for other than authorized activities."*

The protection, conservation and authorized use of U.S. Government property in international acquisition programs can become a complex consideration. The treatment of intellectual and physical property, and the potential liability associated with the use of government property within an international acquisition program, is far beyond the scope of this article. Normally, the U.S. Government must obtain a return, or *quid pro quo*, (equal or equitable, depending upon the legal authority cited) to conduct the program. Strict rules apply to the loan, or transfer, of U.S. Government property in an international program.[16] Experts should be consulted before committing to an international acquisition.

— *"Employees shall not engage in outside employment activities, including seeking or negotiating for employment, that conflict with official Government duties and responsibilities."*

One must be conscious of national sovereignty, and different rules and regulations governing foreign nationals.

The Constitution prohibits compensation to federal officials for employment with a foreign government. However, DoD Directive 5500.7 on Standards of Conduct notes that travel or reimbursement for travel may be accepted under certain circumstances. One should be especially sensitive to any aspect of employment activities with a foreign government. Legal counsel should be obtained regarding any of these activities.

— *"Employees shall disclose waste, fraud, abuse, and corruption to appropriate authorities."*

Disclosure of waste, fraud, abuse or corruption must be made to appropriate U.S. Government authorities. One must be conscious of national sovereignty, and different rules and regulations governing foreign nationals. Ignoring these could be construed as sanctioning unethical activities.

— *"Employees shall adhere to all laws and regulations that provide for equal opportunity for all Americans regardless of race, color, religion, sex, national origin, age, or handicap."*

This principle may become an issue when dealing with certain cultures. Gender is an especially sensitive issue in much of the world, and especially the Middle East and Far East (although this is country dependent). I advise women entering the world of international acquisition to study this issue carefully.[17] Religion could be an issue in selected nations in the Middle East. My personal experience is that race is of lesser importance; Americans are perceived and accepted as a multiracial society. U.S. Government officers and employees should be especially vigilant in avoiding the compromise of this ethical principle in international situations.

Conclusions

International acquisition programs present unique ethical and legal challenges to the acquisition professional. The acquisition professional should become educated on the foreign culture that he or she will be dealing with to avoid any unanticipated negative outcomes from a clash in principles. More important, the acquisition professional needs to become familiar with the highlighted specific principles to avoid breaches in ethical conduct in international situations or, most importantly, to avoid unanticipated administrative or legal violations. A review of my remarks for these principles should serve as a general guide for navigating the international minefield of diverse ethical and legal standards.

Endnotes

1. DoD Directive 5500.7, "Standards of Conduct," May 6, 1987.
2. All foreign visits must be cleared with the host government. Your local security office or international programs office can advise you on clearance requirements and lead times for each country. NATO visits are handled the same as a country visit.

Continued on page 42

STUDIES OF PROGRAMS IN THE PACIFIC RIM

For the past two years, the Defense Systems Management College (DSMC) faculty has been conducting two studies of cooperative acquisition between the U.S. Department of Defense and the corresponding defense department/agency/ministry of selected Pacific Rim (PACRIM) nations: Australia, Japan and South Korea. These studies were conducted to respond to a gradually increasing student demand in our international short courses for information on cooperative acquisition with PACRIM nations. The end result will be new curricula for these courses, as well as portions of a new international acquisition guidebook.

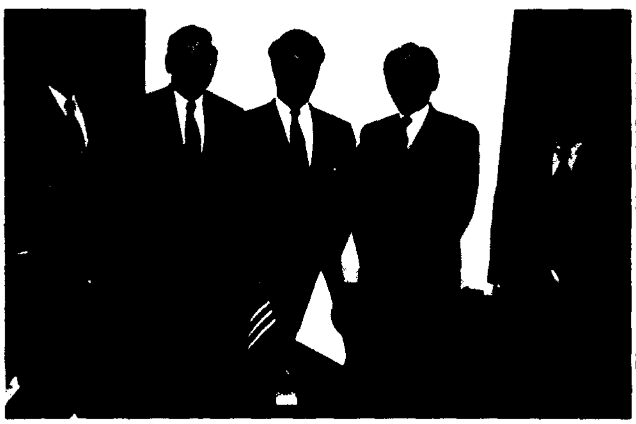
The first study of international cooperative acquisition was conducted by Professor Richard Kwatnoski of the Executive and Short Courses Department. The research objectives were as follows:

• Describe the current reality of cooperative programs in the Pacific Rim.

• Determine the prescription for success by identifying barriers to, and facilitators for, cooperation.

• Examine similarities and differences between PACRIM and NATO Europe programs.

The second study concentrates on the comparative defense acquisition practices of the United States and those of Australia, Japan and South Korea. This effort has been conducted by Professor Charles L. Houston III, recently transferred to the Executive and Short Courses Department to concentrate on international activities. This research, along with similar research on the practices of selected NATO nations, will be used as new curricula for our international courses, as well as a new DSMC Press guidebook. Some of the key comparative acquisition areas are:



From left: Dr. Yoshio Ohyumi; Lt Col (Sel) Charles L. Houston III, USAF (DSMC); Mr. Hiroyuki Kitamura, Japanese Project Officer; Mr. Richard Kwatnoski (DSMC); and Mr. Yukio Miyata, Japan Defense Agency, Technical Research and Development Institute, Tokyo, Japan.

- Legislative Oversight
- Acquisition Agencies
- Major Weapon System Criteria
- International Arms Sales
- Acquisition Education
- Defense Industrial Base
- Acquisition Process
- Planning, Programming and Budgeting System.

The capstone of the research was a two-week trip, sponsored by the Army and Air Force Directors of International Cooperation/Programs, around the Pacific Rim during May 1994. The journey began in Seoul, South Korea, where DSMC researchers met with the Joint U.S. Military Affairs Group - Korea (JUSMAG-K). From there, the researchers went to the Korean Agency for Defense Development, Naval Systems Research and Development (R&D) Center in Chinhae to discuss the Coastal Harbor Defense Project. The next Korean visit was to the Agency for Defense Development, Ground Systems R&D Center in Taejon to discuss the Ammunition Storage Technology Project.

The next stop on the PACRIM journey was Tokyo, Japan, to meet with the U.S. Mutual Defense Assistance Office (MDAO - Japan). All discussions were conducted in Tokyo at the Technical Research and Development Institute of the Japan Defense Agency. Discussions with Japanese government officials were held on the Ducted Rocket Engine Project and the Next Generation Support Fighter, more commonly called FS-X.

The final stop was Canberra, Australia. As in Japan, all discussions were held in the national capital. The first discussions held were with the management of the Jindalee Operational Radar Network (JORN) Program on the Radar Activities Project. Next, discussions were held with management officials of the Nulka Project, or the MK-53 Off-Board Active Decoy as it will be renamed in development and production. Final discussions were with the Australian Army's Director of Survey regarding the Digital Chart of the World Project.

With data gathering complete, the tasks of analyzing and publishing the PACRIM research data remain. Watch for more on this in future issues of *Program Manager.*

A high-level summary of the PACRIM research was presented by Professor Kwatnoski during the Common Defense (ComDef '94) Forum in Crystal City in May. Students attending the DSMC international courses will see the results, in detail, during the special back-to-back PACRIM offerings of the Multinational Program Management Course and the Advanced International Management Workshop planned for the last week of March and the first week of April 1995.

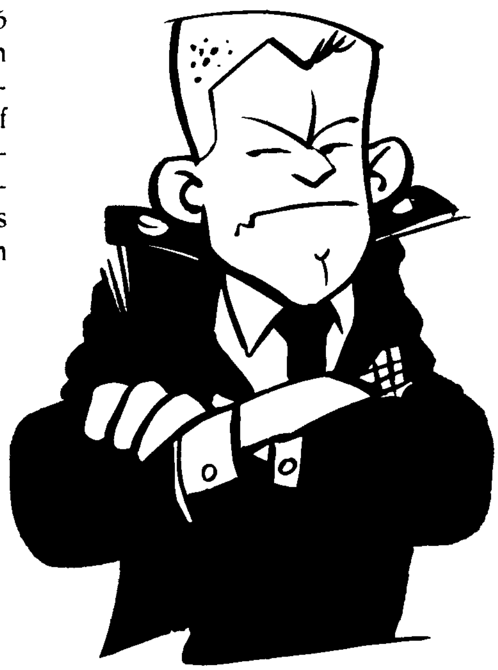
TEN SURE-FIRE WAYS TO CREATE PENTAGON PROBLEMS

A Humorous Look at Maintaining a Good PEO Staff-PEM Relationship

Lt Col Bud Vazquez, USAF • Lt Col Greg Lockhart, USAF

Establishing the Program Executive Officer (PEO) structure in 1986 to streamline the acquisition system program director reporting chain touched off a firestorm of debate that is still simmering. Nonetheless, Air Staff and PEO action officers (AOs) must concern themselves less with structure and more with making structure work.

