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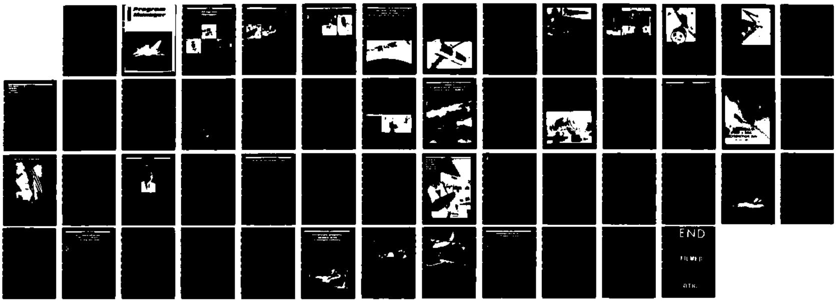

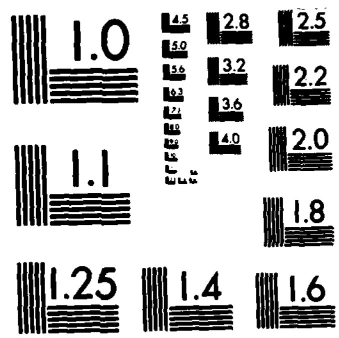

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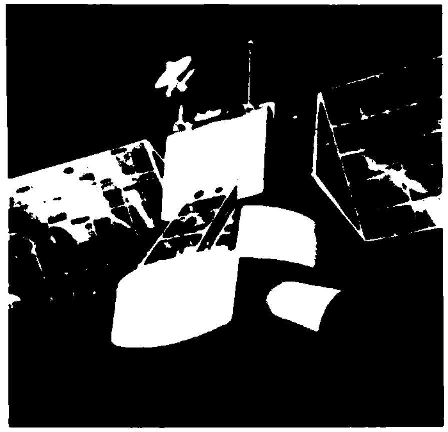

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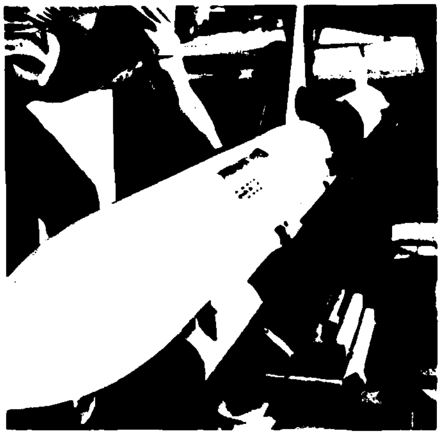

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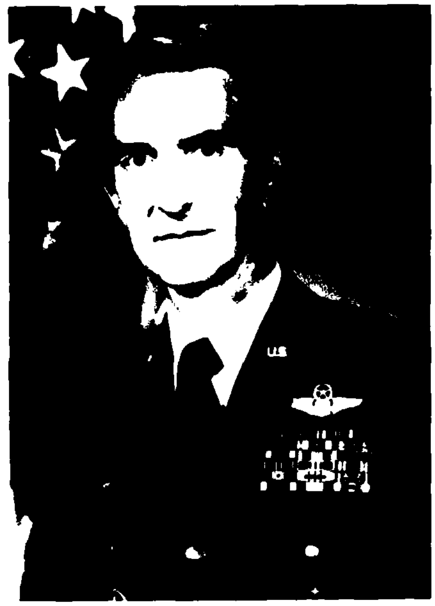
Brig.Gen. Charles P. Cabell, Jr., USAF Is 9th DSMC Commandant

Rear Admiral Roger D. Johnson, who has been commandant of the Defense Systems Management College since April 1984, retired from the U.S. Navy on October 1, 1985.

His successor is Brigadier General Charles P. Cabell, Jr., USAF, who was deputy for Airborne Warning and Control Systems, Headquarters Electronic Systems Division, Air Force Systems Command, Hanscom Air Force Base, Mass., since March 1983.

Brigadier General Cabell received a bachelor's degree in engineering from the U.S. Military Academy and commissioned a second lieutenant in the U.S. Air Force in 1958. He holds an M.S. degree in astronautics from the Air Force Institute of Technology, an M.S. degree in systems management from the University of Southern California, and completed the Air War College in 1974.


RADM Roger D. Johnson, USN


Brig. Gen. Charles P. Cabell Jr., USAF

Navy Admiral Turns Over Helm to a USAF General: Brigadier General Cabell is the 3rd Air Force General To Serve as DSMC Commandant

General Cabell received his pilot's wings in 1959, and was assigned to Chennault Air Force Base, La., where he flew B-47s; afterward, he was a B-52 pilot at Loring Air Force Base, Maine.

In 1967, the general went to the Republic of Vietnam where he initially served as an aircraft commander in F-4 Phantoms at Cam Ranh Bay Air Base, and then as a forward air controller and air liaison officer flying O-1 Bird Dogs in the III Corps area. He has more than 500 combat flying hours.

Returning to the United States, he was assigned to the Satellite Test Center, Sunnyvale, Calif., as director of the field test force for a number of satellite programs. He was selected to serve as military assistant to the director of land warfare for the Directorate of Defense Research and Engineering, Office of the Secretary of Defense, Washington, D.C., and became military assistant to the chief scientist of the Air Force, Headquarters U.S. Air Force. At the Electronic Systems Division, Hanscom Air Force Base, he held key positions including deputy director for the Base and Installations Security Systems Program, director for the Iranian Air Defense Program, director for the Combat Information Systems Directorate, and assistant deputy for Communications and Information Systems.

Transferring to Wright-Patterson Air Force Base, he was deputy for Reconnaissance, Strike and Electronic Warfare Systems, Aeronautical Systems Division. In September 1982, General Cabell was named commander of the Aeronautical Systems Division's Air Force Wright Aeronautical Laboratories. He is a command pilot with 3,500 flying hours.

Admiral Johnson began his navy career as an electronics technician and, later, was graduated from the U.S. Naval Academy in June 1955. He entered flight training and was designated a naval aviator, reported to VFP-63, and was a team pilot and detachment maintenance officer flying F9F-8 Cougar and FBU Crusader reconnaissance aircraft. He served in the Power Plants Division of Fleet Air Service Squadron NINE during the developmental demonstration of the jet engine complete repair concept. He attended the U.S. Naval Postgraduate School, and earned an M.S. degree in June 1963, after which he served on the Staff, Commander Fleet Air Western Pacific.

Reporting to the Power Plants Division of the newly formed Naval Air Systems Command in August 1966, Rear Admiral Johnson was a member of the TF-34/S-3 development team and the early VFX/F-14 study and a specifications effort. He was assigned to Commander Naval Air Force Pacific Fleet as the F-4 Fighter class desk officer, and was executive officer, Naval Air Rework Facility, North Island, Calif. After the Industrial College, Armed Forces, he went to the Naval Air Systems Command as F-14/PHOENIX deputy project manager, and project manager. Before coming to DSMC, he was assistant commander for systems and engineering, Naval Air Systems Command, with a successive assignment as deputy commander for plans and programs. ■

The Why, What and How of the Strategic Defense Initiative

Taken from remarks made earlier this year by Brigadier General Rankine to the American Institute of Aeronautics and Astronautics, Los Angeles, Calif.

The title of my presentation may have confused many of you, as it should, since there is only one Strategic Defense Initiative (SDI), the one announced by President Reagan in his March 1983 "Defense Policy" speech. President Reagan discussed his continued support for the strategic offensive modernization and arms control efforts. He challenged the scientific community to determine the feasibility of developing systems capable of destroying ballistic missiles in flight, thus providing an alternative to sole reliance on offensive nuclear retaliation as the basis for strategic deterrence and leading to the ultimate goal of eliminating the threat of ballistic missiles.

Immediately after that speech, the president directed that two studies be accomplished to investigate the policy and the technology implications of an effective ballistic missile defense system. From these two studies emerged the basis for a long-range research program that the president initiated with his budget request submitted to the Congress on February 1, 1984. In October 1984, the Congress appropriated funds for the Strategic Defense Initiative, financing the new hope for the future, first expressed by the president less than 19 months earlier.

Experiments envisioned include demonstrations of space—based sensors emplaced at high altitude for boost-phase surveillance and tracking, and a midcourse surveillance system that will enable detection, tracking and discrimination of all objects in low Earth orbit, including ballistic missile warheads, decoys, and debris.

To best understand the scope and breadth of this initiative, I have organized this presentation to answer three questions: First, why?—which will address the strategy and policy implications of an effective ballistic missile defense. Second, what?—which will describe the scope and priorities of

the research program under way to determine technical feasibility. And lastly, how?—which will describe the procedures we have established to centrally plan and control the program, yet decentralize the technology efforts.

In the long term, we have confidence that SDI will be a crucial means by which both the United States and the Soviet Union safely can agree to very deep reductions and eventually even the elimination of ballistic missiles and the nuclear weapons they carry. This does not represent a shift from the basic deterrent strategy of the United States, but represents a new means for enhancing deterrence. That policy, in effect since the beginning of the nuclear era, has not changed in its fundamentals, but our ability to deter has hinged upon differing military capabilities ranging from a balanced nuclear bomber and air defense capability in the '50s to almost total reliance on the threat of retaliation in the '80s. The shifts in the basis for deterrence have been forced by the developments of various nuclear delivery systems and not by fundamental changes in policy.

Ballistic Missiles, Deterrence

The emergence of the nuclear-tipped ballistic missiles in the late '50s and '60s changed the timing of nuclear warfare and thus reduced the importance of the need for air defenses in the view of many U.S. leaders. Because ballistic missiles are fast and unrecallable and are becoming increasingly accurate, they potentially are the most destabilizing of the currently deployed systems—particularly the ICBMs, which may be targeted against each other and, therefore, have the potential of increasing deterrence and adding to stability. It would affect this by increasing substantially the uncertainties in the success of nuclear attack by an enemy, thoroughly confounding his targeting strategy, and thus significantly reducing or eliminating the utility of preemptive attack. The system need not be perfect to accomplish this objective but must meet three important criteria.

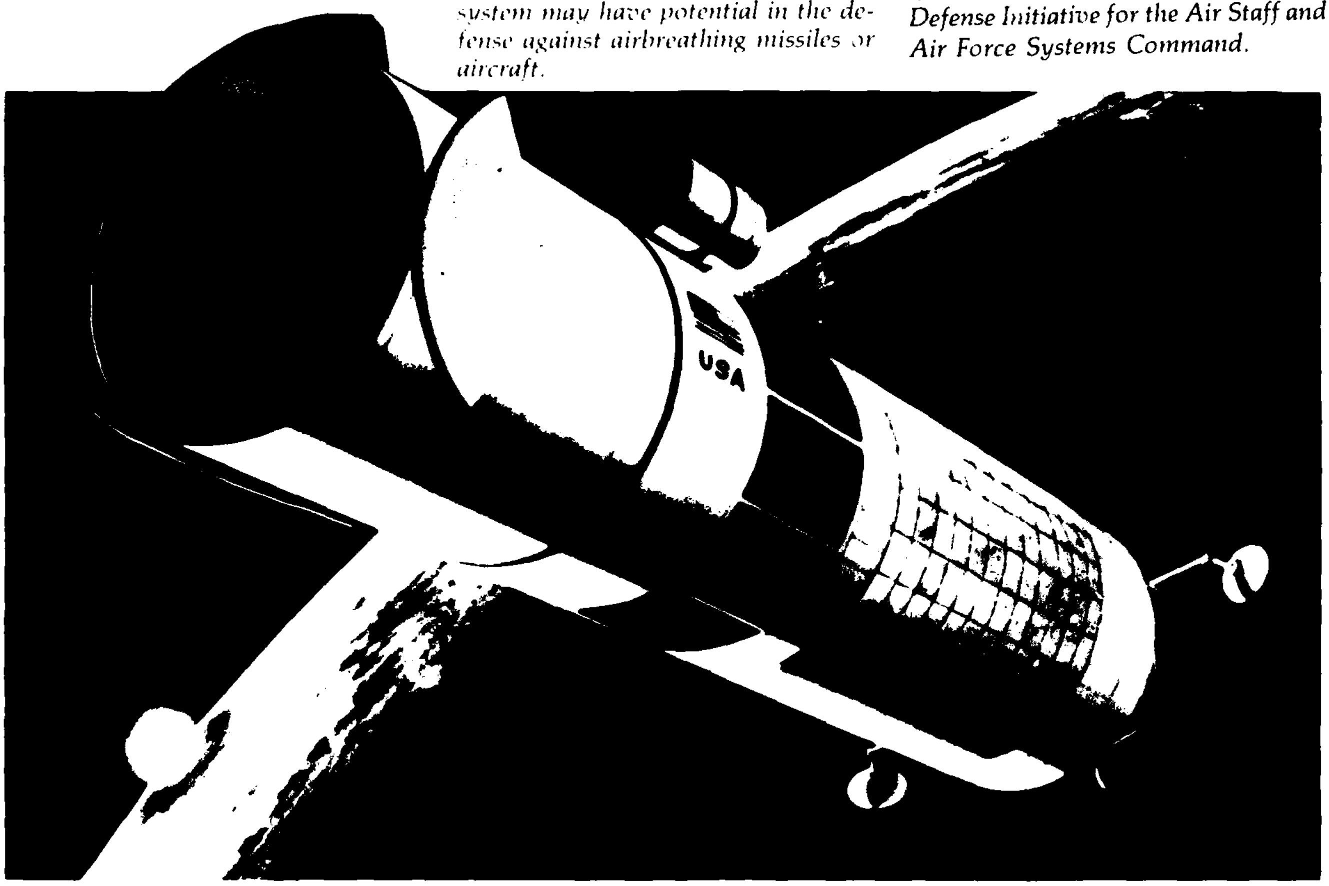
An example of a directed energy weapon is the space-based laser system, which offers the opportunity to intercept ballistic missiles in the boost phase, before they can deploy their warheads and decoys. Since laser light penetrates the atmosphere, this type of system may have potential in the defense against airbreathing missiles or aircraft.

Effective Defense Criteria

First, it must be effective against the systems and countermeasures that exist or could be deployed. Second, it must be sufficiently survivable that it would not encourage an attack on the system itself by either enemy defensive or offensive systems. If it were not survivable, then it might invite a defensive suppression attack as a prelude to an offensive attack, thereby decreasing rather than increasing crisis stability.

Third, in addition to being effective and survivable, defenses must be able to be expanded to maintain effectiveness at lower cost than any proliferation or countermeasure attempts to overcome them. If that were not the case, the existence of defenses would encourage rather than discourage proliferation. Providing for cost-effective and survivable defense is the key challenge to the Strategic Defense Initiative technology program and illustrates the need for research before an informed decision to begin system development is possible.

■ *Brigadier General Rankine is the special assistant for the Strategic Defense Initiative for the Air Staff and Air Force Systems Command.*



Soviet Buildup

In the late '60s and early '70s, the United States had done developmental work on an anti-ballistic missile system known as Safeguard. That system, which was deployed in the mid-1970s, was dismantled shortly thereafter, due in part to the fact that it could not maintain effectiveness against proliferation. The United States also hoped that not deploying U.S. defenses permitted by the ABM (Anti-Ballistic Missile) treaty would encourage the Soviet Union not to build more ballistic missiles. It did not. Not only did the Soviets continue to build ballistic missiles, they also relentlessly pursued technology for defending against ballistic missiles.

An example of this was shown in the U.S. Department of Defense publication "Soviet Military Power 1984," which described a directed energy R&D (research and development) site at Sary Shagan in the central Soviet Union that not only could provide an anti-satellite capability today but possibly a prototype for an ABM system to be deployed in the future. As you are all aware, the Soviets have currently the only operational ballistic missile defense, which is located around Moscow. The system is for terminal defense and similar in many ways to the Safeguard system that we had deployed in the early 1970s. The Soviets are presently modernizing that Moscow system and have developed a rapidly deployable ABM system that has potential for deployment as a nationwide ABM system.

Of even greater concern, however, the Soviets have been pursuing for many years extensive development of technologies that have potential for advanced ballistic missile defense applications. Whereas the United States has been developing basic laser technology, the Soviet Union is exploring many laser technologies. In the particle beam area, the most advanced U.S. technology is derived from Soviet research reported in their technical literature several years ago.

The Strategic Defense Initiative Program thus provides us a hedge against what might otherwise be a Soviet technical surprise. A unilateral Soviet deployment of such advanced defenses, in conjunction with its offensive deployments and its air and civil defense efforts, could result in a significant change in Soviet military capability and could adversely affect the security of the United States and its allies.

SDI: Consistent with ABM Treaty

Some of the opponents of the Strategic Defense Initiative have argued that the research and technology program currently under way is inconsistent with the ABM treaty and conflicts with arms control in general. Quite to the contrary, the initiative is totally consistent with current U.S. ABM treaty obligations. The initiative contemplates only research and experimentation on a broad range of defensive technologies to provide the basis for a decision in the future whether or not to develop systems that would provide an effective ballistic missile defense capability. As we look toward the future, effective defenses have the potential of decreasing the value of ballistic missiles as instruments of national strategy, thus increasing the likelihood of negotiating reductions in those ballistic missiles. Negotiated reductions in offensive forces, in turn, will enhance the effectiveness of the defenses. Thus, we have created a defensive spiral in which both parties would be more willing to negotiate further reductions. Thus, defenses couple synergistically with arms control, leading to attainment of the ultimate goal stated by the president—to eliminate all threats posed by nuclear ballistic missiles.

SDI and Defense Allies

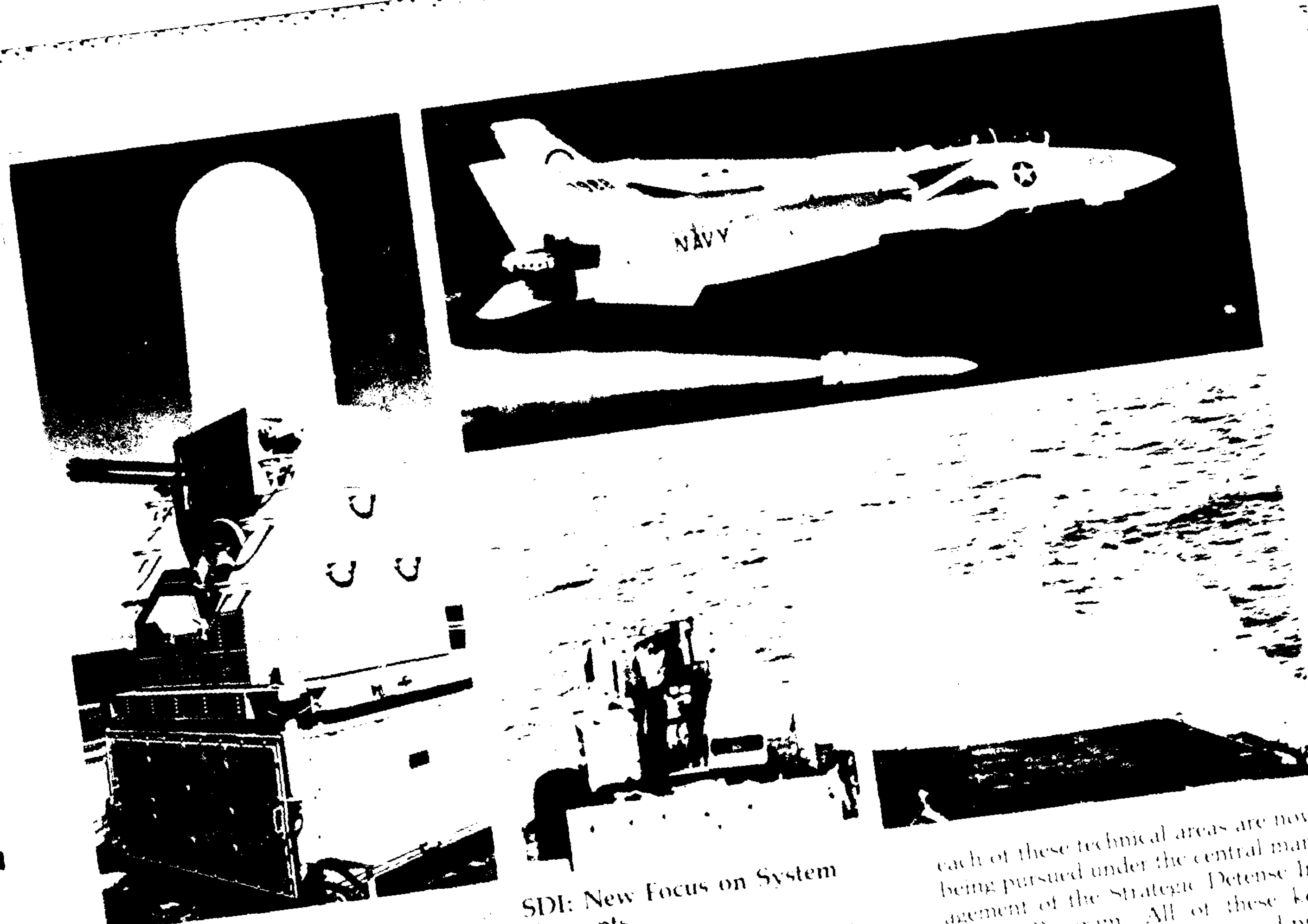
An important aspect of the entire initiative is the fact that the United States is in no way decreasing its commitment to the protection of its allies but, in fact, is examining technologies for defense not only against ballistic missiles that can hit the United States but against shorter-range ballistic missiles that can strike our allies. We are consulting closely with our allies, and that's the reason Lieutenant General James A. Abrahamson, director, Strategic Defense Initiative Organization, is not able to be here.

The emphasis in the Strategic Defense Initiative on defending against ballistic missiles is due to their potential to increase instabilities. But while the slower moving systems, such as cruise missiles and bombers, are less threatening in this regard, there are separate efforts under way in the services to examine the technologies required to defend against these weapon systems as well.

Layered Defense Systems

Having described the rationale for the program, I will now describe the technical scope of the program and what has changed during the last 10 years that has made defense against ballistic missiles both more realizable and more effective. To do this, it is important to understand the flight path of a ballistic missile and the various regimes in which ballistic missiles can be attacked. It starts in the boost phase, in which the ballistic missile, being thrust by a large chemical rocket, slowly rises from the face of the earth en route to its targets. This phase can be characterized by an intensely bright plume that provides a very large characteristic infrared signature. In this phase, the ballistic missile still has all its warheads attached. Attack in this phase could provide large multiplier effects and would thus provide maximum leverage from a defensive point of view. In the next phase, post-boost or the bus deployment phase, warheads and penetration aids are deployed in such a way as to attempt to confuse the defenses. This phase is followed by the longest phase, the midcourse phase. The warheads and penetration aids coast on a ballistic trajectory from minutes to tens of minutes on the way to their target. In the last phase—the terminal phase—the warheads and the decoys re-enter the atmosphere. Discrimination is facilitated in this phase by the differing re-entry dynamics and signatures of the warheads and decoys.

Attacking ballistic missiles in all four of these phases is what is known as a layered defense system. This is a defense-in-depth approach that is not new to the military. For example, it is similar in concept to the approach used by the U.S. Navy to protect a carrier task force. We have the F-14 Tomcat attacking aggressors at long range using the Phoenix missile system; at shorter ranges, using Sparrow and Sidewinder missiles; then followed up by surface-to-air missiles from the support vessels; and finally by the Phalanx Gun system. Layered defenses relieve the effectiveness requirements of each individual layer and are more resistant to countermeasures.



SDI: New Focus on System Concepts

Certain functions need to be accomplished in each of these four phases for the ballistic missile to be attacked effectively. The four functions are: first, detection, acquisition, discrimination and kill assessment; second, pointing and tracking; third, interception and destruction; and fourth, battle management. The scope of the Strategic Defense Initiative Program can be discerned by identifying weapon system concepts for each function in each phase. The collection of technologies that will permit the realization of these concepts define the technical scope of the program. As an example, in the boost phase, the requirements for detection, acquisition, discrimination, and kill assessment could be accomplished by taking advantage of the very bright signature of the booster itself. Space based infrared sensors could detect and track the booster and thus hand off to a boost phase interception and destruction capability that would employ either directed energy or kinetic energy. The technologies that support such a concept include focal plane arrays, lightweight optics, and signal processing for space applications, and programs in each of these technical areas are now being pursued under the central management of the Strategic Defense Initiative Program. All of these key technologies were being pursued previously; hence, the Strategic Defense Initiative is not a new program but an entirely new focus for a collection of relevant programs.

Scope of SDI

In order that you can better appreciate the scope of the program let me describe some notional architectures for the sensors and weapons that might fulfill the functional requirements of a multilayered defense.

In the sensor area we are looking at five interleaved system concepts: first, a boost phase detection and tracking system that would detect launches of ballistic missiles. In the midcourse area we perceive the need for a birth-to-death tracking and fire control system to provide the tracking of the reentry vehicles from deployment to reentry. Also in the mid course, we see the need for a laser or radar system to image the post-boost vehicle to observe reentry vehicle and decoy deployment and thus discriminate between the two. In the terminal phase two systems are currently envisioned

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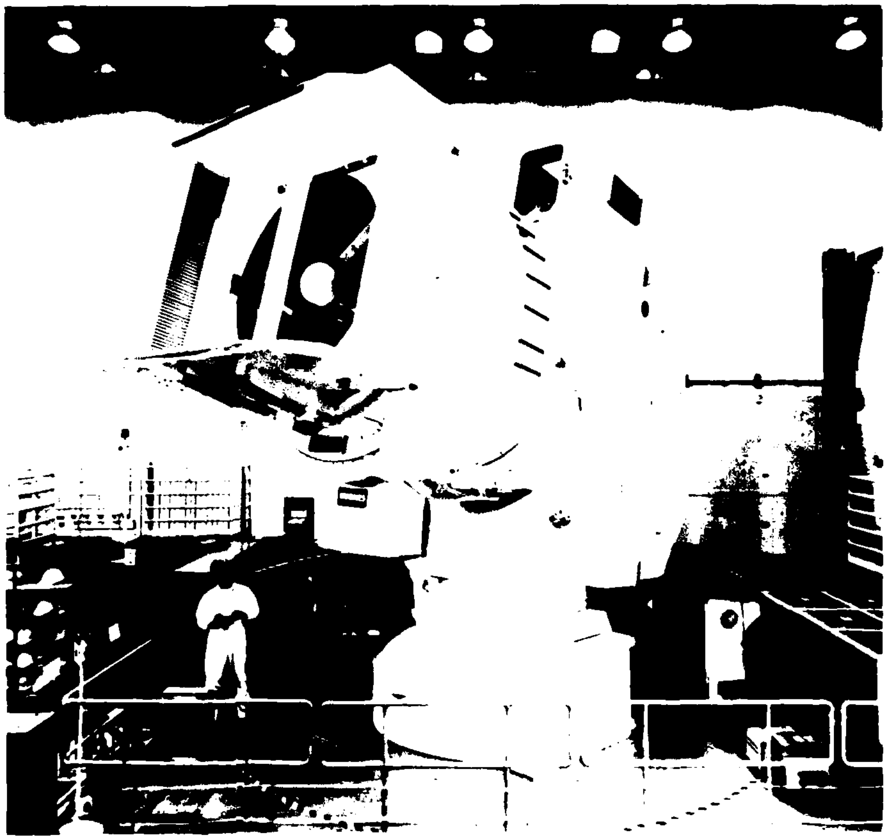


one an airborne optical adjunct that would provide for long-range infrared tracking and discrimination of the re-entry vehicles and decoys. And lastly, a ground-based imaging radar that would provide endoatmospheric discrimination of re-entry vehicles and decoys.

Kinetic Energy Weapons

In the kinetic energy weapons area, both ground-based and space-based assets would provide for attack of ballistic missiles in all phases. In the boost-phase, space-based projectiles propelled by chemical rockets or electromagnetic launcher systems would provide a capability of attacking the booster while it is still under power. These same systems would also be capable of attacking post-boost vehicles and re-entry vehicles during midcourse flight. In the terminal and late midcourse area, ground-based interceptors would provide a non-nuclear hit-to-kill capability to destroy the re-entry vehicles on a one-to-one basis.

As you are aware, the Homing Overlay Experiment (HOE) conclusively demonstrated the technology of hit-to-kill intercept of re-entry vehicles in June 1984. Some new technology breakthroughs occurred recently in the hypervelocity launcher area. We have been able to accelerate projectiles from a repetitively fired electromagnetic railgun launcher up to several kilometers per second. In addition, preprogrammed maneuvering projectiles have functioned after sustaining accelerations in excess of 50,000 Gs.

Directed Energy Weapons

Directed energy weapons are being investigated primarily to attack ballistic missiles in either the boost or post-boost phase. Several options currently exist. Chemically powered space-based lasers might provide long-range, speed-of-light intercept and kill of both boosters and post-boost vehicles. Alternatively, ground-based excimer or free electron lasers could bounce their energy off space-based mirrors and thus be able to attack a large number of boosters without the need to put the laser device in space. Neutral particle beams can penetrate deeply into the ballistic missile, causing catastrophic damage to internal components. Recent work on the Navy Mid-Infrared Advanced Chemical Laser (MIRACL) has demonstrated not only the highest power but now also the highest brightness of any laser in the Free World.

Left: A series of sounding rocket experiments have been conducted at the Navy Pacific Missile Range Facility in Hawaii. The purpose is to test techniques of high precision tracking and atmospheric compensation for ground based lasers. A follow-on to the successful High Precision Tracking Experiment (HPTE) performed with the shuttle discovery in June these experiments, as with all planned SDIO tests, experiments and demonstrations are in full compliance with all U.S. treaty obligations including the ABM Treaty.

Right: The Navy's beam Director is used in High Energy Laser (HEL) research and development. This experimental pointing and tracking system is designed to track targets in flight and direct a high power laser beam to selected aimpoints. It is the largest, most advanced high energy laser beam pointing and tracking system built to date. As part of the Strategic Defense Initiative program the beam director will be mated with the Navy's High Energy Chemical Laser to gain experience in integrating a high power laser with a precision beam director.

Among kinetic energy weapon systems being investigated is the Space-based Hypervelocity Launcher, or Railgun, which employs electrical forces rather than chemical propellants to fire smart projectiles. The electric gun may be able to generate projectile velocities of more than 20 miles a second compared with five miles a second for chemical rockets.

This laser at the White Sands Missile Range will be a workhorse for the Stratgegic Defense Initiative, allowing us to determine by actual testing the trade-offs between booster hardening and laser brightness.

Five Priority Technology Areas

Hopefully, you now appreciate the broad technical scope of the Strategic Defense Initiative; however, not everything within that scope is equal in priority. Five priority technology areas can be defined that provide the keys to an effective defense.

Definition of Weapon Concepts

First is the definition of weapon concepts for boost-phase and post-boost vehicle intercept. Directed energy weapons such as lasers and particle beams have the promise to provide for long-range intercept of the booster and the post-boost vehicle at or near the speed of light. Kinetic energy projectiles propelled to hypervelocity by chemical propellants or electromagnetic force also offer potential for such early intercepts.

Definition of Lethality

Concurrent with the pursuit of technologies that will make such weapons possible is the definition of the lethality required, not only against current deployed Soviet ballistic missiles, but also against new missiles built to incorporate countermeasures intended to overcome the effectiveness of these new weapons.

Discrimination

In the midcourse area described earlier, the key to cost-effective defense is discrimination of re-entry vehicles from the decoys. If discrimination can be accomplished with sufficiently high confidence, midcourse intercept can be obtained with reasonable numbers of interceptors. By simultaneously advancing technology to reduce the cost of the midcourse interceptors, one can trade off the effectiveness of the discrimination with the cost of attacking more expensive decoys in addition to true re-entry vehicles.

Survivability

Survivability of space-based defense assets is a key to the program as discussed earlier. Since these systems must be sufficiently survivable to preclude a pre-emptive attack upon them, major emphasis in the Strategic Defense Initiative Program will be to develop survivability measures for the space-based assets to include such things as electronic countermeasures, self-defense, decoys and hardening.

However, we not only are looking at the technology to enhance the survivability of single satellites but also are exploring the full range of tactics to provide for overall mission accomplishment without the dependency on any one satellite. Tactics of this kind include such things as escort defense, orbit selection, proliferation and maneuver.

Battle Management

The last, and not the least most important priority technology, is in the area of battle management. In the past, the development of high-speed computational capability for the real-time battle management of such a system would have precluded the development and deployment of such an effective layered defense. Today's computer processing capabilities, which are growing by an order of magnitude every three to four years, promise to provide the technology sufficient to support such a system by the turn of the century. Of greater concern, though, is the issue of software preparation and testing. We currently do not have the capability to build and validate the software necessary in a timely manner. Hence, research on "software development tools"—that is, computer programs that can write and test new computer programs—are receiving high priority attention.

SDI Management

With the scope and the priorities of the Strategic Defense Initiative research program thus defined, let me turn now to the question of how the program is being executed. The Congress appropriated $1.6 billion for the Strategic Defense Initiative for fiscal 1985—$1.4 billion for the Department of Defense, and $0.2 billion for the Department of Energy.

Although this was only 80 percent of what the president had requested, it has nevertheless permitted a focused, centrally-managed beginning for the Strategic Defense Initiative. We believe that the central management of those funds by General Abrahamson's newly created Strategic Defense Initiative Organization (SDIO) has introduced economies and efficiencies that enable us to get more for that money than if the pieces were pursued separately. The overall management of the program is characterized by centralized planning and control by the Strategic Defense Initiative Organization with decentralized execution by the Army, Air Force, Navy, DARPA (Defense Advanced Research Projects Agency), Defense Nuclear Agency and Department of Energy.

In FY 1985, the two largest executors are the Army and Air Force, with 40 percent and 35 percent, respectively, of the DOD portion of the program. The Army and the Air Force were able to undertake such large portions of work in FY 1985 because the work had actually begun in previous years. That is, the Strategic Defense Initiative provided a new context and focus for the Army's prior work on ballistic missile terminal defense and the Air Force's prior work on space surveillance and space defense. For example, the Air Force was developing technology for detecting and tracking satellites using long-wavelength infrared space-based sensors. This basic technology, with improvements in sensitivity and resolution, provides the basis for re-entry vehicle tracking. Based upon the $3.7 billion budget request for the DOD part of the program recently submitted to the Congress, the distribution of the funds in FY 1986 will remain much the same as in 1985.

The artist's concept shows an Earth-Generated Laser Beam being reflected toward a high-altitude target by a spaced-based mirror. This is one of a number of ballistic missile defense concepts being explored in the strategic defense initiative research program.

SATKA

For ease of presentation and management, the program has been broken up into five major program elements or thrusts. The first major thrust is surveillance, acquisition, tracking and kill assessment (SATKA), which encompasses the five previously-mentioned system concepts: boost-phase IR (infrared) surveillance system, midcourse IR surveillance, midcourse laser or radar imaging system, late midcourse to terminal airborne IR tracking system, and a terminal radar.

In addition to the pursuit of technologies leading to major experiments conducted in support of each of these concepts, significant effort is under way to gather radar and optical data on missiles and backgrounds and to investigate common technologies such as signal processing and the development of imaging algorithms. The Army and Air Force each will execute about 40 percent of the funds for surveillance, acquisition, tracking and kill assessment in FY 1986.

Directed Energy Weapons

The second major thrust is directed energy weapons, with primary emphasis within the DOD upon space-based chemical lasers, ground-based excimer and free electron lasers, and spaced-beam neutral particle beams. The Air Force is, by far, the largest executor of the directed energy work in FY 86.

Kinetic Energy Weapons

The third major thrust is in the kinetic energy weapons area, which includes the concepts for space-based kinetic kill vehicles, space-based hypervelocity launchers, and ground-based endo- and exoatmospheric hit-to-kill interceptors previously discussed. All of the concepts are supported by major technology efforts in terminal homing, chemical and electromagnetic propulsion, fire control, and acquisition and tracking. The Army will execute the largest portion of the kinetic energy weapons thrust in FY 1986.

Systems Analysis, Battle Management

The fourth major thrust is systems analysis and battle management, where the main efforts are system and battle management architectures and the associated communications, command and control technologies. This area has received much attention lately with the award of 10 $1 million contracts for alternate architecture studies that will identify the key trade-offs of various total-system designs. The results of these studies will help General Abrahamson guide the individual technology programs toward the achievement of overall, integrated system objectives. The funds here are divided almost equally among the Army, the Air Force and the SDIO, with the services' primary thrust in technologies and the SDIO's in systems analysis.

High Prior Technologies

The fifth major thrust includes an assortment of high priority technologies that individually do not take a sufficiently large fraction of the program's funding to warrant a separate program element for each. This includes major efforts in space system survivability technology, lethality and target hardening testing, space prime power from tens of kilowatts to megawatts, and space logistics with particular emphasis on launch, orbit transfer, and on-orbit support. The Air Force is conducting most of the survivability, space power and space logistics work, with the Defense Nuclear Agency directing the lethality and target hardening tests with assistance by the Air Force, Army and DOE.