Few commentaries exist on the PEO staff-Program Element Monitor (PEM) relationship. Thus, this article points out ways to refresh the rapport needed to make any team relationship work effectively by highlighting sure-fire ways to problems. We begin with a brief description of the relationship. The USAF PEOs are responsible for program execution, while the PEM's boss, the Mission Area Director (MAD), is responsible for representing the program to the Air Staff, the Office of the Secretary of Defense (OSD) staff, and to Congress.



1. Be Rigid
2. Don't trust

Lt Col Vazquez is the Director, Airlift Systems, for the Program Executive Officer for Tactical and Airlift Programs, the Pentagon. Lt Col Lockhart is the lead C-17 Program Element Monitor in the Air Force Secretariat's Directorate of Long-Range Power Projection, SOF, Airlift, and Training Programs, Assistant Secretary for Acquisition, the Pentagon.

In theory, this means that the PEO works issues affecting day-to-day management of a program — cost, schedule, supportability and performance. The PEOs were established for three reasons: to provide a direct and streamlined chain of command to the Service acquisition executive, to keep the program director informed of developments "inside the beltway," and to free program directors from frequent trips to Washington so they can manage the program.

On the other hand, the MAD is responsible for coordinating all aspects of the program with those outside the execution chain — funding, congressional reporting and responses, staff coordination, and the like. However, we all recognize there is no clean break of responsibilities. To start our humorous journey, we can examine some of the many interpretations of the roles in Figure 1.

It is easy to see how these different perspectives would affect how one treated the relationship. Not surprisingly, we propose to use our version of the truth — that which would emphasize teamwork — to move into the meat of the ten sure-fire ways to disaster.

How could you ensure strife, argument and disaster in the environment of overlapping responsibilities? Here are our thoughts, broadly lumped into three categories — Roles and Missions, Interpersonal Skills, and Professional Courtesy.

I. Roles and Missions

— Sure-Fire Way to Problems #1: *BE RIGID.* Make sure you view roles and missions as inviolate with no possibility for crossover. For added disastrous results, apply this rule every time you're on leave or temporary duty. Ensure the program office fears crossing the lines you've drawn, too.

3. Take things personally
4. Limit personal interaction

— Sure-Fire Way to Problems #2: *DON'T TRUST.* Too much trust can be trouble for an AO. First and foremost, make sure you don't trust the way the system is set up. Be confident that you're the smartest player around, and there's no way the PEO-PEM relationship could possibly work. This will keep expectations low. Also, don't trust your counterpart individually. This way you are sure to limit your vulnerability for the other guy's mistakes. You get an added benefit of simplifying your life since lack of trust is contagious. You'll never have to worry about his thinking of you! The real pro makes sure he frequently and publicly "bad-mouths" the system and his counterpart so everyone knows where he stands. It's especially effective if you can convince your boss "they can't be trusted." That way you can stymie action almost every time.

II. Interpersonal Skills

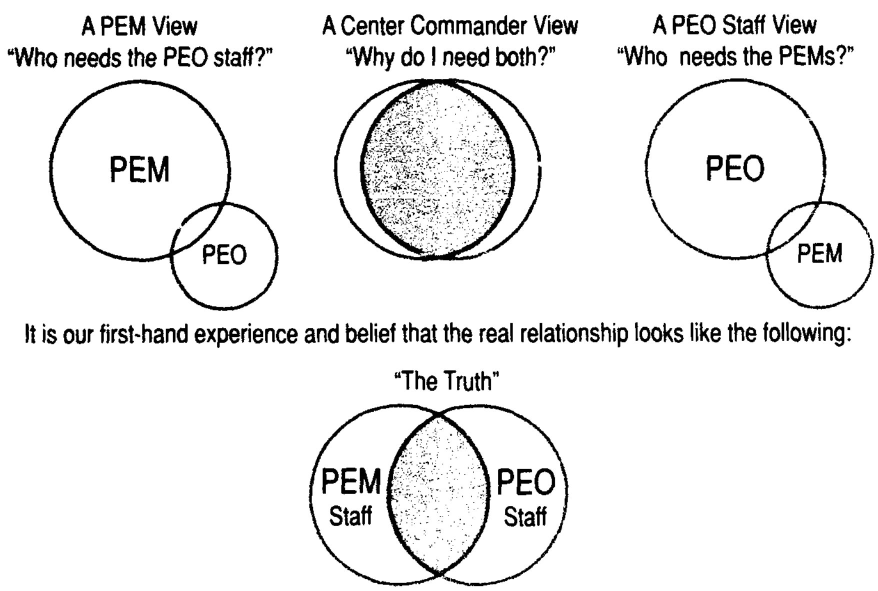
— Sure-Fire Way to Problems #3: *TAKE THINGS PERSONALLY.* Even in the fast-paced world of Pentagon AOs, make sure you're not very understanding, and that you interpret every oversight, statement or action as aimed at making you look bad or limiting your promotion opportunity. For extra-added effect, pick at the scabs from the occasional "broken glass" in order to undermine any trust you might have (see Sure-Fire Problem #2)

— Sure-Fire Way to Problems #4: *LIMIT PERSONAL INTERACTION.* It's easier to fail if you avoid any contact with "the enemy." Faxes work great for this. Limit phone calls to your counterpart, and prefer to leave messages, making "them" call you. An occasional walk to the other guy's office is bad judgment, so is carpooling, and going to lunch together. These heinous actions are only exceeded by socializing with your opposite number off duty. Treat personal interaction as you would fraternization — be discreet.

— Sure-Fire Way to Problems #5: *BE HUMORLESS.* Humor can make the Pentagon tolerable, if not enjoyable, so avoid it like the plague. A serious countenance will ensure you are taken seriously. If you must show emotion, it is much better to get angry.

— Sure-Fire Way to Problems #6. *BE UNRELIABLE.* Reliability is associated with predictability and, like

FIGURE 1.PEM / PEO Relationships



5. Be humorless
6. Be unreliable

a fighter pilot, "jinking" makes you a much tougher target to hit. Therefore, when you say you'll do something, try not to do it. Bust suspenses, don't return phone calls, and constantly revisit closed issues. Best of all, deny you ever made the commitments in the first place (reference Sure-Fire Problem #2).

III. Professional Courtesy

— Sure-Fire Way to Problems #7: *"HOG" INFO.* It is very effective to take a parochial view of who needs what information. Assume you can infallibly predict who will need what information and husband it accordingly. Never, ever send information that might help your counterpart look good if you can help it. For extra style, when the other person asks for information you don't think he needs, tell him you've never seen it! Religiously avoid the practice of sending courtesy copies. Practice good OPSEC/COMSEC.

— Sure-Fire Way to Problems #8: *ENSURE SHORT NOTICE.* Alas, some exercise will inevitably force you to interact to obtain coordination — a meeting, a document or a boss. Train yourself to think of your counterpart only at the last minute (after 5:30 p.m. is best). Then fax a curt note saying "need your comments" within a half-hour of the suspense. The real pro will backdate the note to make it look like you gave more time than in reality. Give yourself extra points when you tell your boss "I gave it to them yesterday and they have not responded."

— Sure-Fire Way to Problems #9: *DON'T BACKFILL.* On those occasions when you attend meetings or listen in on conference calls, try not to slip up and tell the other person about it. Backfilling creates expectations of trust and teamwork, and could provide that bit of information to give "the competition" an advantage in the battle over who's in charge of the program and, ultimately, who gets promoted. Remember, this is war!

7. Hog info
8. Ensure short notice

— Sure-Fire Way to Problems #10: *QUIBBLE.* A good technique on the road to disaster is to be excruciatingly literal. For example, when your opposite number says, "I thought you said you didn't have that information!," responses like "You asked for information, not this document," are very effective. Practice phrases like, "The meeting? What meeting? Oh, the OSD meeting. Why didn't you say that?," for maximum effect. Deny ever being told of meetings or suspenses if you forgot or were overwhelmed by another action. This way you can further foster the feelings in your organization that the "other side" always ignores you.

Conclusion

While we attempted to use humor and a bit of the absurd to make a point, unfortunately, these descriptions are closer to the mark than we would like. Too many critical partnerships inside the Pentagon are poisoned by some of these sure-fire ways to problems. With a little discipline, common sense and courtesy, AOs can, and must, avoid these pitfalls.

We hope this trip through a fictitious PEO-PEM action officer partnership does not ring too true for you, and may serve as a helpful reminder on improving any team or partnership. We believe it is not only possible to have a good PEO staff-PEM relationship, but that the mission requires it.