The goal of the Strategic Defense Initiative has not changed at all since the president's March 1983 speech.

Growth in Funding

A considerable amount of growth in each of these five major thrust areas has been requested in the president's budget for FY 1986. This growth is attributable to the fact that the many technologies that make up the Strategic Defense Initiative each had reached a point where they were ripe for exploration. Indeed, the defensive technologies study led by Dr. James Fletcher in 1983 concluded that "power for new technologies is becoming available that justifies a major technology development effort to provide future technical options to implement a defensive strategy." It is common for the funding of an emerging technology to grow rapidly as it is experimentally applied to potential weapon system concepts after an extended period of low-level research.

Our past is replete with examples such as Tomahawk, which grew by 1,133 percent from the first to the second year of the program, and the M-1 tank, which similarly grew by 145 percent. In the Strategic Defense Initiative we have many such technologies emerging simultaneously, and we are attempting to synchronize their exploitation by collectively managing them.

It should not be surprising, then, that the Strategic Defense Initiative funding profile follows very much the normal R&D program funding profile. New research was started in 1976, with an emphasis on shifting from nuclear to non-nuclear intercept. The level of funding was intentionally held down until the promise for effective defense emerged in the early '80s and was initiated by the president with his FY 1985 budget request.

Growth in Technology Work Force

Complementing the growth in program funding is the associated growth in the number of skilled and trained scientists, engineers and technicians required to execute the research program nationwide. The projected growth from nearly 5,000 working in these technical areas in 1984 to 18,000-plus in 1987 would appear very high until one looks at these figures as a percentage of the national assets available. On this basis, the 84 percent to 87 percent increase means only that 0.45 percent of the nation's scientist-engineer-technician work force will be involved in these technical areas, in comparison with the previous 0.13 percent. In terms of those scientists, engineers and technicians working on defense programs, the change is from 1.6 percent in 1984 to 4.8 percent in 1987.

SDIO: The Organization

Allow me to conclude this section of my remarks by describing how we have organized the Department of Defense to get the job done. The Strategic Defense Initiative has been institutionalized into a Defense Agency organization with the director, General Abrahamson, reporting directly to the secretary of defense.

General Abrahamson has established a subordinate office for each of the five program elements that are the major thrusts of the program: systems,

(See Strategic Defense, page 24)

Because Wisdom Cannot Be Told

Commander J. W. H. Fitzgerald, USN

"So he had grown rich at last and thought to transmit to his only son all the cut-and-dried experience which he himself had purchased at the price of his lost illusions...a noble last illusion of age."

—Honore' Balzac

The Defense Systems Management college (DSMC) has a well-defined target audience, most of whom are destined for a specific job area. The college is sponsored by the Department of Defense in order to provide a tailored education for personnel of the uniformed services, both military and civilian, in the specialized field of weapon system acquisition. The questions the college must constantly readdress are: "What are we trying to achieve in terms of learning objectives?" and "How can we best achieve those objectives?"

In an attempt to answer these questions, I will (1) describe the uniqueness of system acquisition in defense, (2) suggest that it is a particularly complex environment, (3) develop a model of learning objectives to prepare managers to work in that environment, (4) relate learning theory to these objectives, and (5) describe how the college applies its resources to achieve these objectives. Figure 1 represents this thesis and reflects the *anima-animus* mutual support and innate conflict between the "real world" and the college.

System Acquisition: Unique In Defense

To begin with, the field of system acquisition management in the government is unique because of the nature of the organization doing the acquisition, the United States federal government. This uniqueness stems from the very foundation upon which our economic system rests, combined with the constitutional responsibilities of the federal government.

One tenet of our economic system is the belief that the means of production belongs in the private sector. Therefore, most fundamental economic decisions—what to produce with what resources and for whom—should be made by the "free market." Since the U.S. Constitution directs the Congress to "raise an army" and to "provide and maintain a navy," and appoints the president as the "commander in chief," the federal government clearly must see that the "common defense" is provided. The dilemma is that the "free market" does not inherently provide for the "common defense" and the government, as a buyer, cannot act as a "free market."

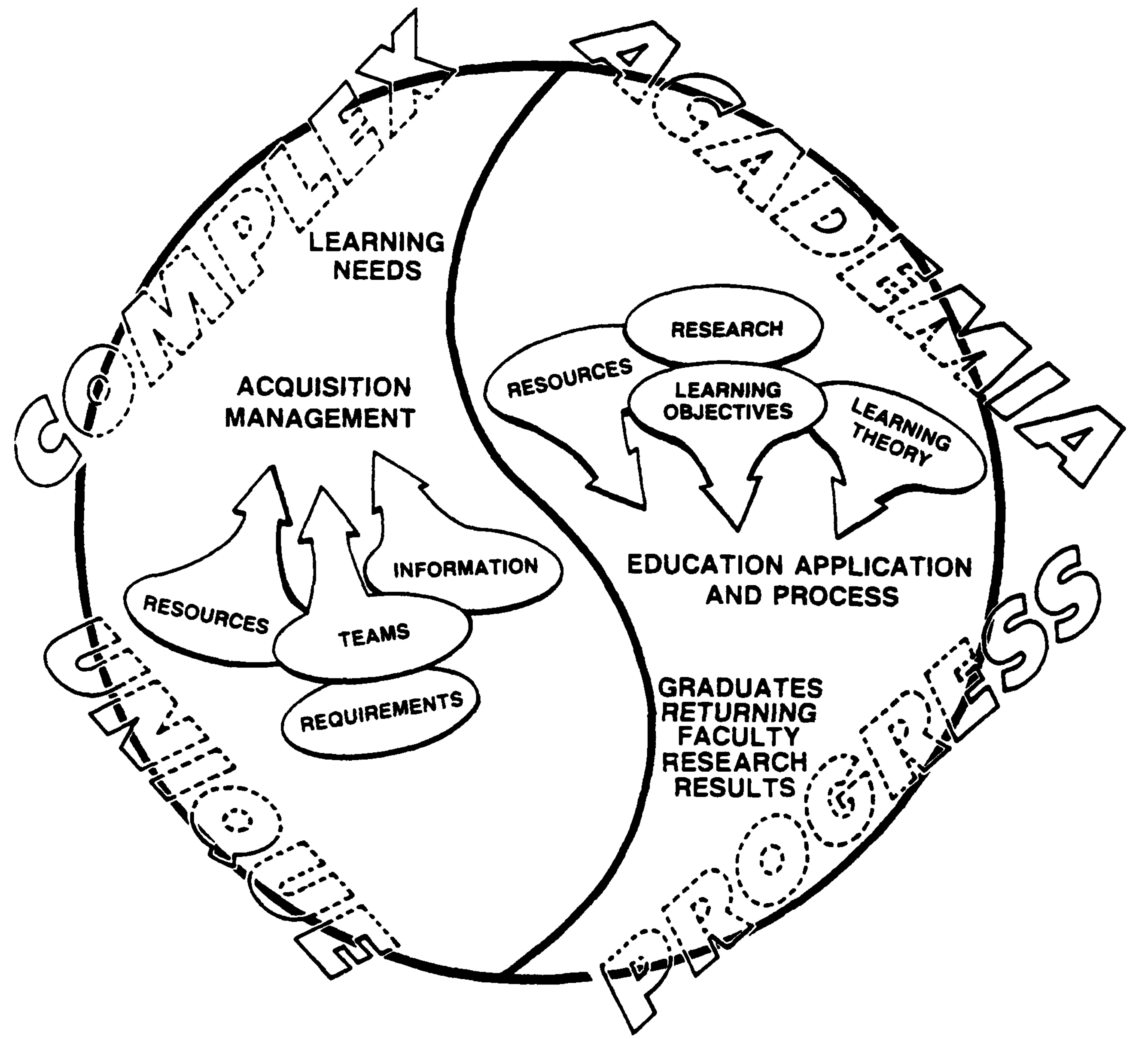
So the government finds itself with a paradox. The economic system for which it is to provide a defense does not, in and of itself, provide the resources needed. In order to obtain the goods and services required for the "common defense," the government must violate one of the two economic axioms discussed earlier. Either the government must acquire the means of production, or it must enter and distort the "free market." It has done both.

While there are examples of government ownership of production capability, the primary approach used by the Department of Defense is to enter the marketplace. The products acquired often have unique military application, press the state of the art, are few of a kind, expensive, and difficult to produce. The buyer side of the relationship is often a monopsony (one buyer) and the seller side is often an oligopoly (few sellers). This market structure, the characteristics of the products, and the resultant interdependence of the organizations involved present the government acquisition management team with an extremely complex business environment. Adding to this complexity is the fact that the buyer is also sovereign. In this role, the government regulates such things as product characteristics, prices, profit levels, personnel policies, management systems, and access to markets.

Turning now to the government's infrastructure, we find another complex set of relationships built into the system by the Constitution. The Constitution charged the Congress with providing the resources and overseeing the way those resources were applied. It also charged the president, as commander in chief, with the responsibility of using the resources provided by the Congress. These requirements are part of the checks and balances designed into our system by wise men concerned with the potential excesses of an uncontrolled government. The legacy, however, is a very complex environment in which the government acquisition management team is often challenged with orchestrating the internal unity of purpose necessary to achieve a successful program.

This complex environment within which the government acquisition management team must survive, per-

Figure 1. SYSTEM ACQUISITION ENVIRONMENT ACQUISITION EDUCATION ENVIRONMENT



form, and make decisions, demands that the DSMC identify appropriate learning objectives, vehicles, and techniques to prepare its students to meet the challenge.

Learning Objective Model

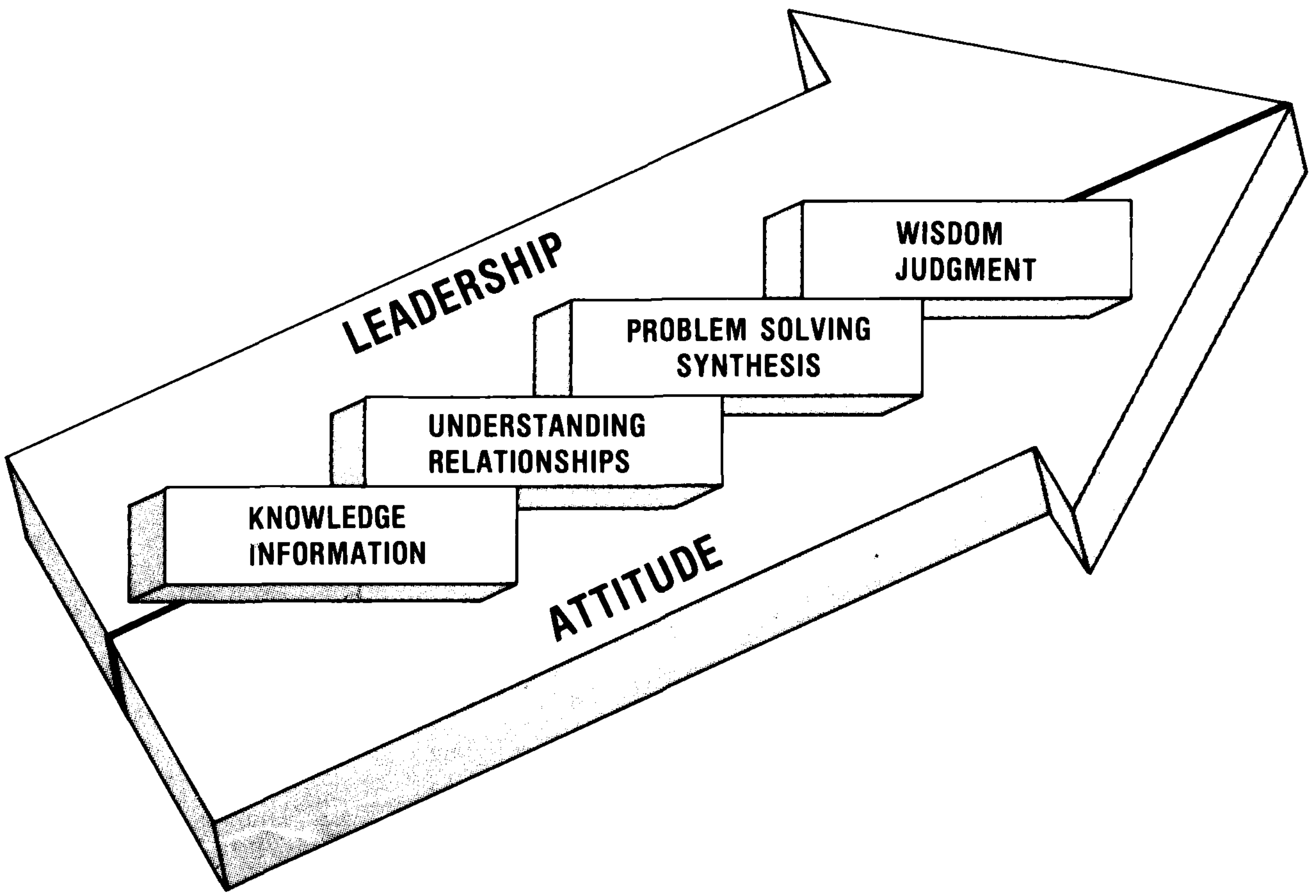
In order to help explain the learning objectives appropriate to DSMC, I have described my view of the learning hierarchy for weapon system acquisition in Figure 2. Fundamental to the model is the belief that there are four levels or stages of learning embedded in, and enhanced by, attitude and leadership. The higher levels of learning require student-oriented learning approaches. This is the basis for the remainder of the discussion contained in this paper.

I'll begin by describing each level of learning as I see it. First, **Knowledge** is awareness of facts and information. It can be viewed as being able to repeat lists of data or replicate graphics. It can be acquired through rote memorization and frequent repetition.

Understanding implies something more than knowledge. It implies comprehension of relationship and meaning. What does it mean to other facts if one is changed? How do they affect one another? It involves analysis of relationships to discern something about the pieces as they relate to one another, and to the broader whole of which they are elements.

Problem Solving is the ability to synthesize or generate new patterns of relationships in order to achieve some new and "improved" whole. It is the generation of alternatives and the building of courses of action. It is more than understanding in that it requires creating a vision of how things could

Figure 2. LEARNING OBJECTIVES



be, and putting together sets of steps to cause the new order.

Judgment is the ability to establish meaningful criteria, weigh the alternatives, and make a selection. It is the critical ability to make a sensible decision in the midst of uncertainty. It is not the last step, of course, since leadership is necessary to see that the decision is carried out, but it is, perhaps, the most difficult to achieve.

Attitude pervades the entire process. It must be positive if one is to persevere. It is the willingness to stand up and make a decision based on one's own "understanding" of the situation, and to delve more deeply into the situation when it is not understood sufficiently.

Leadership pervades the process. In acquisition, little is done alone. The complex nature of the environment requires that we draw on the available resources, yet recognize the differing perspectives, motives, and biases of those resources. It is the final step in carrying out the course of action decided upon.

Learning theory relates educational techniques to the different levels of learning described above (Figure 3). Inherent in the theory is the idea that the level of student self direction required to achieve the learning objectives is greater as we move up and right in the learning objectives model. In order to achieve the highest levels required, the theory states that student directed (adult) learning must be used. The specific techniques that are appropriate are experiential in nature—such things as case study, in-basket exercises, and role play executed by the students under the guidance of a facilitator.

System Acquisition Education at DSMC

The DSMC structures its Program Management Course to take advantage of its resources in the application of learning theory. Functional experts increase the student's knowledge and understanding through lecture-discussions, exercises, readings, and some directed case study. Through dedicated efforts of the functional experts in the Policy, Technical and Business Departments, each student gains a solid foundation in the concepts, policies, and technical skills necessary to manage an acquisition program.

The more general problem-solving skills, wisdom, leadership, and attitudes are dealt with in the Acquisition Management Laboratory. Here, experiential learning techniques and differing levels of self-directed learning are practiced under guidance of faculty experienced in facilitation. When these techniques are applied with their inherent focus on "process," students practice leadership and people skills and improve their ability and willingness to manage programs in the complex environment of system acquisition.

Experiential Learning in the Lab

Students arrive at the laboratory with a bundle of personal characteristics, which contribute to or diminish their ability to manage. Two of the most detrimental "blocks" to effective functioning in the world of acquisition are (1) a black or white view of things, and (2) a tendency to avoid personal decision-making by relying on "expert" authority for direction (Figure 4). It is through the student's practice, application, and experience in the laboratory that these blocks can be pushed aside and our graduates can become open-minded, holistic, good decision-makers, and good leaders.

Now let's zero in on the conduct of experiential learning in the laboratory. In order to execute experiential learning, we, as faculty, have to make two basic assumptions about the students. First, students are fundamentally good people. Second, they are "adult learners." What we cannot assume, however, is that they know and understand the concepts of adult learning as described by Dr. Malcolm Knowles, or that they know and understand the experiential learning process. One of our first tasks as faculty is to help the learners learn to learn!

To begin with, we review the derivation of the objectives and their relationship to learning theory as I described earlier. From here, we develop the methods, ground rules, and environment necessary to achieve our objectives.

One of the first things to do is establish an environment for learning. The students and their faculty guides (called facilitators) must create feelings of mutual trust and respect, an atmosphere for open dialog, and a generally supportive climate.

Then, respective roles are established. The role of the facilitator is generally to help students learn to learn, help establish the climate for learning, establish the high-level objectives, guide them in the process, act as a content resource, and help them in planning and evaluation.

The role of the students is to support the environment, establish complementary objectives, act as a content resource, plan and execute the process, and evaluate their learning and performance.

A model (Figure 5) was developed by a former faculty member, Kenneth Stavenjord, to provide the needed process structure. With it, students sort out essential elements from the complex situations confronting them.