9. Don't backfill
10. Quibble

GENERAL YATES TELLS PMC 94-1 WE MUST NOT LOSE OUR COMBAT EDGE

But, Changes Can Result in Improvements

Esther M. Farria

"We are going through some of the most significant changes in our history, changes that are forcing us to take a hard look at how we do business throughout the defense industrial base...especially in the areas of acquisition and logistics."

The speaker was General Ronald W. Yates, USAF, Commander, Air Force Materiel Command, Wright-Patterson AFB, Ohio, who addressed students of the *Defense Systems Management College* Program Management Course (PMC) 94-1 at its recent graduation.

Citing the end of the Cold War and the cutback on defense spending, General Yates said the post-Cold War "still is a dangerous place....And, as our mission changes to adapt to new world realities, our operational forces are still very busy." He cited our continuing or potential involvement in the Persian Gulf and Somalia, Rwanda and Bosnia.

Reduction in defense spending combined with the uncertainty in the world and high tempo of operations pose "significant challenges for our acquisition corps." General Yates stressed that reducing costs is an overriding concern, and is "one of the fundamental changes sweeping

Mrs. Farria is Managing Editor of Program Manager, *Defense Systems Management College.*

Photo by Richard Vigue

General Yates addresses PMC 94-1 graduates at DSMC.

through the entire defense world. During the Cold War we were always asked to deliver performance and schedule. Now the single most important driving factor is efficiency," he said.

Reducing costs must not mean we "lose our combat edge," the General went on to say. We must look to "high technology to help us achieve efficiencies across the board in the acquisition and sustainment business and at the same time maintain our military cabilities." In the past "our military has relied on advanced technology. We have led the world in technical innovation and spin-offs from our efforts have been a driving force in the civilian world too."

He remarked that the ways we develop and use technology are changing, the race to produce new systems has slowed, and much of our emphasis will be on moving advanced technology into existing systems to increase capabilities and boost system reliability. "In fact, boosting reliability is one of the most important ways of cutting costs while improving our operational capability," he stated; "as part of our effort to reform and streamline the acquisition process, we must increasingly adapt commercial technologies for military use."

General Yates told the class that "to reform and streamline the acquisition process, we must increasingly adapt commercial technologies for military use...dual-use technology will become more important." He believes we're going to need to make greater use of commercial products, buy more off-the-shelf technology, and reduce military specific requirements where possible. He further commented:

- Teamwork is more important now than ever. Each Service is "straining to keep their forces modern and ready...budgetary pressures can rip us apart, or we can all work together to ensure that as a united American fighting force we emerge stronger."

- "Another way we need to achieve efficiencies in the acquisition and sustainment business is through integrated product development." Relying on teams which focus on the customer and include operators, maintainers and industry as part of the acquisition process represents a major culture shift. "Instead of developing narrow specialists, we're [Air Force Materiel Command] focusing on developing people who are able to operate we[illegible], and lead, these multifunctional teams."

• Don't just organize; ask people for their ideas. Many hesitate to do this because someone might have a substantive idea that could cause changes, and changes can be disruptive. More often than not, changes result in improvements.

• Included in other innovative approaches being pursued are lean production and lean logistics, "to ensure we can continue to field and support the best technology at a cost our nation can afford.

• Leadership remains the constant in the requirement for military success. Having learned lot about the mechanics of what a program manager needs to know, head into the real world to do real work. When you get there, you should have the technical preparation you need to succeed."

• The challenge to graduates is to be leaders, to be decisive and willing to take risks, to handle adversity with honesty and integrity. Gather a reasonable amount of data and make a decision, right or wrong. Wrong decisions can be corrected.

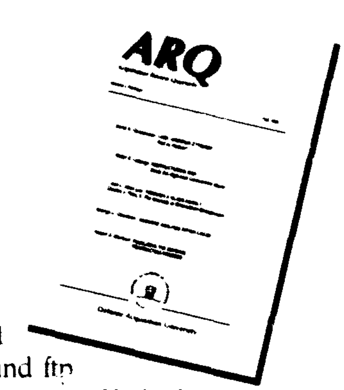
• Be realistic with cost and schedule estimates. D-Day was a triumph of American acquisition, logistics and, more importantly, its triumph of leadership, not just at the top, but throughout the ranks. Data gathered from history can help project the future.

General Yates ended by saying that the challenges of today "still call for bold leadership, decisiveness and risk taking." His wish for the graduates is "the greatest success for each of you. Success in helping provide our nation with the equipment and with the leadership we need to keep America strong."

DSMC ELECTRONIC CAMPUS UPDATE

ACQUISITION REVIEW QUARTERLY NOW ON INTERNET

DSMC Upgrades E-Mail Capability



In June, the Defense Systems Management College (DSMC) completed the first phase of a major program to upgrade its automation facilities. All staff and faculty are now connected to a new network on campus and all have e-mail access to the Defense Data Network (DDN) and Internet.

The Internet e-mail addresses at DSMC are of the form username@dsmc.dsm.mil, where username is normally a person's last name and first initial. Figure 1 lists some well-known e-mail addresses at DSMC which you may find useful.

The DSMC Internet host computer now has the ability to send and receive public files using the Internet file transfer protocol (ftp). The user may ftp to dsmc.dsm.mil (IP address 198.97.207.254) and logon as "anonymous" with the password "guest." After logon, the user should ftp the README file to get the current information concerning file transfers.

One series of files now available is the *Acquisition Review Quarterly* (*ARQ*), Volume 1, Number 1, Winter 1994. To ftp the *ARQ*, change the DSMCPRESS directory, change to the REVIEW1 directory and ftp the README.ARQ file for further information. The *ARQ* files are temporarily in Ventura Publisher format, so the user will need this software to use the files.

We are finalizing arrangements to make *Program Manager* available on Internet.

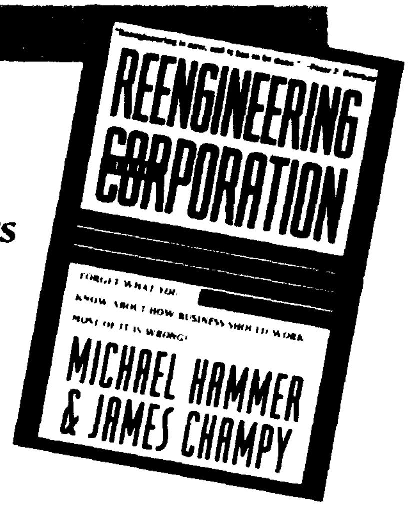
If you have acquisition-related files that you wish to share with others, you can ftp them to the UPLOADS directory. After uploading the files send an e-mail to sysop@dsmc.dsm.mil requesting the files be moved from the UPLOADS directory to a public area.

Additional DSMC services and publications are planned for Internet access, including access to Program Manager. A bulletin board system that will include e-mail and file transfers, the Program Manager's Notebook on-line, and dial-in telephone service are some of the capabilities in the works. The DSMC point of contact is LTC(P) Bert Garcia, USA, garcia@dsmc.dsm.mil, or (703) 805-3462.

FIGURE 1. Well-Known E-Mail Addresses at DSMC

commandant@dmsc.dsm.mil	**Commandant**
dsmcaa@dsmc.dsm.mil	**DSMC Alumni Association**
dsmcpress@dsmc.dsm.mil	**DSMC Press**
library@dsmc.dsm.mil	**Acker Library**
registrar@dsmc.dsm.mil	**Registrar**
sysop@dsmc.dsm.mil	**Systems Operator**

BOOK REVIEW



REENGINEERING THE CORPORATION A Manifesto for Business Revolution

HarperBusiness, A Division of Harper Collins Publishers

by Michael Hammer and James Champy

In *Reengineering the Corporation, A Manifesto for Business Revolution,* the authors offer strong medicine, "Forget what you know about how business should work — most of it is wrong!" Their 223-page book on organizational change, published in 1993, provides supporting theory and real-life examples to support their claim. Reengineering is to total quality what total quality was to traditional management. To implement total quality, you must successively document, measure and incrementally improve a process.

Hammer and Champy point out two weaknesses of this approach. First, if processes in an organization are individually documented and improved, this suboptimization is at the expense of the overall objective. Also, incremental improvements may not be good enough for a company or department (or system program office) in real trouble. Reengineering compels a manager to: consider the complete organization as one process, revisit the operational objectives, and change the work approach to better meet the clarified objectives. Their bottom line is: radical changes to the way you work can radically improve your performance.

This excellent book starts with a comparison of the author's theory of business management to that of Adam Smith. In his *The Wealth of Nations,* Smith explained the principle of the division of labor. The division of labor required workers to specialize. Companies were organized around tasks and typified by elaborate control systems and hierarchical management structures. Both the assembly line and the functional organization are results of Adam Smith's 1776 work. These principles were at their nadir during the tenures of Henry Ford and Alfred Sloan (at General Motors).

Reengineering requires companies to organize around processes. It is not for the fainthearted. The authors believe companies who want to reengineer must, "starting from scratch," be willing to accept risk, and have (or institute) a spirit of individualism, self-reliance and a propensity for change. Most importantly, they must challenge the fundamental assumptions upon which the organization operates.

Ford Motor Company, for example, wanted to reduce their accounts payable department from more than 500 to 400 people. When Ford acquired a 25-percent interest in Mazda, they noticed that the Mazda accounts payable department consisted of only five people. This forced Ford to rethink their entire parts procurement process. Previously, accounts payable oversaw completion of three documents for each transaction — a purchase order to request the part from a vendor, another form to document receipt of the part, and the invoice or bill from the vendor to request payment. The accounting clerks spent much of their time resolving discrepancies among these three documents. Under the new process, a buyer enters the order into an on-line database when the part is requested. When the order arrives, the database is consulted to match the order to the purchase request. If they don't match, the order is refused. The new process employs about 125 people. Reengineering is about substantive change and radical, not incremental, improvements.

The book is easy to read and well-indexed. It provides four case studies to illustrate reengineering theory in action. In the scenarios, Hallmark, Taco Bell, Capital Holding and Bell Atlantic are analyzed as they use reengineering to make their operations quicker and more flexible, improve customer satisfaction, and cut costs. One chapter helps determine if your company is a good candidate for reengineering. Summary information on how to complete the reengineering process is given, also. Managers with experience in developing and implementing vision statements will be on familiar ground here.

Hammer and Champy aren't resting on their laurels. According to the *Wall Street Journal,* their respective management consultant businesses are flooded with speaking and training requests. Each is working on a sequel — Champy, on *Reengineering Management* and Hammer on *Beyond Reengineering.* If these books are half as good as their joint effort, they will be well worth reading.

Major Edward L. Bolton, Jr., USAF, Chief, Upper Stages Engineering Branch,Titan Systems Program Office, Space and Missile Systems Center, Los Angeles AFB, Calif. He is a PMC 94-1 graduate.

A LEARNING CURVE BEGINS

TRAVELING CONTACT TEAM ASSISTS BULGARIA

DSMC Professors Present Overviews

Randy C. Zittel • Charles B. Cochrane • Gary J. Hagan • John P. McGovern

The U.S. European Command (USEUCOM) Military-to-Military Contact Program is an outreach to the newly emerging countries of Central and Eastern Europe and assigned republics of the former Soviet Union. The mission is to assist designated foreign military forces to develop into positive, constructive elements of society during their country's transition to democracy and a free-market economy.

As these nations disengage from a Soviet-style military, the U.S. military offers an effective role model of a military under civilian control. Established by both a Secretary of State policy and an accompanying Department of Defense (DoD) Joint Chiefs of Staff memorandum in April 1992, no formal education, training, equipment, or hardware will be offered through the program, to avoid conflict with existing U.S. foreign military sales programs.* The USEUCOM program consists of the following four elements:

— A permanent (U.S. military) *Contact Team Program Office* at USEUCOM headquarters led by a flag officer and staffed with desk officers (one per country), functional area specialists, and an administrative staff.

— *Military Liaison Teams* established in a country by USEUCOM under the jurisdiction of the U.S. ambassador to that country to coordinate support and assistance.

— *Traveling Contact Teams* (TCT) consisting of U.S. military and civilian professionals providing expertise to the host nation in a specific functional area, and tailored to the host nation's specific request.

— *Familiarization Tours* for host nation personnel who tour U.S. facilities in Europe or the continental United States in conjunction with an American National Guard State Partnership. Bulgaria is partnered with the state of Tennessee and its National Guard. The state hosts liaison visits to U.S. cities where Bulgarians learn firsthand about U.S. industry practices in companies located in Tennessee. The Guard provides a military forum that acts as a positive model for the civilian-controlled militia.

Military Liaison Teams are located in Albania, Belarus, Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and Slovakia.

As part of a TCT, four Defense Systems Management College (DSMC) professors participated

The U.S. European Command (USEUCOM) Military-to-Military Contact Program is an outreach to the newly emerging countries of Central and Eastern Europe and assigned republics of the former Soviet Union.

*The North Atlantic Treaty Organization (NATO) has a similar assistance program. Since "the best defense is to make an enemy your friend" and economic stability is essential for these countries to seed in their democratization, both U.S. and NATO programs are positive efforts to assist this process peacefully within the sovereign integrity of these nations.

recently in the USEUCOM program in Bulgaria. The TCT was hosted by Colonel Richard T. Lee, USAF, head of the in-country Military Liaison Team (MLT) to Bulgaria, and led by Colonel David S. Kiefer, International Cooperative Programs, Office of the Secretary of Defense. (Another DSMC team subsequently has visited Hungary under this program.) The Bulgarian MLT had been in existence for only nine months when we visited, but we were the 62nd team to visit.

The following week, the MLT was coordinating an aviation team from the U.S. Federal Aviation Administration, to coordinate air traffic control issues, and an environmental pollution team to help Bulgaria attack the serious multinational pollution issue in the Black Sea.

The Bulgarians were friendly and welcomed us with open arms. They explained to us during the course of the week that one of Bulgaria's prime contributions to the former Warsaw Pact was electronics development and production capability. It was this community within their Ministry of Defense (MOD) which requested assistance through the U.S. program. Led by Professor (Doctor) Boyal Petkov, Director of the entire MOD Research and Development Directorate, and Brigadier General Dragomir Ivanov, Director of the Military Industry Directorate, they are focused on applying their existing electronic industry to U.S. and NATO defense and commercial markets.

We found the team's Bulgarian counterparts to be sharp, friendly, and well-educated. Their capital city, Sofia, where we stayed, is active, busy and proud of its long regional history. The professionals with whom we met were open-minded and eager to tackle this new freedom to compete in new markets throughout the world.

The agenda consisted of plenary sessions, a tour and visit to the Electron Progress Company, and separate working sessions with Bulgarian specialists on research and development, engineering, manufacturing, specifications, standards and patents.

The TCT also hosted an "icebreaker social" for the Bulgarian team, to which the Bulgarians reciprocated by hosting an end-of-visit, three-hour luncheon. Anyone who has ever worked with Europeans knows how much fun their farewell activities become.

Twenty-one officials of the Bulgarian Ministry of Defense attended the plenary sessions and working groups related to their area of expertise. It took time to establish a common ground and develop the specific areas of Bulgarian interest, which is normal in international technical exchanges. The discussions were open and extensive, although limited by the required back-and-forth language-translation. Shown below is a summary of the presentations and working group sessions:

Plenary Sessions

Charles B. Cochrane, Acquisition Policy Department, DSMC, gave an overview of defense acquisition policy and procedures and the Planning, Programming and Budgeting System; Gary J. Hagan, Acquisition Policy Department, DSMC, the military requirements generation system and system life-cycle management; Randy C. Zittel, Systems Engineering Management Department, DSMC, the systems engineering management and military specifications and standards; and John P. McGovern, Manufacturing Management Department, DSMC, an overview of manufacturing management and quality assurance.

Policy and Program Management Working Group

The sessions were hosted by LTC (Engineering) Vladimir Takov and attended by Bulgarian defense program managers (PMs) at the Senior Assistant (Major) and Branch Chief (LTC) levels.

An *ad hoc* and wide-ranging discussion touched on the relative powers and responsibilities of the PM and milestone decision authority, the qualifications and selection of PMs, the contracting process, international cooperative development, testing and test types, the appropriations process, contract management, cost issues associated with small-scale production of defense systems, the U.S. Foreign Comparative Testing Program, and export controls on U.S. defense articles and technologies.

Responding to perceived interest in how the United States contracted for defense materiel, Professor Cochrane delivered a 45-minute presentation on contracting procedures as part of the working group's agenda.

Specifications and Standards Working Group

Bulgarian members of the working group were engineers and specification document specialists whose areas of interest were U.S. military specifications and standards, quality assurance, and the implementation of the ISO 9000 quality standards and patents.

The discussion was open and extensive. It centered on the legal basis for U.S. military specifications and standards, the administrative process for developing U.S. specifications and standards, the applicability of military standards and specifications to commercial work, patent rights of technical information developed under U.S. government contracts, differences between U.S. military standards and NATO standards, the manner in which the U.S. government exercises control over the production of military articles, and the NATO codification system for defense items.