In addition to the process model, students are exposed to interpersonal models as part of their instruction in the Policy Department. These models help students to understand the way people function so they can observe, identify, and assess the impacts of dif-

Figure 3. LEARNING OBJECTIVES

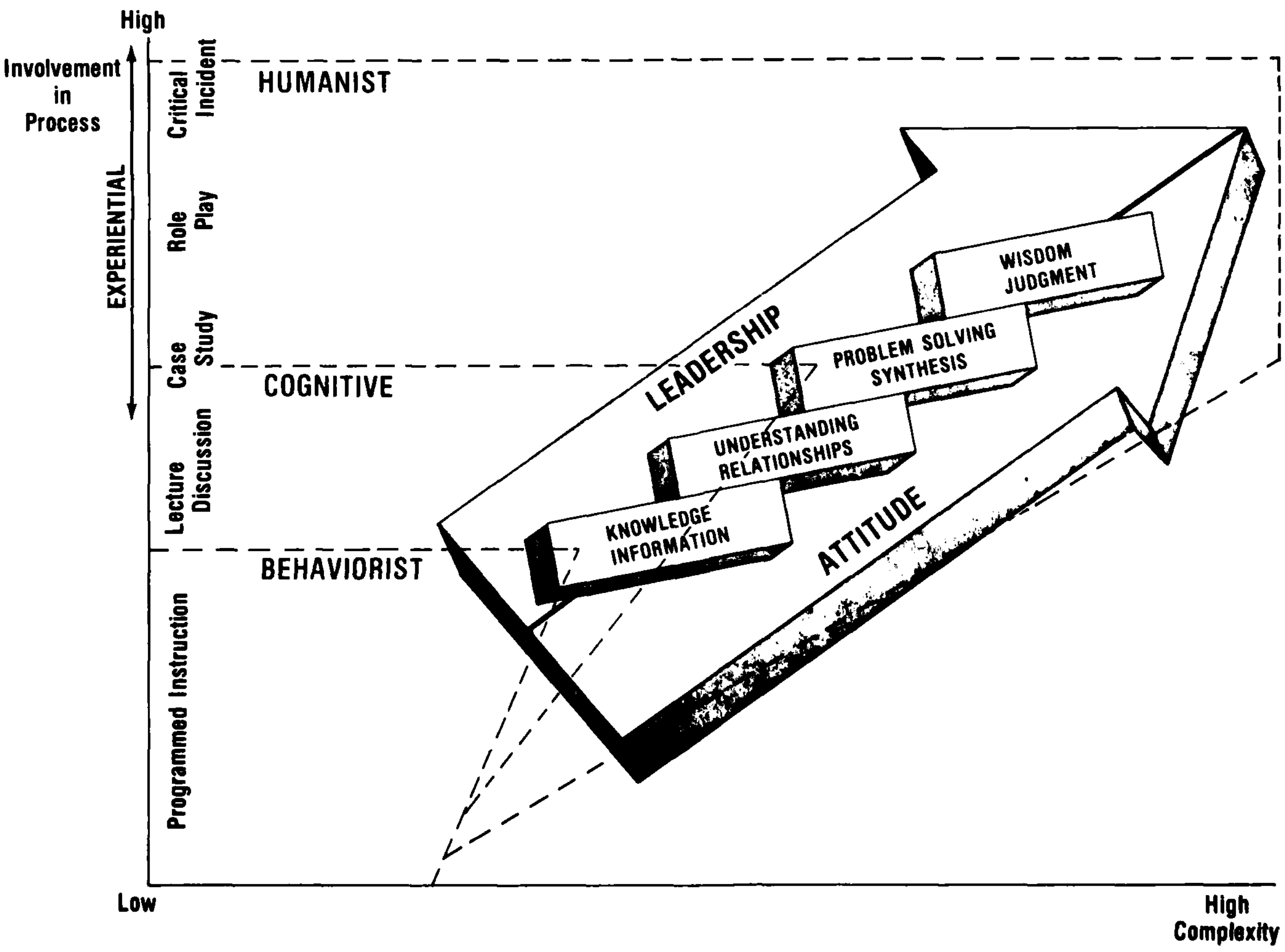
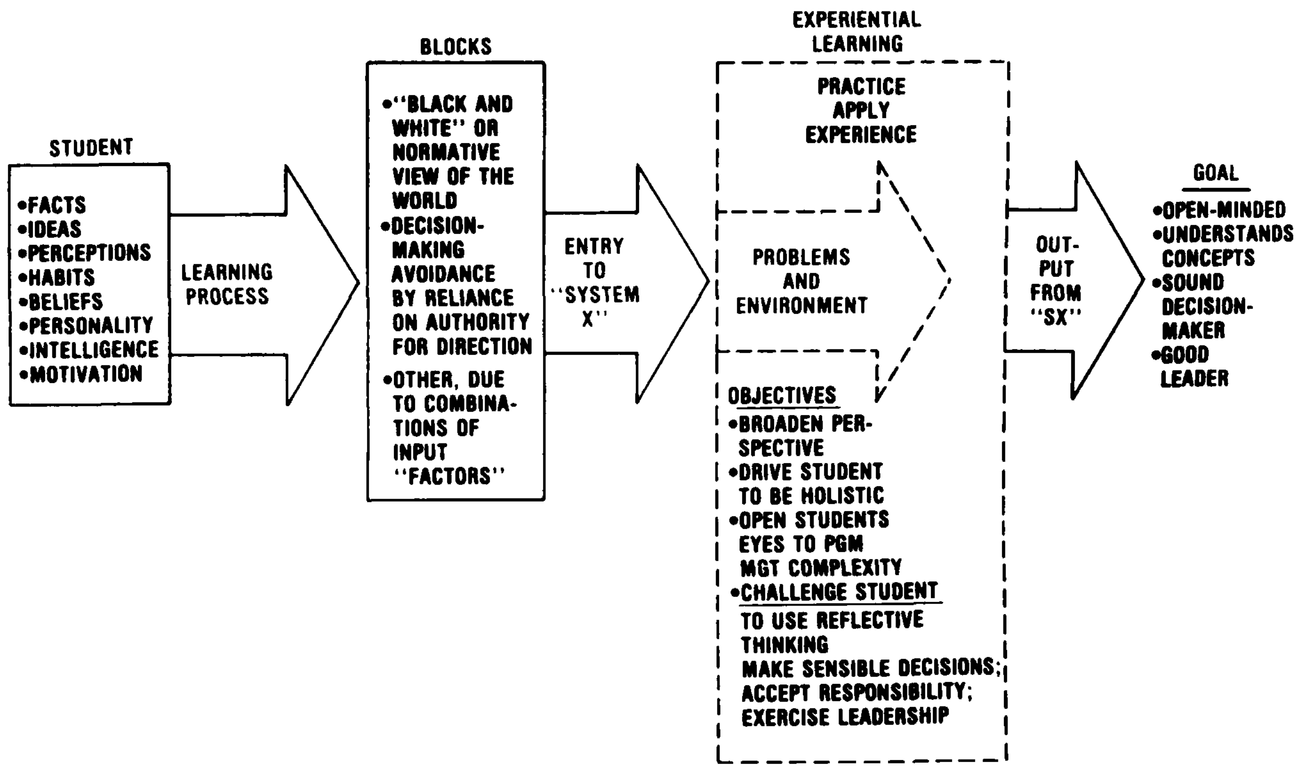


Figure 4. SYSTEM X APPLICATION IN AMLD



ferent interpersonal behaviors on their ability to accomplish each day's objectives. Each student can then give feedback to others about what they observed and can practice different interpersonal styles to discover what works best for them in varying situations.

So, armed with the process model, the interpersonal models, an exposure to learning theory, the guidance of a facilitator, and student leadership, the class learns through experiencing many elements of the acquisition process. In fact, the laboratory environment allows them to work with all phases of the acquisition life cycle.

How successful is it? I believe we achieve the objectives we set for ourselves. As with most things, there are some losses, but for the vast majority of students this experience is one of the most significant learning opportunities they have had. Some comments from our students support this:

—"I learned that program management is a lot more complex than I ever realized. You really opened up my perspective."

—"I'm going to facilitate my meetings back at the company."

—"I experienced the frustration of requirements changes. They're hard to stop, but we must learn to control them."

—"Before I came here, I was satisfied with being a GM-14. Now I have applied for a GM-15!"

—"I learned how difficult it is to achieve integration of work effort. I will put considerable emphasis on that in my next job."

—"I finally understand the relationship of requirement packages and appropriate tradeoffs within them."

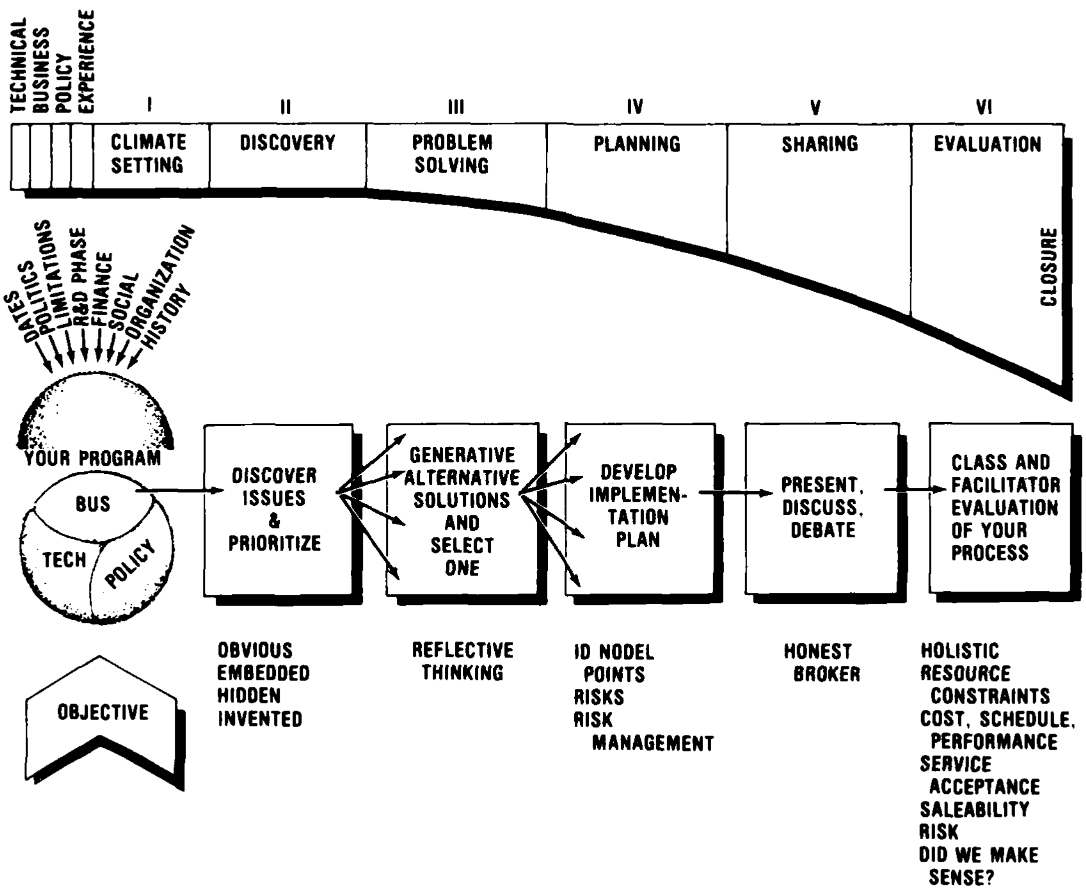
—"Now that I'm back at the company, I find every day is like another SX case. That was the most important part of the school for me."

One very experienced senior civilian, Mr. Michael Heffron, PMC 84-2, was particularly eloquent in a paper he wrote dealing with the transferability of the process to the program management offices in his command.

"In the DSMC environment, populated by military-government-industry personnel who are clearly within the institutionally accepted range of conservative dispositions, a 'happening' such as occurs in SX is a self-limited liberation that is focused on group goals, acknowledges group values (the rules of the game), and encourages individual forays into unexplored regions of thought and behavior in order to arrive at a mutually satisfying group consensus.

"Earlier I listed some of the positive attributes of the flower-child 'happening'—freedom, curiosity, participation, trust, innocence, and naivete. It is basically these same attributes, I believe, that have characterized our SX experience. We have permitted ourselves—and have been encouraged by our resident class authority figure, the instructor—to bring these attitudes and values to bear in a controlled and non-threatening environment in order to solve some very typical institutional problems. In an institution of risk averters whose prototypical value is commonly supposed to be Cro-Magnon machismo (can risk averters really be macho?), this has been a fascinating performance."

Figure 5. SFM—You Are the Program Advocate



Recent Advances in Experiential Learning at DSMC

Faculty research projects into experiential learning techniques coupled with experimental classroom exercises led to a trial series of more complex and longer-running classroom scenarios in PMC 85-1. Conceived by Lieutenant Colonel Eugene T. Gibson, USAF, a laboratory facilitator, these "combined cases" provided the opportunity to simulate a program office environment in the classroom. Higher-level learning objectives were more easily achieved—especially those related to interpersonal communication and organizational integration.

The 3-day event provided the opportunity to involve faculty of all departments as well as the senior executive service advisers to the college. With more time and a more complex scenario, the class was thrust into a very real pressure—and time-sensitive environment. Students had to confront the situation, organize themselves, determine what needed to be done, distribute the tasking, bring it all together in a package, and brief the senior people mentioned above.

The following is a representative selection from the majority of the student comments:

—Importance of planning and scheduling

—All aspects...must be brought together..cohesive program

—Interface early-on with supporting functions important

—The PMO could accomplish a great deal in short time

—Massive amount of specialties...communication among them needed

—How to work as a team

—Amazed how we could put whole program together

—Grind out organization, accomplish great things

—What planning, coordination, and documentation required MSI

—While still in CE had to know where we wanted to be at the end of D/V

—Need to identify critical issues, objectives, products, and prioritize

—Opportunity to see the whole picture

—Able to experience trying to pull it together

—Allow creative thought and massive exchange of ideas

—Could tackle a lot of problems at once

—First time we functioned as a group

—Worked toward common goal, pride of ownership

—Sense of purpose, when we decided what had to be done

—Latitude in attacking problems, developing solutions.

The comments reflect the immense variety and complexity of the problem students faced and the personal attitudes and interpersonal interactions they observed and practiced. These comments demonstrate our ability to achieve the high-level objectives necessary to graduate people ready to function constructively in the program office environment.

The Future for PMC

Insights gained through the experimental process in the laboratory will be a major resource in the ongoing design of PMC for the future. Known as "enhanced PMC," this new course structure will be in place for classes beginning in fiscal year 88. The college is committed to a major upgrade of the PMC and is investigating areas such as very sophisticated simulations, student programmed learning, electives, and advanced technology applications.

The Acquisition Management Laboratory will continue to provide an on-campus support base to the college for on-line experimentation and growth. The college as a whole continues to mature and adapt to the ever-changing acquisition environment. Powerful new educational technologies emerging from private sector laboratories, and the ever-increasing understanding of human behavior and performance are being invoked to meet the educational needs of the acquisition community.

Conclusion

The Defense Systems Management College is the right place to learn system acquisition. We bring together a unique system of instruction that produces well-rounded leaders prepared to function in the "real world" acquisition environment. In addition to business and technical management education, common to similar management training by other institutions, we include the necessary elements of public administration and political science. It is this eclectic package of specialties brought together synergistically as an educational system that makes DSMC unique. The consistent recruiting of our graduates by visiting program managers lends credence to this assertion. My personal observation of the confidence, skill, and attitude displayed by students at graduation has convinced me it is true. ■

■ Commander Fitzgerald is a professor in the Acquisition Management Laboratory at DSMC.

DSMC Professor Is Participant In Gantt Medal Award

Left to Right: Dr. Thomas R. Horton, President and Chief Executive Officer, American Management Association; Nathan Hurt, President, Goodyear Atomic Corporation, Member of the Gantt Board; Lewis W. Lehr, Chairman and Chief Executive Officer, 3M Company (Recipient of the Gantt Medal); David D. Acker, Professor of Management, DSMC, Member of the Gantt Board.

David D. Acker, professor of engineering management in the Department of Research and Information at DSMC, participated in the presentation of the Gantt Medal to Lewis W. Lehr, chairman and chief executive officer of 3M Company. The presentation was April 16 at the Fairmont Hotel, New Orleans, before almost 1,500 people.

Warren L. Serenbetz, chief executive officer of Interpool Limited, who succeeded Professor Acker as chairman of the Gantt Board, made the presentation.

The medal is awarded annually by the American Management Association and The American Society of Mechanical Engineers for "distinguished achievement in management as a service to the community." Established in 1929, it memorializes the accomplishments and great service to the community rendered by Gantt, a distinguished management engineer, industrial leader, and humanitarian. The Gantt concept was the result of over 30 years of his work as a mechanical engineer and management consultant in industry, advising industry, and stimulating production for national defense.

Today's Acquisition Strategy for Tomorrow's TOMCAT

CDR B.R. Sellers, SC, USN

Streamlining...Competition...Breakout...Fixed-Price Contracting...Baselining...Commonality...Concurrency...Pre-planned product improvement...Warranties...Program Stability...Risk Reduction...Synergism...

Sound like a scrambled hoard of acquisition buzzwords?

For Captain Bill Bowes and his program management team, and for Grumman Aerospace, the F-14D prime contractor, these are much more than buzzwords they are a way of life! The purpose of this article is to describe the manner in which these contemporary concepts have been integrated into an overall acquisition strategy for the full scale development and future production of the F-14D.

The ultimate goal of the acquisition strategy is to deliver, in 1990, the first of a new breed of TOMCAT—one

with vastly improved engines, an upgraded radar, and a digital avionics suite capable of handling advanced systems such as JTIDS (Joint Tactical Information Distribution Systems), AMRAAM (Advance Medium Range Air-to-Air Missile), IRST (Infrared Search and Track), ASPJ (Airborne Self-Protection Jammer), and others. From a technical standpoint the acquisition strategy must generate an air superiority fighter, unmatched by any other aircraft in the world at long range interdiction of enemy aircraft and missiles. From an operational standpoint, this advanced aircraft must be available to meet the projected threat of the 1990's and must retain its air superiority well into the twenty-first century. From a business standpoint, all this must be accomplished at minimum cost and at an acceptable level of risk for both the government and the many companies who will contribute their expertise to the development and production of tommorrow's TOMCAT. (It is important to note at the outset of this article that the Secretary of the Navy, while solidly supporting the F-14D program, placed a rigid funding cap on the cost of the full scale development effort—$750M for the contractor and $105M for Navy in-house costs [in 1984 dollars]).

The best way to portray such a complex and innovative acquisition strategy is to focus first on its four major components: streamlining, risk-reduction, program stability, and other techniques for containing and/or reducing costs. Within these major components, a variety of different techniques will be described which are being employed to minimize cost without jeopardizing performance or schedule.

Streamlining

Streamlining refers to a variety of actions designed to make the development program as quick and easy to execute as possible, while still meeting the technical requirement. Streamlining requires a dedicated team effort between the Government and the contractor to eliminate non-essential, time consuming, costly requirements from the contract.

In the case of the F-14D full scale development contract, steamlining involved several months of intense cooperative effort between Navy and Grumman personnel. Every aspect of the procurement, including the specification itself, the data requirements, the test plan, and the logistics support analysis, was reviewed and reduced to its absolutely essential elements. The most important aspects of streamlining each of these areas will be briefly described below.