The Bulgarian team specifically requested 13 U.S. military standards and specifications which dealt with telecommunications and associated electronics. This is indicative of their interest in applying their electronic

Joint Military-to-Military Contact Program

production capabilities in order to qualify as a U.S. source. These documents, along with patent-related portions of the Federal Acquisition Regulations and the DoD Index of Specifications and Standards, have been forwarded by DSMC through the U.S. Military Liaison Team to the Bulgarian MOD.

An interesting discovery in this working group was when the Bulgarians explained that their country had no patent, trademark or copyright laws. Although their legislature has just passed a patent law, the whole concept of patent rights was foreign to them, and essentially comes on the immediate heels of the dissolution of the Warsaw Pact where state ownership of everything was so complete.

The ensuing conversation demonstrated the fascinating opportunity here to watch bright and talented people try to understand the concepts of freedom and free enterprise in one fell swoop. As is so often the case across cultural borders, the Bulgarians were concerned about worst case issues in the free enterprise system. This concern was focused on their potential loss of their technical rights.

Western industry has created an interlocking and complex web of technical rights ownership through decades of evolving national and international patent, trademark and copyright law. Bulgaria has no patent attorneys, so the MOD engineers address the issues in parallel with their other branches of government which are trying to develop capability in these important new areas.

As every Western company knows, their lead (or lack thereof) in their particular market is based mainly on their dynamic ability to meet change and their internal technological lead.

Visit to the Electron Progress Company

The DSMC contingent of the TCT visited the Electron Progress Company and was hosted by the company director, Mr. Ivan Nicolov and his staff. Although Electron Progress is entitled a company, it is really a captive MOD radio design laboratory. The "contracts" the company receives from MOD are really production orders for military radios. Any subsystems, such as microelectronics, are "subcontracted" to another MOD facility, which exclusively fabricates the required microchips.

Based on the discussions at the facility, their apparent capability in the microchip area is only at the medium scale of integration. Their radio technology is digital and their scientific research is current. They also review U.S. and Western technical publications closely. According to the Bulgarians, visits have been made by U.S. Department of Commerce teams with American industrial representatives, but no U.S.-Bulgarian teaming arrangements have resulted, as yet.

Observations and Conclusions

The Bulgarians seem familiar with issues related to modern program management of weapons systems and the accompanying policy questions.

They have an intense interest in upgrading their manufacturing and technology base; therefore, the majority of their interest centered on subject areas relating to engineering and manufacturing areas (i.e., specifications, standards, commercial/industrial practices, patents, the contracting process, and contract management).

Since the Bulgarian defense industry remains fully government owned, their understanding of the competitive contracting process is especially weak. As noted earlier, DSMC has forwarded additional information related to specifications and standards to the Bulgarian MOD through the in-country MLT in the near future.

The Bulgarian delegation clearly demonstrated a totally different concept of the contract. To them it represents a service order from one governmental echelon to another which cannot be refused. The competitive, open nature of obtaining the contract, along with the American system of contract performance was a foreign concept, and much discussion was spent in trying to explain this.

Their questions were directed at the end of the process to the application of contractually-required military specifications, and how such standards evolve into military programs through the contracted acquisition process. As previously mentioned, the Bulgarian government has just enacted a patent law, which increased their interest in applying this to their infrastructure.

As we went deeper into our system of "open markets" and "free enterprise" during the working group sessions, we were proud of how well American industry works. As we discussed issues of quality assurance, Defense Contract Management Command (DCMC), etc., we were taken back when the Bulgarians drew a parallel between their government-owned captive industry and American industry with extensive program office and DCMC in-plant representatives monitoring every step of the development and production process.

In the plenary and group sessions it was mentioned, also, how our major system acquisition programs have strong DoD and congressional oversight. The TCT free-market nonexperts explained that the key difference is that private industry has ownership of their technology and the ability to compete or not compete for new work. Also, the continuous DoD Acquisition Reform effort is to empower the engineering strength of our private sector, but it must live in the real world of tax dollars at work.

No further DSMC assistance is scheduled. The focus of the USEUCOM program is to assist each nation with what *they* want as they want it. Once they've had a chance to study the forwarded U.S. specifications and regulations, they may call upon another team to extend the learning curve. Free-market forces are strongly at work on the Bulgarian people from outside, causing them to spread their valuable resources thin as they embrace so much opportunity so fast.

Continued from page 31

3. DoD Instruction 2015.4, "Mutual Weapons Development Data Exchange Program and Defense Development Exchange Program," November 5, 1963.

4. Under Secretary of Defense (Policy) Memorandum I-93/16347, Subject: Security Arrangements for Multinational Armament Cooperative Programs, September 21, 1993. Document Number 4., "Security Clauses," paragraph 2 - "Clauses Governing Visits"; and Document Number 7, "International Visit Procedures."

5. DoD Instruction 2015.4, "Mutual Weapons Development Data Exchange Program and Defense Development Exchange Program," November 5, 1963.

6. DoD Directive 2000.9, "DoD Participation in International Technical Exchange, Cooperative and Coproduction Programs." Draft.

7. DoD Directive 5230.11, "Disclosure of Classified Military Information to Foreign Governments and International Organizations," December 31, 1994.

8. DoD Directive 5530.3, "International Agreements," June 11, 1987.

9. Title 10 U.S. Code.

10. Section 27 of the Arms Export Control Act (22 U.S. Code 2767, "Authority of the President to Enter into Cooperative Projects with Friendly Foreign Countries."

11. Section 2350a of Title 10, U.S. Code, "Cooperative Research and Development Projects: Allied Countries."

12. "Is U.S. Business Obsessed with Ethics?" Daniel Vogel, *Across the Board: The Conference Board Magazine*, November/December 1993.

13. DoD Directive 1005.13, "Gifts from Foreign Governments," October 13, 1988; Change 1 dated February 21, 1990. This directive allows for periodic increases in the value of gifts of minimal value.

14. Public Law 95-105, "Receipt and Disposition of Foreign Gifts and Decorations." August 17, 1977.

15. Section 2350b of Title 10, U.S. Code, "Acquisition of Defense Equipment Under Cooperative Projects." Original Quayle Amendment, further amended.

16. Section 65 of the Arms Export Control Act (22 U.S.C. 2796), "Leases of Defense Articles and Loan Authority for Cooperative Research and Development Purposes."

17. *The Cultural and Political Environment of International Business: A Guide for Business Professionals*, Don Alan Evans, McFarland & Company Inc., 1991. This reference contains an especially good write-up on gender as well as other related considerations, such religion and culture.

SOFTWARE ACQUISITION MANAGEMENT MATURITY MODEL (SAM³)

A Concept

Emanuel R. Baker • Lee Cooper • Barry A. Corson • Arthur E. Stevens

Software has become a major technical and cost concern in all corners of the federal government. The amount of money spent annually on software acquisition and development grows at approximately 12 percent. The added functionality demanded from software grows at an even faster rate. In fact, today's modern systems have become so complex and software intensive they are unable to perform any portion of their mission without software.

In the Department of Defense (DoD), an increasingly greater proportion of the money is spent on software in weapon system acquisition and modernization. At the same time, software has become one of the most mission critical, and yet difficult-to-manage components in the DoD weapon systems. Historically, software development has not been managed and controlled well. This has resulted in software deliveries that are behind schedule, over budget, and contain significant errors. This increased reliance on software and the inability of our software development contractors to deliver quality software on time and within budget has created a "crisis" in the software industry. This crisis demands close attention by highly experienced and software-knowledgeable program managers (PMs).

The Office of the Secretary of Defense (OSD) and the Services have been addressing the software development problem for some time. A number of initiatives, including the development of standards, introduction of Ada, research into new technologies and methodologies, and development of process assessment techniques, have been undertaken to improve the contractor's software development activities. On the other hand, very few, if any, significant initiatives have addressed the processes, methods and tools used by DoD PMs in software acquisition management. Nothing in use today characterizes and measures the capability of program management offices to manage and control software acquisitions effectively.

To meet that need, we have undertaken a study to characterize and measure the capability of program management offices to manage and control mission critical computer software (MCCS) acquisition. The purpose of this study is to develop a Software Acquisition Management Maturity Model (SAM³).

The SAM³, a hierarchical structure of Key Process Areas, Key Practices and Key Indicators (see Figure 1) has each Key Process Area (KPA) organized into five levels of maturity, similar to that of the Software Engineering Institute (SEI) Capability Maturity Model (CMM). The acquisition management maturity model would then become the basis for assessments of the acquisition management capability of the organization. As with software process assessments (the performance of which are based on the CMM), the assessment would result in a set of findings, corresponding recommendations, and an action plan to facilitate the implementation of the recommendations, based on the structure of the SAM³ model.