—*Specification Streamling*. The objective of specification streamling was to identify and eliminate the "nice-to-have" elements of the specification and to include in the contract only those technical requirements which were truly essential to obtain the needed performance improvements. The most significant aspect of streamlining is the decision to perform a major upgrade to the existing F-14A airframe rather than develop a completely new aircraft. This approach decreased development costs dramatically, reduces risk, and results in faster introduction into service of total weapon system capability which offers sufficient performance improvements to successfully defeat the projected threat. The underlying philosophy was not only to retain the F-14A as the basic airframe, but to change it only where necessary to accomodate the specified engine, radar, and avionics improvements. Other, perhaps desirable, changes to the airframe were rejected based on affordability

—*Data Streamlining*. The data requirements were closely scrutinized and many reporting requirements were reduced in frequency or eliminated entirely. this data scrub is an ongoing effort which continues even today...more than a year after the contract was signed.

—*Test Plan Streamling*. The test plan received special attention in the overall streamlining effort. Manufacturing the test articles, conducting the tests, and collecting and analyzing the data from the tests represent a major portion of the cost of the full scale development phase of the program. Streamlining the test plan, while not creating unacceptable technical risk, was a high payoff effort. Results of this streamlining included, among other things, reduction of the number of flight test aircraft to four avionics/radar test aircraft with only one which includes the new GE F-110 engines, and limiting the application of full reliability development testing to those components and subsystems which had experienced a configuration change of 25 percent or greater.

—*Logistics Streamlining*. The streamlining concept was also applied to the requirement for logistics support analysis. Full logistics support analysis was required only for those components which were new or were modifications of existing components.

Risk Reduction

In order to realistically execute a program as complex as the F-14D within the schedule and funding constraints imposed by the Secretary of the Navy, risk reduction is an absolute necessity. Risk, of course, comes in different flavors. For example, there is technical risk, cost risk, and schedule risk. Significant efforts have been expended to deal with each of these types of risk as will be described below.

—*Technical Risk*. A number of different actions are being taken to minimize technical risk. First and perhaps foremost, is the risk-reducing influence of using systems that are common with other Navy and Air Force aircraft. This allows the TOMCAT to benefit from development efforts which are already underway, or which have been completed by other aircraft programs. Further benefit will be gained in the form of reduced production and logistics support costs as a result of this commonality. Virtually all the major systems in the F-14D have extensive commonality with other aircraft including the General Electric F110 Engines, now being procured for the Air Force F-16; the Hughes APG-71 radar, a sister of the APG-70 radar which is being developed by the Air Force for the F-15; and the JTIDS and ASPJ systems which are common among many aircraft. Other systems which are common with other Navy aircraft (F/A-18, AV-8B, A-6F) include AYK-14 computers, ALR-67 radar warning receiver, ASN-130 inertial navigation system, ARN-118 TACAN, ARC-182 radios, Multi Function Displays, and many others. In fact, the planned avionics WRA-level commonality with existing aircraft is greater than 80 percent.

A second strategy for dealing with technical risk is the concept of preplanned product improvement. This strategy uitilizes systems which meet the technical requirements with technology which is within the current state of the art. However, conscious allowance is made for the upgrading of the systems as new components or new technology becomes available. An example of this approach has been to provide a large excess computer processing throughput and memory to enable the easy integration of ongoing R&D efforts, such as sensor integration through artificial intelligence. Other methods for reducing technical risk, particularly in software development and maintenance, which contribute to the concept of pre-planned product improvement are the use of Navy Standard CMS-2 higher order programming language and military standard 1679 for software documentation. These requirements will facilitiate software update and new system integration with relative ease as new systems and software concepts come on-line in the future.

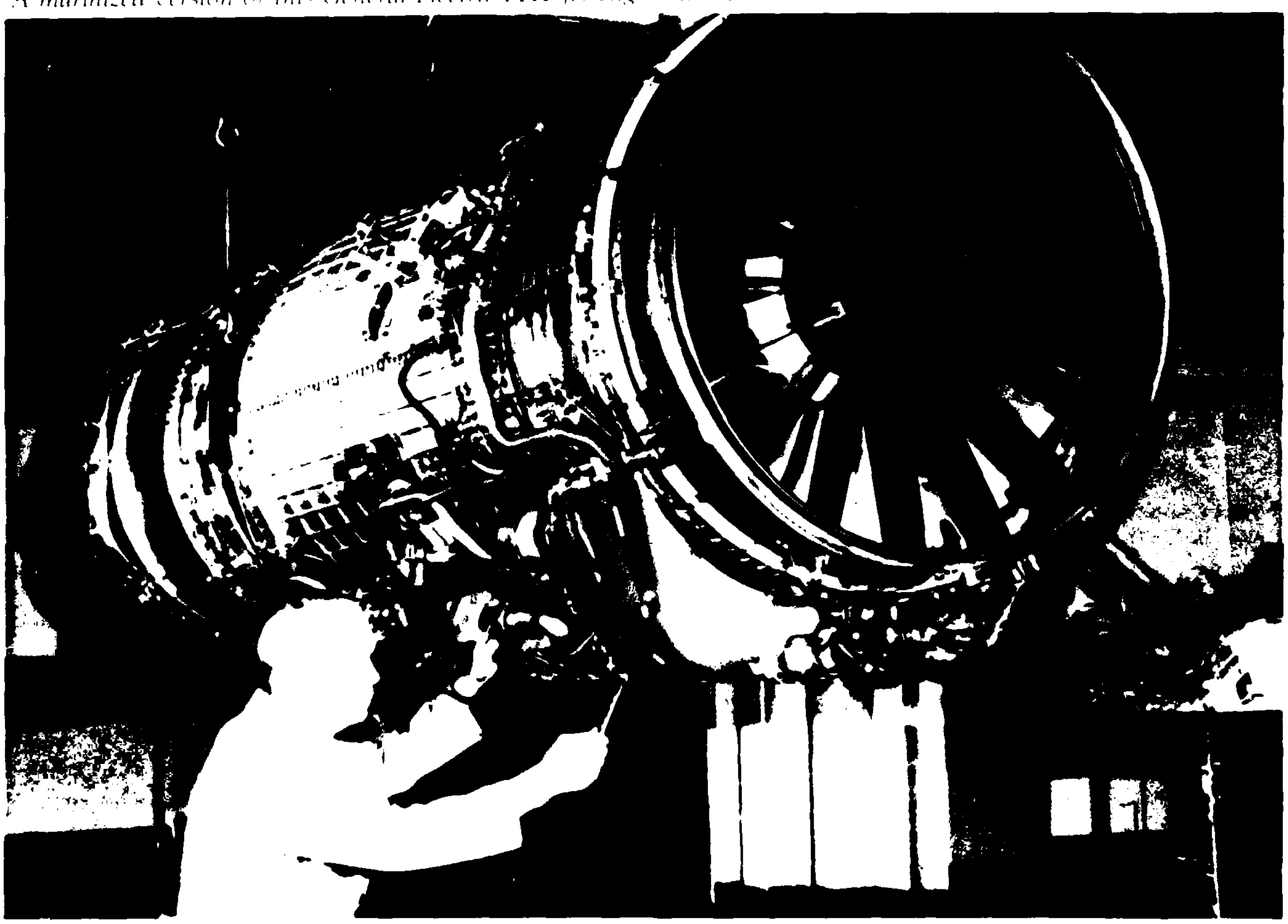
Among other technical risk reduction approaches is segregating the incorporation of the higher risk GFE system such as JTIDs, ASPJ, AMRAAM, and IRST so that delay or failure in any of these systems is an independent event. The remainder of the development program can proceed as planned.

—*Cost Risk*. Cost risk has been given special attention, particularly in light of the affordability constraint imposed by the Secretary. many of the techniques previously described such as commonality and pre-planned product improvement have the effect of controlling or minimizing cost risk. Of particular value in reducing cost risk is the use of a fixed-price (with economic price adjustment) type of contract. This contract includes the procurement and integration of the engines, radar, and a digital avionics system as well as the integration of all the GFE systems, and acceptance testing of the complete aircraft weapon system.

In addition to these methods of protecting against cost growth in the full-scale development effort, Grumman has been able to obtain not-to-exceed (NTE) prices from its subcontractors for production of all critical subsystems. These NTE prices are effective for 2 to 10 years of production, depending on the subsystem. Grumman has also given the Navy very attractive NTE prices for the FY-86 and FY-87 production of F-14A(PLUS)'s prior to the FY-88 commencement of F-14D production.

—*Schedule Risk*. In a program with a streamlined specification which is within the current state-of-the-art and with a fixed-price contract, schedule is the most vulnerable parameter. Certainly, the use of common and/or off-the-shelf systems helps to reduce schedule risk as does the risk reducing aspects of pre-planned product improvement. Nevertheless, schedule risk is still considered moderate to high. One technique for helping to stay on a tight schedule is the judicious use of concurrency. The F-14D program, because of the relatively low hardware technical risk, is beginning its pilot and limited production before full scale development has been completed. In addition, the Navy and Grumman will be conducting participatory test

A marinized version of this General Electric F110 jet engine will be used in the F-14D TOMCAT.



flights. Navy aircrews will fly in a minimum of 30 percent of all development flights, thereby decreasing the length of the total test program.

Other Cost Reduction Techniques

In addition to streamlining and various actions to reduce risk, the F-14D acquisition strategy includes a number of techniques aimed primarily at cost reduction. These techniques include an aggressive breakout program, innovative use of competition, and the synergism that comes from a large scale "block upgrade" program.

—*Breakout*. Thanks to the desire fo commonality and use of off-the shelf technology, the program office has had the opportunity to provide most of the avionics suite as GFE, thereby saving the additional layer of overhead and profit which would be charged if these items were provided by the prime contractor. In fact, there are more than 800 pieces of GFE being provided to Grumman for the full scale development contract. Many of these items are competitively procured, saving additional dollars in the process. Other items, such as the engine, which is currently CFE, will become GFE in the production phase.

—*Competition*. The prime contract for full scale development is, of course, sole source with Grumman, as will be the production of new F-14D's. Nevertheless, the benefits of competition are being pursued and successfully obtained in many aspects of the F-14 program. In fact, the F-14 program is a particularly interesting study in the various theories and applications of competition. The program is benefiting from "traditional" techniques such as technical data package, leader-follower, and contractor teaming on various GFE subsystems within the aircraft. In addition, however, the program has been particularly aggressive and successful in devising some "innovative" application of production competition. In several instances, without having to undertake the time and expense of establishing a second source, a genuinely competitive environment has been created between the current producer and a potential second source. Under the proper conditions; i.e., the existence of a credible potential competitor and a viable means of transferring the technology, the rewards have been significant.

—*Synergism*. Another cost reducing facet of the acquisition strategy is the simultaneous integration of several new avionics systems. Upcoming systems, such as JTIDS, ASPJ, and IRST would be far more costly to install and integrate into the weapon system if done one at a time. Incorporating them all simultaneously results in significant savings. This is the concept of block upgrades in action and on a grand scale.

Cost reduction techniques must be innovatively and judiciously employed.

Program Stability

Program Stability has long been recognized a key ingredient for program success and cost effectiveness. The best of acquisition strategies can be scuttled by budget cuts, program stretch-outs, and quantity reductions. Program stability was one of the principal thrusts of the Acquisition Improvement Program initiated by then Deputy Secretary of Defense Frank Carlucci in April, 1981. Program stability was also one of the six "Carlucci Initiatives" emphasized by Mr. Paul Thayer when he succeeded Mr. Carlucci.

A constant battle for any program manager is to chart an effective and efficient course through the troubled acquisition waters and then be allowed to follow it. Program stability is a combination of technical, schedule, and financial stability. This is not meant to imply that once an acquisition strategy is in place, no change can be tolerated. Necessary changes can be accomodated within the overall context of the strategy. Random, radical change, however, is devastating to an effective, integrated strategy.

The F-14 program in general, and the F-14D program in particular, has taken significant steps to achieve and maintain program stability. The F-14D FSD program is constructed around a technical baseline which is contained within a SECNAV-directed cost cap. Captain Bowes has made it clear to Navy and Grumman engineers that technical baseline changes which would break this cost cap will not be tolerated. Financial stability is a two-sided challenge: to ensure the contractor performs within the available funds and, from year-to-year, to ensure that funds are available to support the contractor's efforts. The first challenge was achieved by signing a fixed-price (with economic price adjustment) contract for the entire FSD effort with Grumman. The second challenge is truly a never-ending one. Until FSD is complete, the development effort is constantly vulnerable to the budget process because it is an incrementally funded research and development contract. the Secretary of the Navy has been firm in demanding that the capped budget of this fixed- price FSD program be protected from discretionary budget cuts. Schedule stability is largely a function of technical and financial stability. If these two can be managed by the program manager, then it is primarily the contractor's responsibility to manage the schedule risk.

Summary

Effective program management demands an acquisition strategy which begins with a streamlined requirements package. Risks—technical, cost, and schedule—must be analyzed and minimized. Cost reduction techniques must be innovatively and judiciously employed. And finally, this must all be accomplished in stable environment. Following these principles, Captain Bowes and his program management team have constructed and are executing a complex, integrated strategy utilizing the best of today's acquisition techniques to develop the best of tomorrow's air superiority fighter aircraft.

Will the program go exactly as they have planned it? Of course not. Will they be successful? Probably. Ask me again in 1990. ■

■ *Commander Sellers is the deputy program manager for business and financial management, R-14 program. He previously served as a professor of financial management in DSMC's School of Systems Acquisition Education Business Management Department.*

BOOK REVIEW

Quality, Reliability, and Process Improvement

By Norbert L. Enrick

New York: Industrial Press Inc., Eighth Edition, 1985, 397 pages

Whenever students encounter a textbook difficult to apply in their studies, there develops an alternate to clear the confusion. Where necessary, this book would certainly be such an alternative. Fortunately, it is widely used as a basic text and is acclaimed by teacher and student alike as evidenced by the demand for this eighth edition. The jacket quotes the *Journal of Quality Technology*—"His (Enrick) gamut of topics continues to make (the book) suggested reading for those preparing for Certified Quality Engineer(ASQC) examination. Certification hopefuls in particular will appreciate Enrick's extensive use of practical applications and the diversity of those included. "It may be hard to believe that a text can be effective for both the developing student *and* the certifying professional, but it is.

Naturally, the book is slanted toward the private sector of the economy (where by far the highest product value lies). But there are many modern concepts included which must be internalized in the defense system acquisition process. Quoting from the preface, "quality starts with the *conception of the product*, as represented by design and development, and ends with the *consumer* and his or her long-term satisfaction with the product....Today, the growing interest of consumers in long-term product performance guarantees and the critical needs of high technology products focus attention on the *time dimension of quality*, that is, reliability." Other examples include emphasis on an integrated quality system in chapter 1 and chapter 8 starts out with "Quality cannot be inspected into a product. It must be created as part of product design and built into the components during production."

This eighth edition retains its dedication to treatment of the basics augmented by interesting cases but has added four modern topics:
—error standard deviation
—quality and reliability experiments, additional applications
—quality and reliability experiments, using covariance analysis
—special methods for participative quality control activities

"...Today, the growing interest of consumers in long-term product performance guarantees and the critical needs of high technology products focus attention on the time dimension of quality, that is, reliability."

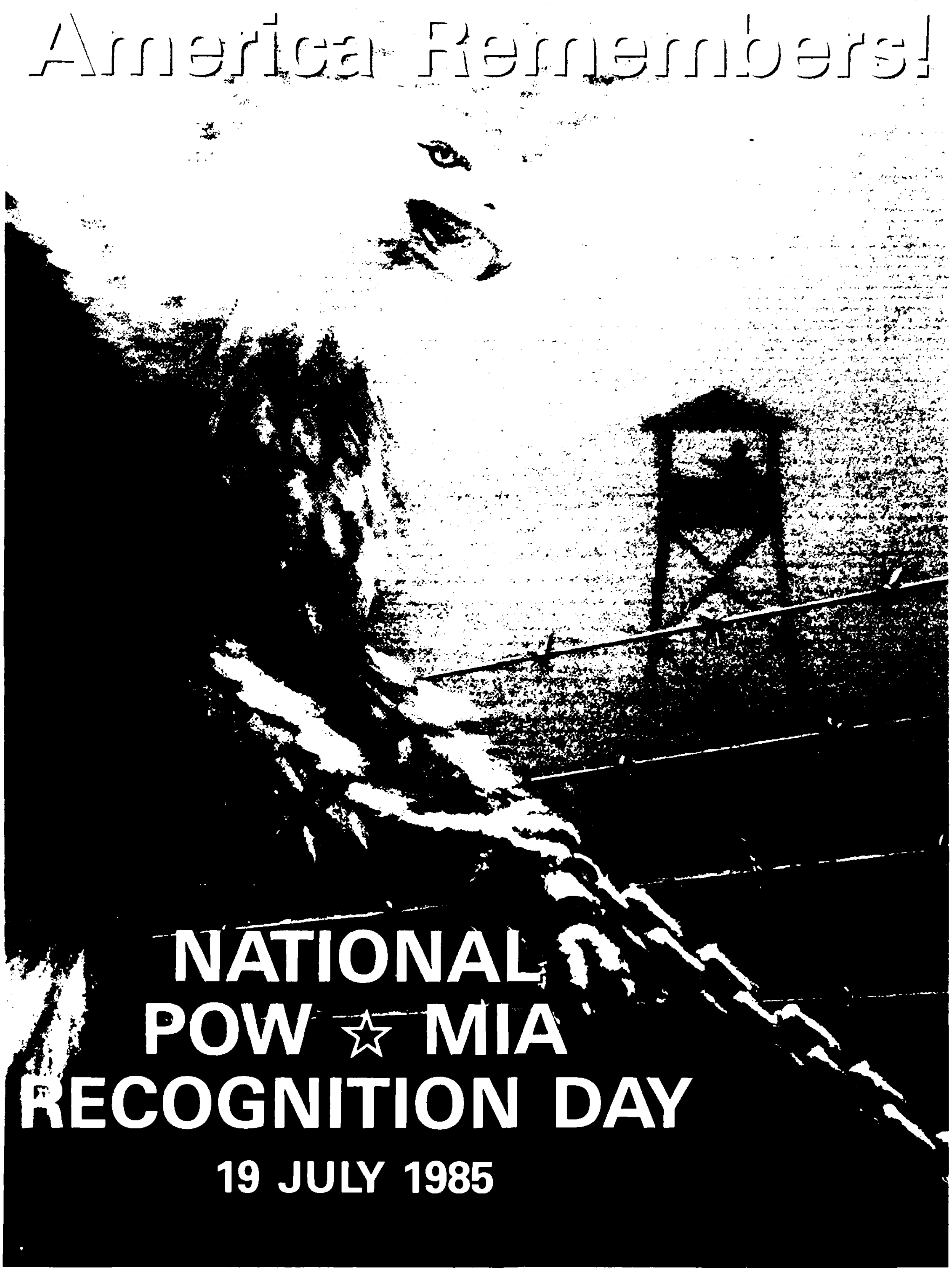
It is organized such that the practitioner can skip topics and pick up the desired thread of study. An example of the breadth of coverage comes from the Functional Table of Contents: Control of Quality (Sampling plans, control charts), Product and Process Improvement (Analysis and Design, Planned Experiments), Assurance of Reliability, Management Aspects.

But, as the opening of the second paragraph hinted, this is not a panacea for the Department of Defense (DOD) quality and reliability assurance practitioner. In fact, it may mislead the trainee regarding the policy, rigor and organizational emphasis required for DOD products, particularly in the chapters covering "when to institute a quality system" and organizational alternatives. And the new chapter on "participative quality control" is, at best, a cursory treatment of a broad and complex issue which reaches to the foundation of participative management and can have counterproductive effects if not properly done. If the DOD reader views the coverage in these areas as introductory and thought provoking then the concern will pass.

The hope for the future is that the ninth edition or some other text will integrate the beautiful simplicity and coverage of these complex topics with a DOD slant. the contractor is responsible for his products including vendor and subcontracted parts. This requires a rigorous paln to assure the necessary quality and reliability as well as an emphasis that engrains dedication to quality in the organizational fibre. And there are plenty of cases which can emphasize the successes of good quality programs and show the failures of bad ones.

But until such a text is generated, this is a very useful edition for teacher (aids are available), trainee, and practitioner when used in conjunction with current DOD policy and implementation training. ■

Wilbur Arnold


America Remembers!
NATIONAL
POW ☆ MIA
RECOGNITION DAY
19 JULY 1985

National P.O.W./M.I.A. Recognition Day, 1985

By the President of the United States of America

A Proclamation

Since the Revolutionary War, America's men and women have made unselfish sacrifices to defend freedom. In each of America's wars, America's prisoners of war have faced extraordinary hardships and overcome them through extraordinary sacrifices. The bravery, suffering, and profound devotion to duty of our P.O.W.s and M.I.A.s have earned them a preeminent place in the hearts of all Americans. Their heroism is a beacon to follow forever. Their spirit of hope and commitment to the defense of freedom reflects the basic tenets of our Nation.

This country deeply appreciates the pain and suffering endured by families whose fathers, sons, husbands, or brothers are today still missing or unaccounted for. These families are an example of the strength and patriotism of all Americans. We as a people are united in supporting efforts to return the captive, recover the missing, resolve the accounting, and relieve the suffering of the families who wait. We accept our continuing obligation to these missing servicemen. Until the P.O.W./M.I.A. issue is resolved, it will continue to be a matter of the highest national priority. As a symbol of this national commitment, the P.O.W./M.I.A. Flag will fly over the White House, the Departments of State and Defense, the Veterans' Administration, and the Vietnam Veterans Memorial on July 19, 1985, and over the Vietnam Veterans Memorial on Memorial Day and Veterans Day.

By Senate Joint Resolution 87, the Congress has designated July 19, 1985, as "National P.O.W./M.I.A. Recognition Day." On this day, we recognize the special debt all Americans owe to our fellow citizens who gave up their freedom in the service of our country; we owe no less to their families.

NOW, THEREFORE, I, RONALD REAGAN, President of the United States of America, do hereby proclaim Friday, July 19, 1985, as National P.O.W./M.I.A. Recognition Day. I call on all Americans to join in honoring all former American prisoners of war, those still missing, and their families who have endured and still suffer extraordinary sacrifices on behalf of this country. I also call upon State and local officials and private organizations to observe this day with appropriate ceremonies and activities.

IN WITNESS WHEREOF, I have hereunto set my hand this 27th day of June, in the year of our Lord nineteen hundred and eighty-five, and of the Independence of the United States of America the two hundred and ninth.

Ronald Reagan

AMERICA REMEMBERS

The POW MIA flag (L) flies with the flags of the United States, the United Nations, and State Flags during National POW MIA Recognition Day ceremonies at the Pentagon.

Twelve years have passed since the Paris Peace Accords were signed. Yet, almost 2500 Americans are still missing in Southeast Asia. Many believe that some of those missing are still alive and are being held in Southeast Asia against their will.

President Reagan is fully committed to resolving the POW MIA issue and has made it a matter of highest national priority. During his Memorial Day 1984 address at the interment of the Vietnam unknown, the President said, "One way to honor those who served or may still be serving in Vietnam is to gather here and rededicate ourselves to securing answers for the families of those missing in action...an end to America's involvement in Vietnam cannot come before we've achieved the fullest possible accounting for those missing in action."

The President and the Secretary of Defense have asked for support for officials' efforts and assistance in increasing awareness. Participation in active public awareness programs is one way we can all help achieve this accountability.

The President proclaimed July 19, 1985, as National POW MIA Recognition Day and Secretary of Defense Weinberger hosted a POW MIA Recognition Day ceremony at the Mall entrance of the Pentagon. The ceremony was attended by ex-prisoners of war and their families.

This supplement contains the presidential Proclamation and a copy of the National POW MIA Recognition Day poster. ■

YOU ARE NOT FORGOTTEN

AMERICANS MISSING IN INDOCHINA

2,464 AMERICAN SERVICEMEN AND CIVILIANS ARE STILL MISSING OR OTHERWISE UNACCOUNTED FOR IN SOUTHEAST ASIA!

THE UNITED STATES GOVERNMENT IS FULLY COMMITTED TO RESOLVING THIS ISSUE AS A MATTER OF THE HIGHEST NATIONAL PRIORITY!

WHILE THIS COMMITMENT IS TO OUR FELLOW SERVICEMEN AND CIVILIANS, THIS OBLIGATION ALSO EXTENDS TO THEIR FAMILIES.

* TO PURSUE VIGOROUSLY ALL REPORTS CONCERNING REPORTED SIGHTINGS OF AMERICANS WHO MAY STILL BE HELD CAPTIVE IN SOUTHEAST ASIA.

* TO WORK TO ACHIEVE THE FULLEST POSSIBLE ACCOUNTING OF ALL AMERICANS MISSING OR OTHERWISE UNACCOUNTED FOR IN SOUTHEAST ASIA.

* TO SEEK THE IMMEDIATE REPATRIATION OF ALL AMERICANS WHO HAVE DIED IN SOUTHEAST ASIA AND WHOSE REMAINS HAVE NOT BEEN RETURNED.

* TO MAKE EVERY RESPONSIBLE EFFORT TO SECURE THE FURTHER COOPERATION OF THE LAO PEOPLE'S DEMOCRATIC REPUBLIC AND THE SOCIALIST REPUBLIC OF VIETNAM IN RESOLVING THIS HUMANITARIAN ISSUE OF FUNDAMENTAL IMPORTANCE.

(LOGO) Artwork for the front cover was provided by the Veterans Administration, as produced on their National POW/MIA Recognition Day poster.

President Names Blue Ribbon Commission on *Defense Management*

David D. Acker

On July 15, 1985, President Ronald W. Reagan named 14 industrialists, retired miliary officers, former Pentagon officials and others close to the White House to a Blue Ribbon Commission on Defense Management. The executive order creating the commission was signed at Bethesda Naval Hospital. President Reagan indicated the decision to form the commission was based on discussions over several years with Secretary of Defense Caspar W. Weinberger and officials of the Office of Management and Budget.

The work of the commission will be based on some of the suggestions received by President Reagan from Representative William Dickinson of Alabama, the ranking Republican on the House Armed Services Committee. Dickinson met with the president on April 1, 1985, and twice afterward to express his thoughts on the formation and role of the commission.

In accordance with its charter, the commission will study issues surrounding defense management and organization, as well as policies and procedures. In the area of acquisition, the commission will review the procedures for developing and fielding defense systems and equipment incorporating new technologies in a timely fashion. In addition, the commission will study and make recommendations concerning congressional oversight and investigative procedures related to the Department of Defense (DOD). At the outset, the commission will devote its attention to the procedures and activities of the DOD associated with the procurement of defense systems and materiel.

The commission, composed of persons with extensive experience and national reputations in commerce and industry, as well as people with broad experience in government and national defense, is chaired by former Deputy Secretary of Defense David Packard, chairman of the board of Hewlett-Packard Company. Packard, who served from 1969 to 1971, "founded" the Defense Systems Management College on July 1971 and issued the DOD Directive 5000.1, "Acquisition of Major Defense Systems," on July 13, 1971.

David Packard

Members of the commission, which will be in place for a year, are:

Ernest Arbuckle, dean emeritus of Graduate School of Business, Stanford University.

General Robert H. Barrow, former Marine Corps commandant.

Nicholas F. Brady, former Republican senator from New Jersey and now chairman of Dillon Reed & Co., Inc.

Louis Wellington Cabot, chairman of the Cabot Corporation, who was chairman of the Federal Reserve Bank of Boston in the 1970s.

Frank C. Carlucci, chairman and chief executive officer of Sears World Trade, Inc., and the deputy defense secretary from 1981 to 1982, who initiated the defense acquisition improvement program, best known as the "Carlucci Initiatives."

William P. Clark, who was deputy secretary of state and, later, national security affairs advisor and interior secretary during President Reagan's first term. Clark is now counsel to the law firm of Rogers and Wells.

General Paul F. Gorman, former commander of the U.S. Southern Command, which covers Central and South America, and now vice president, Burdeshaw and Associates.

Carla Anderson Hills, secretary of Housing and Urban Development during the Ford Administration, and now a partner in the firm of Latham, Watkins & Hills.

Admiral James Holloway, former chief of naval operations, and now president of the Council of American Flagship Operators.

William J. Perry, former undersecretary of defense research and engineering, and now managing director of Hambrecht and Quist.

Charles J. Pilliad, Jr., a former chief executive officer of Goodyear Tire and Rubber Company.

General Brent Scowcroft, national security adviser to President Ford and chairman of of the Commission on Strategic Forces during President Reagan's first term, who is now vice chairman of Kissinger Associates, Inc.

Herbert Stein, former chairman of the President's Council of Economic Advisors, and now a senior fellow at the American Enterprise Institute.

Robert James Woolsey, a former defense and National Security Council analyst, who was undersecretary of the Navy during the Carter Administration and an advisor to the U.S. arms talks delegation.

In accepting the assignment as chairman of the commission, Packard recalled that he "...had to deal with the same problems when (he) was at the

Pentagon 15 years ago." He indicated that the exorbitant prices for spare parts, illegal charges, illegal payments, defense systems that don't work, and the growing evidence of problems that did not originate in the present administration have to be addressed. These problems are long-standing and the public would like to see them corrected. Mr. Packard added that there is also a need for more flexibility in defense contracts. One technique to obtain flexibility is to streamline the specifications called out in new contracts. This approach is being fostered by Deputy Secretary of Defense William H. Taft IV.

Senator Sam Nunn (Georgia), ranking Democrat on the Senate Armed Services Committee, when endorsing the appointment of Packard, said that some existing rules and regulations may have to be repealed and more flexibility may have to be given to Department of Defense procurement practices. Nunn added that, although the blue-ribbon commission has been formed, he would continue to press for reorganization of the military command system structure and the Joint Chiefs.

In the Congress, four committees formerly had jurisdiction over the Department of Defense. Today, according to President Reagan's principal deputy press secretary, Larry Speakes, "There are about 24 committees and subcommittees that the Defense Department has to deal with." The Department of Defense is interested in streamlining its organization and the acquisition of defense systems.

During 1986, the commission will review the adequacy of oversight by the secretary of defense and the decision-making structure within the Office of the Secretary of Defense (OSD). The organization of the Joint Chiefs of Staff, and the unified and specified command system will be investigated. Procedures for developing and fielding military systems that incorporate new technologies will be reviewed. Finally, the commission will study the Senate and House oversight and investigation of the OSD, and, based on the findings, recommend methods to stabilize defense system program funding.

Recommendations of the commission for improving DOD procurement will be submitted to the president and the secreatry of defense by December 31, 1985. An interim report on the non-procurement aspects of the study will be presented to the president by the end of March 1986, and the final report will be submitted by the end of June.

Mr. Packard is appointing a professional and administrative staff to support the commission. The staff will be directed by Rhett B. Dawson from the law firm of Dickstein, Shapiro and Morin, Washington, D.C., former staff director and chief counsel of the Committee on Armed Services, U.S. Senate. ■

■ *Mr. Acker is a professor of engineering management at the Defense Systems Management College.*

Strategic Defense Initiative

(Continued from page 10)

sensors, directed energy weapons, kinetic energy weapons and support technology. Each of these offices is directed by a senior executive service civilian or a senior military officer.

The Strategic Defense Initiative Organization also includes unique groups such as an innovative Science and Technology Office providing interface and funding to small businesses and universities. The proposed funding in this area is $100 million in FY 1986.

To provide the streamline management to execute the program, each of the services has a direct reporting organization. The Army Ballistic Missile Defense (BMD) Organization has for years served as the Army focal point for ballistic missile defense with the commander, Maj. Gen. Gene Fox, reporting directly to the Office of the Chief of Staff of the Army.

Under General Fox, two major organizations execute the technical program. The first, the Ballistic Missile Defense Systems Command, conducts the system-level work, with emphasis on the major experiments like the airborne optical adjunct and endo- and exoatmospheric non-nuclear interceptors. The second major organization, the BMD Advanced Technology Center, directs technology thrusts in areas like optics, data processing, radar, directed energy and discrimination.

The Air Force did not already have such a streamlined management system in place. Therefore, to provide a direct link among General Abrahamson's SDIO and the executing Air Force laboratories and product divisions, a special assistant for SDI was created. As that special assistant, I not only work as a member of the Air Staff but as a member of the Air Force Systems Command. I can thus interface with General Abrahamson under my Air Staff hat and with the Air Force field organizations under my Systems Command hat. The process is working very well and allowing very rapid direction and execution of Air Force technology. The Air Force product divisions are responsible for executing the major space experiments to demonstrate technology integration for system concepts such as the boost and space surveillance and tracking systems, and the space-based kinetic kill vehicles. The Air Force laboratories and technology centers execute the basic supporting technology efforts such as optics, focal planes, cryocoolers, directed energy devices and many others.

I have just discussed the "why, what and how" of the Strategic Defense Initiative. Let me conclude by returning to the origin of the program.

SDIs Original Goal Continues

The goal for the Strategic Defense Initiative was eloquently established by President Reagan in March 1983, when he challenged all of us in the scientific community to create a means for rendering ballistic missiles impotent and obsolete. The goal of the Strategic Defense Initiative has not changed at all since the president's March 1983 speech, even though the understanding of that goal by the program's opponents may have changed. The president's original goal still drives this research and technology program, with the need for the United States "to get started now" as he stated in his State of the Union Address. ■

A Step to Production

Henry J. Winkler

"Perhaps the most often discussed aspect of the acquisition process in the Department of Defense (DOD) is the length of time it takes to develop and field weapons system...although the long acquisition cycle is certainly not a desirable situation, it might be tolerable if the process yielded satisfactory results."[1]

The traditional defense system acquisition cycle is separated into clearly defined phases set apart by key milestones as outlined in Figure 1. These phases are conceptual validation/demonstration, full-scale development, and production. This phasing approach is designed for evolutionary risk reduction, which is accompanied by a decrease in engineering changes and, ultimately, a frozen design baseline that has been qualified. Each phase has detailed objectives that are manifested by completion of predefined tasks. Typically, completion of these tasks initiates a review process and a decision for continuation or stoppage. This entire process has an overall goal of fielding a production end-item at a needed time. This is referred to as providing the initial operating capability (IOC).

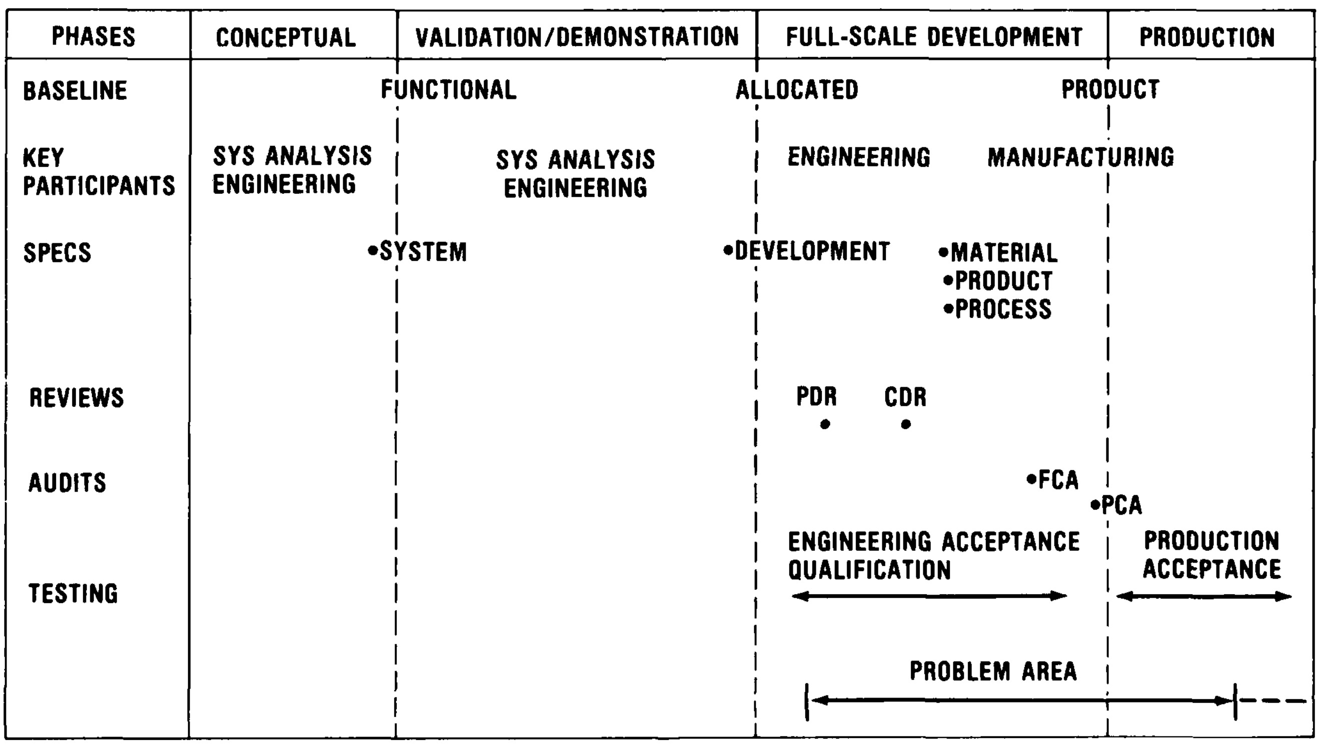
Although this process seems thorough, Willoughby suggests it is lacking, and most contractors would agree. Careful examination of the acquisition cycle reveals that phase-goals are sets of tasks with only peripheral relationships among phases. Each phase is viewed as an end to itself. The ultimate end-item, fielding a system, is hidden from one's immediate objectives.