While the impetus for this study originated within the DoD, the problem is common to many organizations that acquire software in both the defense and private sectors of the economy. Whether we are talking about acquiring an off-the-shelf management information system application, acquiring utility software pack-

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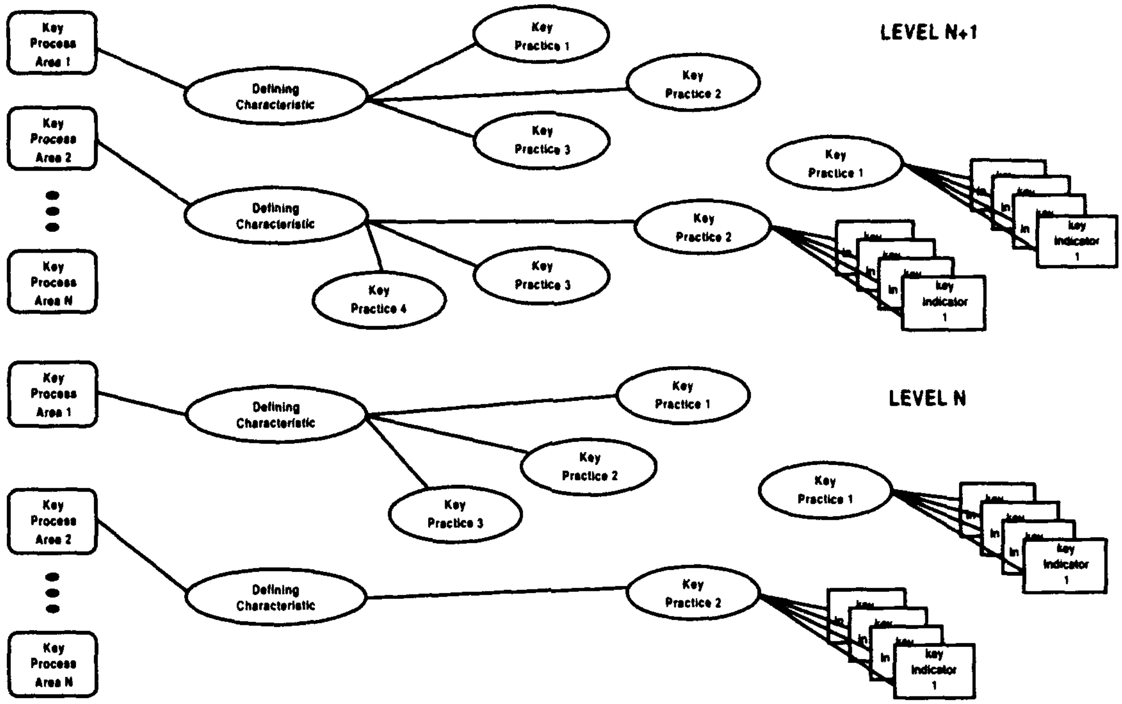
FIGURE 1. Key Process Area Structure



ages, or libraries of functions to incorporate into production scientific or engineering applications, organizations that acquire software often have *been prone to misadventures in such* software acquisition.

Although developed to characterize the acquisition of MCCS for military systems, the model described in this article contains many principles that can be applied to the acquisition of MCCS for any organization — commercial, information systems, military, government, defense contractor, etc. — that acquires, from outside sources, software that is critical to the mission of the organization or the quality of its deliverable products. It can be tailored to fit the needs of any such organization — in many cases, by merely substituting the appropriate acronyms.

This article describes the model and its underlying concepts.

Underlying Concepts

Efforts have been made to characterize the maturity of various kinds of endeavors. Examples are models to characterize the capability of organizations to develop software, and those to characterize the measurement technology maturity of organizations. One of the better-known models to characterize the capability of software development organizations[1,2] is the Capability Maturity Model (CMM).

Developed at the Software Engineering Institute (SEI) of Carnegie Mellon University, Pittsburgh, Pa., under the guiding hand of Watts Humphrey, this model identifies five levels of maturity: Initial, Repeatable, Defined, Managed and Optimizing. Each level has key processes associated with it, excepting Level 1 (Initial Level), in which no formalized key processes exist. In other words, software development is performed by applying *ad hoc* management and development practices.

On the other hand, a Level 2 organization is characterized as one that has the project planning and management, configuration management, quality assurance, requirements management, and subcontractor management key processes in place, and is operating in accordance with these prescribed practices. The Level 2 focus is the project management practices of the organization.

At Level 3, the organization has defined and codified the software development practices, and has instituted training in them. The primary concern in Levels 1-3 is for establishing a defined and repeatable process to achieve uniformity in the quality of the software products.

Beginning with Level 4, the focus of the organization shifts to process improvement in order to achieve better levels of quality in the software product. At Level 4, process measures have been established, and a database of process measures is being collected. Corrective action is instituted, as necessary, to maintain the performance of existing processes within acceptable bounds. At Level 5, the process measures are being used to provide feedback for process improvement, and continuous optimization of the processes is being performed.

The key processes cluster into key process areas (KPAs), considered to be essential building blocks for the

TABLE 1. Software Acquisition Management Maturity Model Levels and Associated KPA Characteristics

Level	Description	Characteristics
1	Initial	The processes associated with this KPA are performed in an *ad hoc* manner. No key practices are in place (formalized) to implement the KPA. The organization is completely event- and interrupt-driven with regard to this KPA, and tends to operate in a fire-fighting mode.
2	Repeatable	Some rudimentary, bare-bones key practices are in place for this KPA, but not all that should be performed. Those that are in place are performed per management direction, but they may or may not be codified. Variability may exist in the performance of the key practices from individual to individual.
3	Defined	All the key practices that should be performed for this KPA are codified and are performed per management direction.
4	Managed	Measures of the effectiveness of the processes within this KPA have been defined and verified as appropriate for the KPA. A project database of these measures is being collected. The measures are being fed into a database for the acquisition organization so that improvement of the acquisition process within the entire organization can be effected.
5	Optimizing	The defined measures are being analyzed and used to optimize the acquisition process.

maturation of the organization from the initial level to the optimizing level — in other words, process improvement. In constructing buildings, each new row of bricks must build on the previous row. In the same manner, the building blocks at one level of the CMM must all be in place before going on to the next. At each level of the CMM, the key processes essentially must be fully operative for the organization to be considered as functioning at that specific level of the CMM.

On the surface, it would appear the CMM has KPAs that are unique to a specific level of the model; i.e., all aspects of that KPA must be in place at the level with which it is related. For instance, training is a KPA associated with Level 3. The inference could be drawn that training is instituted only in improving from Level 2 to Level 3. This is not a correct interpretation. Elements of training necessary for the organization to achieve Level 2 on the CMM will evolve when going from Level 1 to Level 2. Careful scrutiny of the recently revised CMM reveals the threading of the key practices associated with any key process through the KPAs at increasingly higher levels of maturity.[3]

Looking at other arenas where maturity models have been developed, Daskalantonakis, Yacobellis and Basili,[4] have characterized the software measurement technology maturity of organizations in a manner similar to that of the SEI's CMM. Their model consists of five levels, and the definitions of the five levels are identical to that of the CMM. One major difference between the CMM and the maturity model proposed by Daskalantonakis *et al* is that the measurement technology maturity model is comprised of 10 themes, each of which has definable characteristics existing at each level of maturity. For instance, Formalization of the Measurement Process is one of the themes. The characteristic of this theme at Level 1 is that there is no formalization. At Level 2, formal procedures are established. At Level 3, the standards are documented and applied. Improvement mechanisms are in place at Level 4, and the organization has learned and improved at Level 5.

The themes proposed by Daskalantonakis *et al* are analogous to KPAs in the CMM. The way these themes are structured has a great deal of appeal. This structure shows a more explicit maturation in an organization's implementation of the various development processes. A more direct way of characterizing the maturation of the organization is desirable, whether we are talking of software development capability, or acquisition management capability.

FIGURE 2. Software Acquisition Management Maturity Model

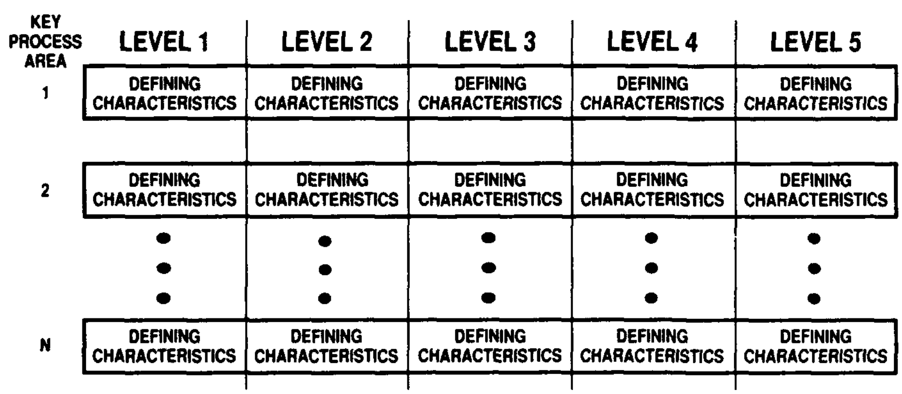


TABLE 2. Key Process Area Descriptions as a Function of Maturity Model Level

KEY PROCESS AREA	LEVEL 1 INITIAL	LEVEL 2 REPEATABLE	LEVEL 3 DEFINED	LEVEL 4 MANAGED	LEVEL 5 OPTIMIZING
REQUIREMENTS MANAGEMENT	No process exists. Inputs received from users and others accepted on faith.	Program office takes charge of requirements definition activity; however, no codified procedure exists. Process highly dependent on key individuals taking charge.	Process for defining software requirements is established, formalized and followed. Responsibilities of all interfacing organizations are identified.	Measures for determining the adequacy of the requirements definition process are established. Corrective measures are implemented.	Measures for determining the adequacy of the requirements definition process are being used for process improvement.
MCCS ACQUISITION MANAGEMENT	No process exists to provide MCCS inputs to support mandated DoD or Service requirements for the acquisition of systems.	Requirement for generating inputs and supporting documentation for Service or DoD system acquisition process requirements is established.	Process for managing MCCS acquisition and generating required supporting inputs is established and codified.	Measures for determining the adequacy of the MCCS acquisition management process are established. Corrective measures are implemented.	Measures for determining the adequacy of the MCCS acquisition management process are being used for process improvement.
SOFTWARE PROJECT MANAGEMENT	No structure exists for managing program office activities and those of supporting government organizations. No training provided in skills needed for managing MCCS acquisition.	Program office tracks internal costs, schedules, problem resolution. Structure established for coordination with outside organizations, but is not codified. Training is provided, but in an unorganized fashion.	Instructions, procedures exist and are followed for tracking program office project management performance. Formal agreements are established and followed for interfacing with organizations external to the program office. A formalized training plan exists.	Measures for determining the adequacy of the project oversight process, interfaces with organizations external to the program office, and staff training are established. Corrective measures are implemented.	Measures for determining the adequacy of the project oversight process, interfaces with organizations external to the program office, and staff training are being used for process improvement.
SOFTWARE TECHNICAL MANAGEMENT	Contractor managed by *ad hoc* reviews and decisions.	Program office specifies to the contractor some subset of software engineering requirements, and tracks contractor costs, schedules, problem identification and resolution.	Instructions, procedures specifying appropriate software engineering and contractor monitoring requirements exist and are followed for comprehensive tracking of contractor performance.	Measures for determining the adequacy of the contractor management process are established. Corrective measures are implemented.	Measures for determining the adequacy of the contractor management process are being used for process improvement.
TRAINING	No training provided in skills needed for MCCS acquisition.	Training is implemented, but no formalized training plan exists to ensure that organizational, individual needs are met.	A formalized training plan exists to ensure that organizational, growth needs are met.	Measures for determining the adequacy of the training program are established. Corrective measures are implemented.	Measures for determining the adequacy of the training program are being used for process improvement.
QUALITY ASSURANCE	No software quality assurance (SQA) function exists.	SQA established, but no formal procedures exist.	Formalized SQA implemented for monitoring contractor, program office performance.	Measures for determining the adequacy of the SQA process are established. Corrective measures are implemented where necessary.	Measures for determining the adequacy of the SQA process are being used for process improvement.
CONFIGURATION MANAGEMENT/ DATA MANAGEMENT	Program office does not exercise configuration management (CM) or data management (DM) over contractor-delivered documentation, products.	Baselines established for software requirements, other major deliverables. A repository of such materials is established.	Formalized CM and DM implemented for all project deliverables and coordinated with affected software support organization(s).	Measures for determining the adequacy of the CM and DM processes are established. Corrective measures are implemented where necessary.	Measures for determining the adequacy of the CM and DM processes are being used for process improvement.
SUPPORTABILITY	No structure exists for coordination with organizations outside of the program office to adequately define supportability requirements. Supportability requirements are not adequately addressed in solicitations.	Supportability is addressed in an organized fashion in the process of preparing solicitations, but is not properly addressed during the full-scale development and post-deployment software support activities.	Supportability is properly addressed throughout the entire life cycle in accordance with documented procedures and agreements with the software support activities, users and other field activities.	Measures for determining the adequacy of the definition of supportability requirements and their implementation are established. Corrective measures are implemented where necessary.	Measures for determining the adequacy of the definition of supportability requirements and their implementation are being used for process improvement.
TEST AND EVALUATION (T&E)	The definition of the T&E requirements are left completely up to the contractor and DoD organic elements responsible for T&E.	Responsibility for the generation of the Test & Evaluation Master Plan is assigned to a lead person for T&E. Test and evaluation is addressed in piecewise fashion.	An integrated T&E approach is defined, based on life-cycle considerations. Planning for, and monitoring of, the T&E effort is performed in accordance with documented procedures.	Measures for determining the adequacy of the planning and conduct of the T&E effort are established. Corrective measures are implemented where necessary.	The measures for determining the adequacy of the planning and conduct of the T&E effort are being used for process improvement.
RISK MANAGEMENT	No risk management is performed.	Risk management is implemented, but the program office is dependent primarily on the development organization for performing it.	A formalized risk management process is in place, and the primary responsibility for its managment is placed in the program office.	Measures for determining the adequacy of the risk management process are established. Corrective measures are implemented, where necessary.	Measures for determing the adequacy of the risk management process are being used for process improvement.

In structuring the SAM[3], the following approach was taken: utilize the SEI concept of five levels of maturity, and use the approach taken by Daskalantonakis *et al* in defining a maturation process for the constituent themes. In defining the MCCS key acquisition process areas, the key processes would be treated as the themes were. A set of KPAs would be defined, along with a set of characteristics that described them at each level of the maturity model. These were used to help define the key practices subordinate to the KPAs. This approach also becomes a building-block model, in that the practices associated with each level of the KPA would have to be implemented by the organization in order for it to be considered as functioning at that level. Figure 1 illustrates this hierarchy.

Key Process Area Structure

The literature[3] on the revised CMM was used as a reference point for defining a KPA structure. It contains far more detail than does the literature on the original version; therefore, it is more useful for this purpose. In the description of the original version of the model,[1] KPAs are hinted at but not specifically identified. In the revision to the model, a hierarchy of maturity levels, KPAs, key practices and key indicators has been established and elaborated upon. The maturity level indicates process capability and contains key processes (or KPAs) which achieve goals for each of the levels. The KPAs contain key practices which describe implementation or institutionalization activities. Key practices specify key indicators which spawn candidate questions for the questionnaire used in the assessment process to ascertain the capability level at which the organization is functioning.

In the structure established for SAM[3], the definitions of the levels are the same as for the SEI model, but their characteristics reflect the concerns of MCCS acquisition, rather than software development processes. The definitions and characteristics of the levels are described in Table 1. In this model, organizations may be at one level with respect to one key process area, but at a different level with respect to another. In this regard, the model recognizes that organizations tend to mature differentially. For example, an acquisition organization may be better equipped to exercise control over the program's contractors, in one instance, than their capability to perform configuration management or quality assurance. The levels are also cumulative. For an organization to be at Level 4 in any one KPA, for instance, all the key practices identified for that KPA at Levels 2 and 3, as well as those for Level 4, must be in place and in force.

In drafting this initial version of SAM[3], 10 KPAs have been defined. They are:

— Requirements Management
— MCCS Acquisition Management
— Software Technical Management
— Software Project Management
— Supportability
— Test and Evaluation
— Configuration Management/Data Management
— Quality Assurance
— Risk Management
— Training.

A set of definitions for these KPAs was established to delineate clearly what kinds of activities were subsumed under them. These definitions are presented at the end of this article. For each of these KPAs, characteristics were defined at each of the five levels of the maturity model. Figure 2 illustrates the structure. Table 2 provides the detailed descriptions of the characteristics.

The key practices explicitly define the kinds of activities that must be performed at each level for the key processes for the organization to be considered as operating at that level. They identify all subjects of interest within the KPA for that level, and are high-level representations of those subjects. For instance, at Level 3, for Configuration Management/Data Management, there is a key practice requiring a written policy or standard that defines the scope of CM activities to be performed. It is at the next tier of the model; i.e., the key indicators for this key practice (refer to Figure 1), that the specifics of what is to be included are defined. At that level of detail, the issues of procedures for configuration identification, change control, baselines, status accounting, etc., are addressed. The key indicators are the detailed designation of what constitutes the fulfillment of the key practice. Because they are so detailed, they serve as the basis for developing questions to include in a questionnaire to give to program office key personnel as part of an assessment process.