In addition, rotation of government program managers and supporting casts tends to reinforce a short-term view. This means production is viewed as "always in the future" and that each new program manager works *his* tasks on *his* watch. New ideas, changes in procedures, direction, and planning are a way of life for both government and contractor program offices.

A Major Problem

The full-scale development (FSD) programs focus on meeting specifications; i.e., performance parameters in development, qualification, acceptance, and operation tests are measured against specification requirements. "Meet the numbers" is the goal. Manufacturers in FSD would like to focus on producibility and testabili-

Figure 1. Acquisition Cycle



ty; however, they usually are invited to participate in the process at the production request-for-proposal. Even the government focuses upon engineering development, as witnessed by their staffing. While not totally ignoring production, they certainly are not motivated and do not aggressively apply or listen to the appropriate disciplines. Clearly, both government and contractor production manufacturing personnel are second-class citizens during FSD.

In defense electronics, we are building very complex hardware—clipboards, flashlights, boots, and pencils are not the products. Although some hardware is not advancing the state of the art, it most assuredly is at the cutting edge. This poses new and different production problems. Rate, schedule, cost, quality, and reliability are certainly the major concerns.

During FSD there is usually a limited amount of hardware built. The hardware quantity is tied directly to the need to support *testing*. To meet development schedules, this hardware is usually built by engineering in either quick-reaction laboratories or specialty shops. Testing is then conducted and completed on this *engineering built hardware*. In doing this the "tweeking" or "make it work" syndrome frequently overshadows the true ability to repetitively build the hardware in a factory, or even ascertain the relationship of manufacturing process upon performance.

So now it's tested. It passed with the usual set of needs: with jumper wires, cuts in etch, and so on. Changes in the design at this point have been confined to completing the invention. Marginal attention has been given to the key producibility and testability issues. At best, a paper production readiness exercise was required. Manufacturing must now produce it.

Clearly, the traditional acquisition approach does not always result in a producible design. "In the acquisition process, first evidence of weapon system problems usually becomes apparent when a program transitions from full-scale development into production. This transition is erroneously thought to be a discrete event in time."[2]

It is certain that the present process is such that without forcing a consideration for production during FSD, a positive change will not occur. Somewhere in the acquisition cycle a proof-of-manufacturing must be injected. Sensitivity to more than meeting specification numbers dramatically increases with the demand to prove that it can be produced.

A Suggested Approach

The existing acquisition approach with minor modifications could achieve significantly improved production results. However, to obtain improved results for both schedule and product it is imperative to inject quantitative milestones into the process. The full-scale development phase requires a subtle but expanding change to remove the embedded "development engineering only" thought process. The FSD phase must include both an engineering development cycle and a manufacturing preproduction (design maturation) cycle. Pictorically, this is modeled in Figure 2. This change shifts the emphasis from specifications only to both specifications and producibility. Engineering must now be conscious of production as well as development. Unfortunately, however, this is only a conceptual change.

Normally, a functional configuration audit (FCA) and a physical configuration audit (PCA) are conducted near the conclusion of the FSD phase. These reviews serve to establish the production baseline. In accordance with MIL-STD-1521, "The Physical Configuration Audit (PCA) shall be the formal examination of the as-built version of a configuration item against its technical documentation in order to establish the Configuration Items product baseline." The objective of the FCA shall be to verify that the configuration items actual performance complies with its Part I development specification. If the audits are successfully completed, which means that all specification requirements are either met or officially modified and the drawings and hardware match, the design is transferred to production, and the FSD phase ends.

The PCA and the FCA are the quantitative milestones that drive discipline into the FSD phase. The two-cycle FSD approach noted previously would have a full FCA with a delta PCA at the engineering cycle conclusion, and a full PCA with a delta FCA at the preproduction cycle conclusion, which imposes quantitative milestones in each cycle. Such quantitative measures, which require revelation and proof of drawings matching hardware items, and measured performance meeting specified values, will assist in moving toward a matured production baseline. In addition, this approach results in proof of design and proof of manufacturing hardware being produced and evaluated.

Obviously there are risks in this approach, but the payoff for future production is enormous. To achieve a relatively smooth and efficient POD to POM transition a commitment to material procurements must be made at an early time. However, "if timed properly," the expenditure and percentage of scrap can be minimized. More importantly, specifications, drawings, planning, processes, procedures and the like will be given that critical review so necessary to move smartly into production. Furthermore, a significant change will result in the contractor's and government's process of hardware development evolution. Table 1 projects changes that must evolve if the government utilizes logical measured milestones, such as PCA and FCA, and the contractor expects to complete a successful FSD phase, which means moving efficiently to full-production go ahead. However, recognize that to be effective the POM must be produced in the true production facility; at worst, in a half-way house which is a complete but reduced copy of the full manufacturing facilities.

Summary

Validation demonstration managers demonstrate the concept's feasibility; the full-scale development managers must demonstrate that the practical solution meets specification numbers and requirements; the production manager must efficiently clone the approved solution. Although the FSD is to be the entry to production, neither skills, monies, tasks, nor milestones support a meaningful production introduction. In fact, the design is usually perceived by the manufacturer as having been thrown over the wall by engineering. Yet, FSD has met its objectives. There is a design; it is tested, and it is documented. Can it be built?

■ *Mr. Winkler, a graduate of PMC 78-1, is associated with Hughes Aircraft Company, Fullerton, Calif.*

Important keys to achieving "satisfactory results" in production lie in adherence to an approach, which removes barriers among acquisition phases and imposes a true manufacturing build during FSD. Only through an actual factory build can the FSD design be matured to a satisfactory production baseline. The PCAs and FCAs are referred to as "fessup reviews." A PCA on the *factory build* hardware prior to FSD completion can serve as a forcing function to smooth the transition between engineering and production.■

Notes

1. "Solving the Risk Equation in Transitioning from Development to Production," Defense Science Task Force on Transitioning from Development to Production, May 25, 1983. p.3.

2. Ibid, p. 3.

3. Dr. David Weimer, CMC, Management Consultant

Figure 2. A Different Full-Scale Development Phase

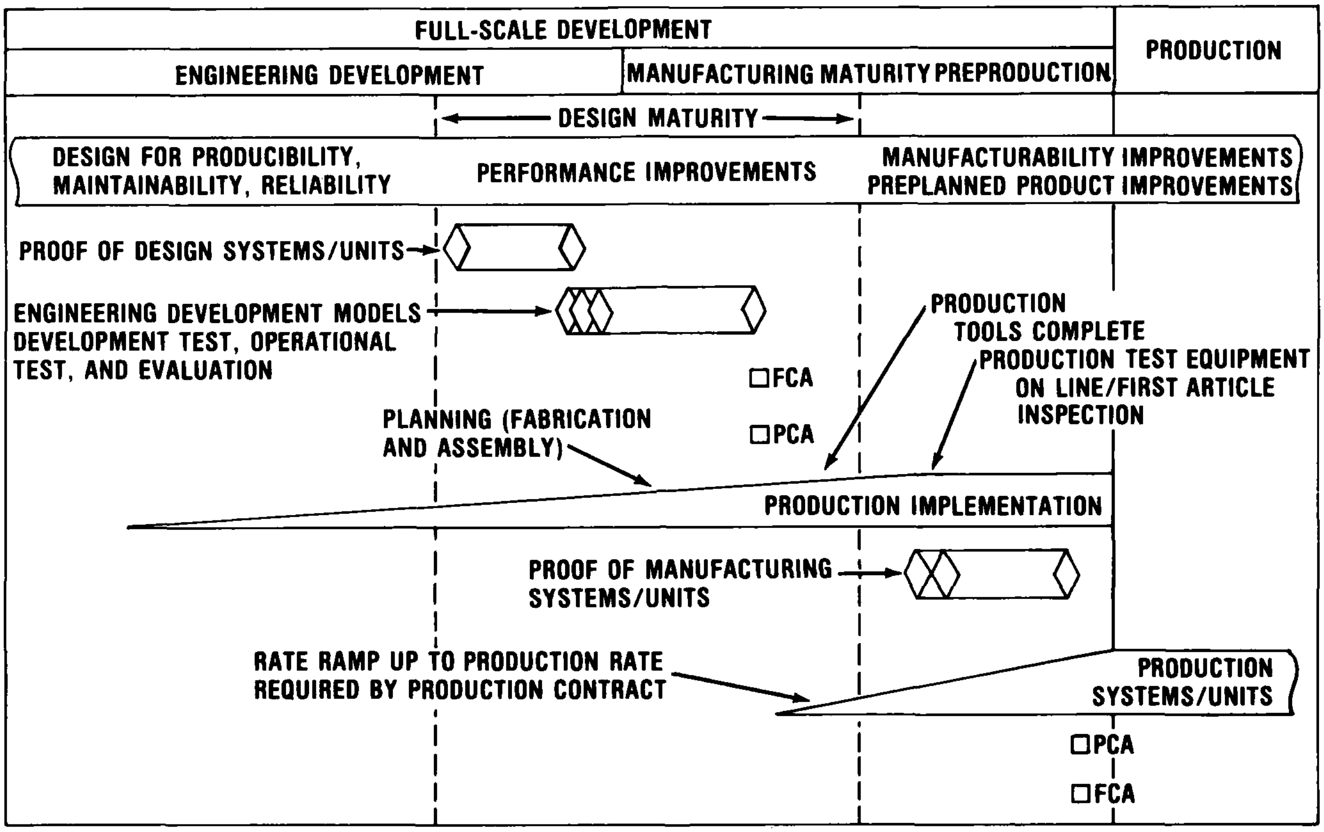


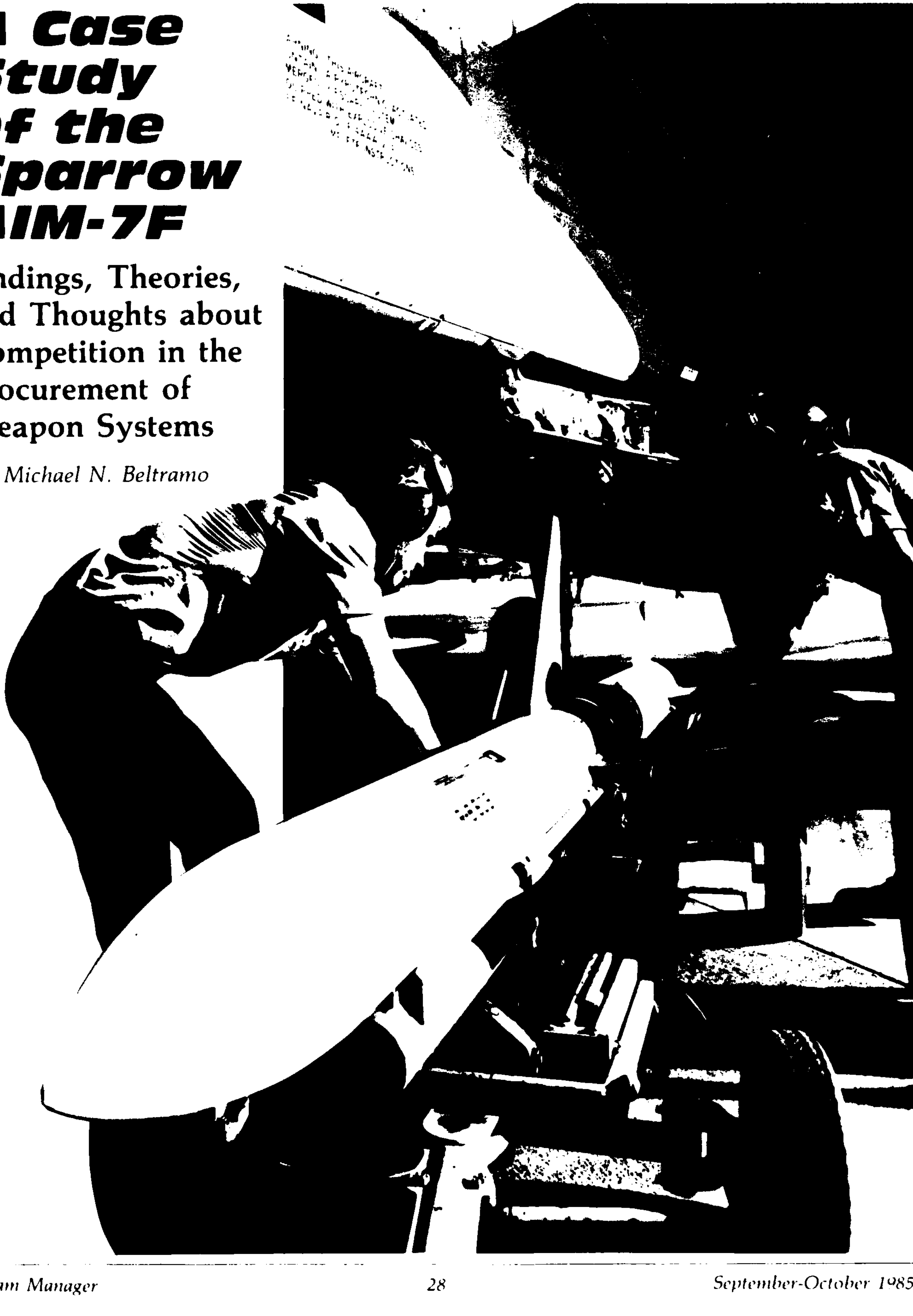
Table 1. Production Developers Approach[3]

SUCCESSFUL	UNSUCCESSFUL
1) Designers design to standards set by manufacturing engineering.	1) Designers design to engineering standards
2) Production engineering "signs off" drawings.	2) Production engineering is not a design participant.
3) Management focuses on "How much will it cost to produce?"	3) Management focuses on "will it perform?"
4) A "Pilot" production line is used for matured FSD units to "Get the bugs out."	4) FSD nevers matures as engineering discipline, is not exercised to complete the design and prove the design early in FSD.
5) Production entry is the culmination of a carefully planned process for profit maximation—with only "unkown unkowns" being worked late in FSD.	5) Production gets the result of the above process to "Do its best."

A Case Study of the Sparrow AIM-7F

Findings, Theories, and Thoughts about Competition in the Procurement of Weapon Systems

Dr. Michael N. Beltramo



Free, competitive markets are widely recognized and acknowledged as the cornerstone of our great society. At the same time, there is disagreement regarding whether, and how much, government involvement in the regulation of certain aspects of our economy is desirable. The government has recently taken major steps to deregulate two important sectors: the telephone system and the airlines. These actions have received decidedly mixed short-term reviews and whether they will be viewed positively over the long run is difficult to say.

Some government officials who have embraced competition as a panacea are now attempting to expand its application in the procurement of weapon systems as they believe that it will lead to less expensive products of higher quality. Their intent is commandable. However, in their eagerness to embrace competition many have not made an effort to understand how it might be effectively applied within the confines of the defense marketplace. Also, they have failed to differentiate among the general types of competition available and to determine circumstances under which each would be likely to yield the desired outcomes.

A good example of this tendency to view competition through rose-colored glasses is illustrated by the following remarks made by a senior defense official advocating to increase the use of competition in procurements: "As for aerospace, fewer than half the number of commercial aircraft delivered last year were delivered this year—the fourth straight year of decline. We cannot see any substantial revivals of commercials business...in the near future. It is clear that defense programs will sustain a large segment of...[aerospace] for the rest of the decade...."

It is indeed ironic that the official did not mention the role that deregulating the airlines played in reducing the capital available for fleet modernization and, thereby, in significantly contributing to the decline of commercial aircraft business. The point is simply that government-imposed changes to an existing market structure may have major unintended effects. Therefore, actions in this area should be based upon comprehensive and well-founded analyses to avoid unplanned outcomes.

This paper considers the effects of the two general types of competition available to DOD—*winner take all and split buy*—on cost. The methodology used to estimate these effects is described. A case study of the Sparrow AIM-7F program is given special attention because it underscores many issues regarding competition that cannot readily be resolved by quantitative analysis. Finally, I make general remarks to highlight some of the core issues related to understanding the defense marketplace and how it might be affected by increased competition.

"....government-imposed changes to an existing market structure may have major unintended effects"

The Bottom Lines

Since many decision-makers want a simple, direct answer to the question of whether or not competition should be established for a production program, one will be provided. Yes, if the program is amenable to annual winner-take-all competitions without long lead-time and high start-up costs. The data to support this answer are presented in Table 1 and are essentially unambiguous. However, if it is necessary to establish and qualify a second source and to maintain two contractors in production simultaneously in order to hold annual competitions, then no easy answer can be given. As shown in Table 2, competitive split buys have apparently resulted in both higher and lower recurring production costs than would have been experienced under sole-source production. (Since added non-recurring costs were usually incurred in the establishment of second sources even programs for which recurring production savings are indicated may have been more expensive overall.)

Analytical Methodology

The main issue in measuring added costs or savings resulting from competition during recurring production is: "Compared to what?" Obviously, once competition has been introduced into a program, the recurring production costs of a sole source must be estimated rather than measured. Costs tend to decrease for successive units produced due to learning. Thus, if a learning curve has been established by the initial source, then the cost for producing various quantities may be estimated. To establish a sole-source learning curve, cost (in constant year dollars) and quantity data for at least two non-competitive buys are required.

Once a sole-source learning curve has been established, the effects of competition may be estimated. If the government's actual cost for the competitive quantities is above the cost estimated for a sole source, an added cost is assessed to competition; if its actual cost is below the estimated cost, a savings is credited to competition. This methodology is depicted in Figure 1.