Use of the Model

The model will be detailed down to the level of the definition of the key indicators for each key process area at each level of the maturity model. From the key indicators, an assessment questionnaire will be developed.

The model should become the basis for performing assessments of acquisition organizations within the DoD. An assessment process, analogous to the SEI's software process assessment, will be developed. It will include using questionnaires and interviews to determine the level at which the organization is functioning for each KPA. The primary goal of the assessment will be to determine what actions are necessary to improve the functioning level of the organization with regard to its acquisition practices. The intent is to reduce risk in MCCS acquisition and obtain better visibility into the development and maintenance processes to preclude (at best) or minimize (at worst) the occurrence of unwanted surprises.

The assessment process results will be portrayed in a Kiviat Diagram which shows the maturity level for each KPA.

FIGURE 3. Example Assessment Outcome

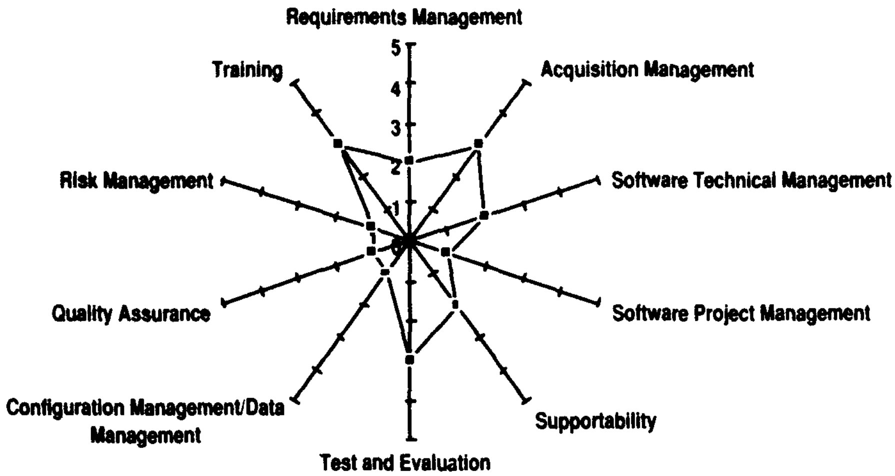


Figure 3 illustrates what an assessment outcome could look like. Note that each KPA is plotted on the Kiviat diagram according to its maturity level as ascertained by the assessment process. This provides a great deal of useful intelligence.

The hypothetical example provided in Figure 3 notes the following findings:

Key Process Area	Level
Requirements Mgmt	2
Acquisition Mgmt	3
Software Technical Mgmt	2
Software Project Mgmt	1
Supportability	2
Test and Evaluation	3
Config Mgmt/Data Mgmt	1
Quality Assurance	1
Risk Management	1
Training	3

In some areas, this program office is doing well; in others, quite poorly. A reasonable strategy for improvement for this program office would be to focus on bringing the Level 1 KPAs up to Level 2, and then bringing all the Level 2 KPAs up to Level 3. This means that this hypothetical program office should concentrate on establishing the key practices related to exercising oversight of activities in the program office; managing interfaces with external organizations such as research and development (R&D) laboratories, software support activities, members of the user community, etc.; exercising good configuration and data management over project documentation produced by the contractor or the program office; and exercising good quality assurance practices over the project's development products.

If the assessment was performed on a number of program offices that report to one program executive, the information would be presented as a composite of the program offices within the executive's organization. The level shown for each KPA would be an average of all the program offices for that KPA.

In general, it would seem that the SEI methodology for performing the software process assessments should be followed here. This methodology provides for anonymity of the sources for the information, and the findings reported to an organization's management are a composite of all surveyed programs in that organization. They also represent a consensus of opinion of the practitioners within that organization — those supporting the surveyed programs, and those working on others. The guarantee of anonymity and the emphasis on consensus prompts cooperation from all the assessment participants. If an acquisition assessment were performed on a single program office, or if the results within an executive's organization were reported by program office, anonymity could not be guaranteed. The assessment would appear to be an audit, and participants would feel threatened. Such an assessment may not be successful. Consequently, the same principles applied to a software process assessment should be followed in the assessment of an acquisition organization.

Conclusions

The approach outlined here holds great promise for properly characterizing an acquisition organization's capability to manage MCCS acquisition. It combines proven concepts from the SEI Capability Maturity Model together with innovative concepts suggested by Daskalantonakis *et al.* A first cut at developing key practices for the key process areas indicates that the acquisition maturity model is viable. Refinement of the key practices is in progress. Verification of the key practices is the next logical step after completion of the key indicator definitions. This latter activity is utilizing a number of source documents to ensure the key practices reflect all mandated actions, as well as those that a consensus indicates should be in place as good practice.

Endnotes

1. Humphrey, W. S., "Characterizing the Software Process: A Maturity Framework," CMU/SEI-87-TR-11 (ESD-TR-87-112), June 1987.
2. Humphrey, W. S., *Managing the Software Process*, New York; Addison-Wesley, 1989.
3. Paulk, M. C., Curtis, W., and Chrissis, M. B., "Capability Maturity Model for Software," CMU/SEI-91-TR-24 (ESD-TR-91-24), August 1991.
4. Daskalantonakis, M. K., Yacobellis, R. H., and Basili, V. R., "A Method for Assessing Software Measurement Technology," *Quality Engineering*, 3(l), 27-40 (1990-91).

KEY PROCESS AREA DEFINITIONS

1. **Requirements Management**. How well the program office manages the process of defining, baselining and controlling changes to the MCCS requirements that will eventually be imposed on the development contractor or the software support activity. It also relates to assuring complete traceability backward and forward from the original statement of overall system requirements through changes to the software requirements definitions that occur during Post-Deployment Software Support (software maintenance). It relates, as well, to ensuring the participation of all affected parties in the definition process.

2. **MCCS Acquisition Management**. How well the program office manages the process of developing the acquisition management requirements prescribed by the DoD and Service directives and instructions, and in developing content for the MCCS portions of the solicitation for the various phases of the system life cycle. In particular, this relates to the supporting MCCS information required as a consequence of the provisions of DoD Directive 5000.1 and DoD Instruction 5000.2, and implementing regulations/instructions.

3. **Software Project Management**. How well program management manages the activities of the program office with regard to MCCS acquisition, such as budgeting, scheduling, estimation of software size and development costs, staffing, training, etc. It also relates to program office interfaces with other affected DoD organizations supporting the management of the acquisition, for example, software support activities, R&D laboratories, etc. Also included is the program office's understanding of the necessity for their personnel to acquire the skills necessary to effectively manage and monitor MCCS development and maintenance. Accordingly, it addresses the planning and execution of training programs to acquire the requisite skills.

4. **Software Technical Management**. How well the PM manages the technical aspects of the contract(s) let to the prime contractor(s) or to organic software development organizations for the MCCS. It also relates to the definition of the life-cycle model to be implemented, language deviations or waivers to be allowed (if at all), provisions for software safety, security, etc.

5. **Quality Assurance**. Relates to the performance in the program office of Software Quality Assurance on the contractor(s) products and activities, as well as to activities performed by the program office in carrying out configuration control, test, or similar activities on delivered products.

6. **Configuration Management/Data Management**. Relates to the performance in the program office of software configuration management (SCM) and data management (DM) on products delivered from the contractor(s). It also relates to the coordination of SCM and DM requirements with the affected software support organization(s) and other field organizations and users, to ensure compatibility.

7. **Supportability**. Relates to the ability of the program office to address the supportability issues unique to MCCS, particularly, specification of quality goals for the MCCS and the reliability of the military system in which it is embedded, definition of the support system and support levels required to field the system, maintainability of the software and the computer system in which it is embedded, training for both the users and the personnel maintaining the system at the software support activities, etc.

8. **Test and Evaluation**. Relates to the ability of the program office to plan, monitor and participate in the MCCS test and evaluation (T&E). Specifically, the goal is to develop an integrated approach to T&E ensuring that:

— The contractor's development and acceptance test efforts mesh with the government's operational T&E efforts

— Both programs complement each other in validating that the fielded software meets operational requirements.

9. **Risk Management**. Relates to the ability of the program office to identify, analyze, control and mitigate technology; development organization capability, performance, schedule, cost and supportability risks associated with MCCS development and maintenance.

10. **Training**. Oriented toward the understanding of the program office of the necessity for their personnel to acquire the skills necessary to manage and monitor MCCS development and maintenance effectively. It addresses the planning and execution of training programs to acquire the requisite skills.