The application of this simple methodology for estimating the effect of competition on recurring production cost allows comparable estimates to be made for several cases. Of course, it also has the disadvantage of suppressing collective program peculiarities which should be of interest to the decision-maker. For example, it was observed that the final sole-source purchase was often above or below the calculated learning curve. A final sole-source point below the calculated learning curve could indicate that the firm was improving its efficiency as a reaction to the impending competition. A final sole-source point above the cost, calculated learning curve could mean that it was taking advantage of its sole-source position and maximizing profit while still able to do so. Of course, assumptions regarding the reason for the location of the final sole-source point would be speculative. Nonetheless, it does not seem reasonable to assume that a sole-source buy would be more expensive

■ *Dr. Beltramo is president of Beltramo and Associates, Los Angeles, California.*

Table 1. SELECTED COST/QUANTITY DATA FOR WINNER-TAKE-ALL COMPETITIONS

System	Total Quantity	CAC ($FY72)	Percent Savings or (Added Cost): First Lot Competed	Percent Savings or (Added Cost): Total Program	Percent Savings or (Added Cost): % Savings/ % Competed
MK48 Torpedo (warhead)*	1,032	9,717	54.3	23.7	50.9
MK38 Torpedo (elec. assy.)	1,034	12,603	37.5	11.6	24.9
Standard Missile	5,927	51,999	(13.9)	(2.4)	(2.9)
Hawk Missile (motor parts)*	14,498	1,534	33.4	19.9	46.7
TD-660 Multiplexer*	3,593	9,141	35.4	14.2	35.9
AN/GRC-103 Radio Relay	963	28,863	59.1	11.9	53.8
APX-72 Airborne Transponder[6]	27,529	3,014	32.5	9.4 or (1.6)	28.4 or (3.1)
SPA Radar Indicator*	2,011	8,919	25.3	14.2	75.1
TD-352 Multiplexer	3,741	7,399	58.1	36.0	58.0
TD-204 Cable Combiner*	8,733	3,430	56.2	35.5	51.2
CV-1548 Converter	11,583	3,088	63.9	40.2	61.0
TD-202 Radio Combiner*	3,692	3,258	58.1	36.5	51.1
Aerno 60-6042 Ele. Cont. Amp.	666	7,326	53.2	8.5	43.1
MD-522 Modulator-Demod.	4,805	3,112	61.4	25.9	55.0
AN/PRC-77 Manpack Radio	143,347	708	32.2	25.2	29.2
FGC-20 Teletype Set[7]	1,980	2,091	32.6	4.0	28.8
Aerno 42-2028 Generator	1,679	645	10.7	7.3	19.0
Aerno 42-0750 Voltage Reg.	2,175	110	48.6	29.9	58.1
Average			41.1	19.5	42.6

*Last sole source buy significantly below learning curve slope.
Commonality between 7859 and 7859A is at issue: if common, total savings; if not, total loss.
Last sole source buy significantly above learning curve slope.

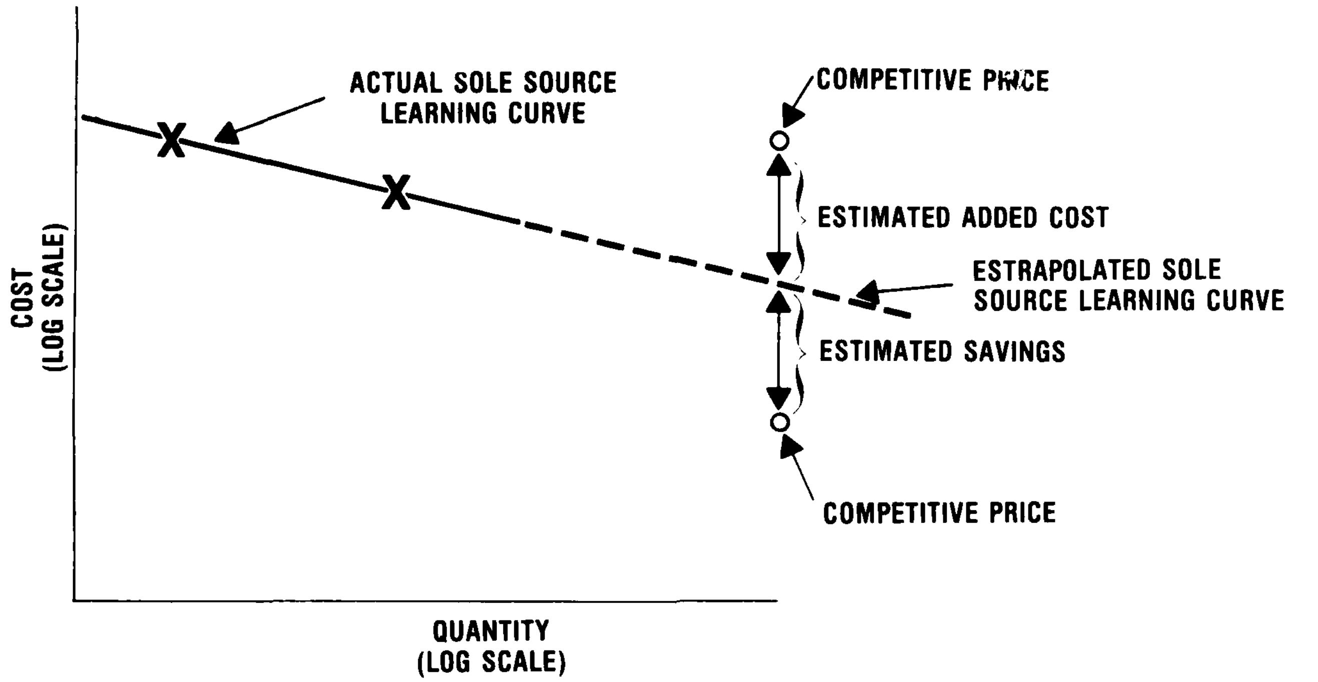
Table 2. SELECTED COST/QUANTITY DATA FOR COMPETITIVE SPLIT-BUYS

Item	Competitive Split-Buy % savings or (Cost)*	CAD 10,000 $FY72 (000)[6]	Initial Sole Soucre Learning Curve Slope %	Initial Source Pre-Competition	Quantities Second Source Education	Competitive Split-Buy
Bullpup Missile G&C	25.8	7.6	82.0	10,895	0	30.575
TOW	22.6	5.6	97.7	18,250	2,885	10,500
Rockeye Bomb	3.7	4.3	83.9	53,913	0	72,558
Shillelagh Missile	(6.3)	7.1	76.3	17,945	4,960	29,386
Sparrow AIM-7F G&C	(20.5)	46.7	75.6	1,805	295	7,124
Sidewiinder AIM-9D/G G&C	(22.0)	3.8	86.4	425	0	2,770
MK46 Torpedo Airframe & G&C	(36.4)	28.9	81.8	1,650	0	7,298

*Actual competitive split-buy costs divided by extrapolation of initial sole source learning curve for competitive split-buy quantity.

[6]Estimated based on initial source cummulative average cost (CAC) equation for comparability.

Figure 1. METHODOLOGY FOR ESTIMATING EFFECT OF COMPETITION ON PRICE



per unit than the immediately preceding one, yet that assumption is implicit in many of the reported cases.

Specifically, of 40 cases considered, 25 were suitable for analysis in that competition was actually implemented following two or more sole- source procurements and complete cost/quantity data were available. Of these cases, which are represented in Tables 1 and 2, five had only two sole-source procurements so that the final purchase was on the learning curve by definition. Thus, for the cases where more than two sole-source procurements had been held, the final sole-source lot unit cost was above the learning curve in six cases and below it in 12 cases. When it was above the curve, it was usually considerably so. If it is assumed that the final sole-source buy would be more significant than the earlier buys in estimating the cost of the next sole source buy, then savings were over-estimated on the average. Arbitrarily weighting a particular data point is not statistically acceptable and, while a preferred alternative to the method of extrapolating a sole-source learning curve in order to estimate its future cost performance has not been identified, the potential pitfalls inherent in this methodology are acknowledged.

Perhaps even more significant is the tendency of any methodology that looks at the results in the aggregate to conceal unique characterisitics of individual programs. For example, although the procurements of the Rockeye Bomb and Shillelagh Missile have been labeled "competitive," the data indicate that in both cases the higher cost producer received the larger split-buy quantity. Thus, competition for those items may have been more apparent than real. To provide a more in-depth look at the problems inherent in obtaining fully satisfactory results when applying a simple methodology, a single program, the Sparrow AIM-7F, is considered below in greater detail.

Sparrow AIM-7F: A Case Study

The Sparrow AIM-7F is one of the several versions of the Sparrow Missile designed by Raytheon and produced since 1956. The operational requirement for the Sparrow AIM-7F was identified in 1965. The AIM-7F guidance and control (G&C) utilized a solid state design which proved more complex than anticipated and resulted in stretching the development effort over 8 years. Since the G&C group accounts for about 90 percent of the missile's cost, it is the focus of the following discussion and analysis.

Raytheon received its initial production contract for Sparrow AIM-7F in FY 72 and in FY 74 General Dynamics was established as a second source. Dual-source competition was initiated beginning with the FY 77 buy and four split-buy competitions were held, three of which were won by Raytheon. Complete cost and quantity data for the Sparrow AIM-7F program are presented in Table 3.

Quantitative Analysis

To apply the analytical methodology discussed above, it was necessary to calculate Raytheon's sole-source learning curve for use in estimating the sole-source cost for the total quantity. Power functions were fitted to the average unit costs and cumulative average costs of the four Raytheon sole-source buys preceding the split-buy competitions to derive the learning curve.

As shown in Table 3, the cost of the first competitive lot (FY 77) for 1,320 units produced by Raytheon and General Dynamics was $105.7 million. Sole-source cost estimates for the same lot are $88.3 million and $92.2 million, depending on whether the unit or cumulative average cost equation is used. Thus, dual-source competition is assumed to have added between 14.6

and 19.7 percent to the cost of the first competitive lot.

A second method for measuring the effect of competition on recurring production cost is to compare the actual total recurring production cost with the estimated sole-source cost for the total quantity. As shown in Table 3 the actual recurring production cost for all 9,224 units was $758.1 million. Sole-source estimates for that same quantity are $632.5 million and $656.9 million. Thus, dual-source competition is assumed to have added between 15.4 and 19.8 percent to the total recurring production cost of the Sparrow AIM-7F program.

Finally, the estimated added cost for the total production program was divided by the percentage of the total quantity that was competed to provide an indication of the effect dual- source competition might have had on total recurring production cost by implementing it at the outset. By dividing the estimated cost percentage added to the total production program (15.4 to 19.8 percent) by the percent of Sparrow AIM-7F units produced under dual-source competition (77.2 percent), it is estimated that total production program costs would have been increased by 19.9 to 25.6 percent if competition had been implemented at the beginning of recurring production.

Substantial non-recurring costs also were incurred to establish competition for the Sparrow AIM-7F. Specifically, an additional $38.7 million was estimated for data package preparation, planning, tooling, and test equipment, and second-source qualification. Also, a conservative estimate of the added cost of the educational buy ($25.4 million) was made by multiplying the difference between the initial and second-source average unit costs during the precompetition phase by the second-source quantity. Thus, an estimated added non-recurring cost of $64.1 million was required to establish GD as a second source.

In conclusion, by using this simple, generally accepted methodology it is estimated that total costs for the Sparrow AIM-7F Program were increased by between $165.3 and $189.7 millions of FY 77 dollars as a result of establishing a second source and implementing dual-source competition.

Subjective Judgments and Comments

Some have challenged the above conclusion by arguing that the unusual steepness of the Raytheon sole-source learning curve was caused by the threat of competition from GD. To examine the merit of this argument, data were obtained for previous models of the Sparrow (i.e., AIM-7C, D, E and E2), all of which were procured from Raytheon *on a sole-source* basis.

It is hypothesized that learning-curve slopes would be flatter for models of a given item having greater commonality with previous models—all else being equal.[1] This is because models with only very minor modifications over the previous version may be viewed largely as a continuing down on the existing learning curve, whereas a model with major modifications would begin with a true first unit.

Since the AIM-7F has little in common with the preceding models, a steeper slope would be expected for it than for the AIM-7D, 7E, and 7E-2—all else being equal. Thus, the assumption is made that the expected sole-source learning curve slope for the Sparrow AIM-7F would have been approximately the same as that experienced for the AIM-7C (84 percent, cumulative average) since both versions were essentially new designs. This learning curve slope was used to recalculate AIM-7F sole-source projections to determine whether savings would be indicated if a more "normal" learning curve slope had been used. In fact, a total program savings of about 11 percent could be attributed to competition by applying this assumption. On the other hand, a case could be made that, if the government had exploited the threat of competition and negotiated effectively with Raytheon as a sole source, even greater savings might have resulted from optimizing the added economies of scale inherent in a single producer.

Since the preceding discussion takes the analysis of the Sparrow AIM-7F dual-source competition from the objective to the subjective by discussing "normal" learning curve slopes, it is also appropriate to cite and consider other significant and related issues.

Table 3. SPARROW AIM-7F TOTAL RECURRING PRODUCTION COST DATA

	Raytheon			General Dynamics			Yearly Totals	
Fiscal Year	Quantity	Average Cost (FY77$M)	Total Cost (FY77$K)	Quantity	Average Cost (FY77$M)	Total Cost (FY77$M)	Quantity	Total Cost (FY77$M)
72	100	415.8	41.6	--	--	--	100	41.6
73/74	225	212.0	47.7	15	916.5	13.7	240	61.4
75	600	111.6	67.0	70	233.2	16.3	670	83.3
76	880	94.7	83.3	210	130.2	27.3	1090	110.6
77	1110	75.0	83.2	210	107.0	22.5	1320	105.7
78	1400	65.1	91.1	750	77.5	58.1	2150	149.2
79	900	62.1	55.9	1310	52.4	68.6	2210	124.5
80	1144	53.5	61.2	300	68.6	20.6	1444	81.8
Totals	6359	--	531.0	2865	--	227.1	9224	758.1

The first is that, in winning the initial competition, Raytheon managed to double its profit percentage from about 13 to 25 percent (based on data provided by NAVAIR), while lowering its price primarily by reducing manufacturing support costs. From a parochial, programmatic viewpoint, this may not be cause for alarm. However, from a broader vantage point, significant questions should be raised:

—If these manufacturing support personnel were expendable, why did government program management personnel not have them eliminated at a much earlier date (e.g., during AIM-7C production)?

—What happened to Raytheon's manufacturing support personnel when it left the AIM-7F program? If it was loaded onto another DOD program, perhaps competition on the AIM-7F served only to reallocate costs among several in-house programs, provided added profit for one of them and, therefore, higher total costs to the government.[2]

—How did the elimination of manufacturing support personnel affect producibility improvements over the long-term? Specifically, is there any correlation among the major difficulties currently being experienced in producing the AIM-7M and the reduction of sustaining engineering manpower on the prior model?

It also is noted that GD incurred a loss on the one competitive lot it won by bidding too optimistically. While a loss of this magnitude by a major defense contractor may not be cause for concern, it is important to recognize that a fundamental characteristic of our economy is free entry and exit from markets. If the management of a firm can identify more profitable long-term uses of its resources, it is guilty of malfeasance if it does not pursue them. It would be ironic indeed if dual-source competition did not achieve one of its stated purposes—enhancement of the mobilization base—but rather had the opposite effect by causing contractors to seek greener pastures.[3]

The most significant point to be learned from the Sparrow AIM-7F dual-source competition is that, even when complete and accurate data are available, a crystal ball is required to determine "what happened and why." Of course, answers to these questions are crucial in determining whether and how to proceed with the establishment of dual-source competition for future programs.

A crystal ball is required to determine "what happened and why."

Further Remarks

Some people feel that top DOD officials, legislators, and their support staffs have all too often failed to grasp what competition and how critical factors that drive acquisition costs are influenced by dividing a fixed production quantity between two sources. Reasonable policy decisions may be made only if based upon a sound conceptual framework. Volumes would be required to thoroughly examine these issues; however, only a few brief comments will be made below in hope of stimulating further inquiry and discussion.

Competitive Strategies

"Competition" is loosely used by many to evoke images of unbridled rivalry among two or more firms. In fact, dual-source "competition" (a duopoly dealing with a monopsonist) may create no more rivalry than the bilateral monoploy typifies (sole source) weapon systems acquisition. To amplify on this, you must recall that businesses seek to maximize profit; however, their approach to achieving this goal may vary widely depending upon how they define profit; e.g., time period covered, organizational boundary (corporate, division, prod-

A Sparrow AIM 7 is test fired from an F A-18 Hornet.

uct) and the base to which it is applied (sales, return on investment). In his book, *Competitive Strategy: Techniques for Analyzing Industries and Competitors*, Michael E. Porter identifies three generic strategies that firms follow to out-perform others in their industry. They are:

—**Differentiation.** Creating the perception that the firm offers something unique (e.g., technology, innovation, reliability).

—**Focus.** Serving a particular target (e.g., buyer or segment of product line very well.

—**Cost Leadership.** Emphasizing efficiency.

Only the cost-leadership strategy has cost reduction as its objective. To be successful, this startegy often requires significant capital investment to capture market share which, in turn, risks obsolescence should new designs or manufacturing technologies be developed. While cost is not unimportant in pursuing the other two strategies, it is a secondary concern. Thus, superior profit performance may be achieved by a higher cost producer.[4] And dual-source competition, where a guaranteed minimum annual quantity exists for the high bidder, leaves ample room for the higher cost producer to "game" the situation in order to maximize profit. Several means of avoiding such gaming have been discussed by government personnel (e.g., step-ladder quotes) but they may be readily manipulated by a shrewd contractor. A point that cannot be overstated is that once a second source has been established and found wanting, the government has lost a very important "stick" for keeping the initial source in line (i.e., the threat of competition).

The Application of Learning Curves

As discussed above, cost/quantity relationship (i.e., learning-curves) are a key concept for comparing and analyzing two producers of a given product. An overview of these important relationships is provided below and an attempt is made to clarify some of the serious misconceptions that have crept into analyses of dual-source competition.

Although cost/quantity relationships simply indicate the extent to which cost declines as greater quantities are produced, they reflect the complex interaction of several variables including: industry, organization, and operator learning; economies of scale and production rate; manufacturing processes used (i.e., mixes of labor, capital, and material); and factor prices paid. Each of these variables makes a significant contribution to learning-curve slope; however, it is difficult to specify theoretically their relative impacts for a particular case, and impossible to measure them empirically given the inadequate data available.

It is generally felt that a firm's learning-curve slope may serve as a proxy for measuring efficiency (i.e., the steeper the slope the more efficient the firm). However, like most simple rules, many exceptions exist. For example, a firm could be very efficient and have a relatively flat slope if it utilized a high proportion of capital equipment. Also, if the item being produced used many off-the-shelf components, then a true first unit cost would not be represented by the data. Furthermore, a firm could be operating efficiently and have a relatively steep slope but its output could still have a higher cost than a less efficient firm paying lower factor prices.

Economies of Scale

Dividing production between two sources causes potential economies of scale to be foregone that might have been available to a single source producing a larger quantity. When a firm begins to produce an item, an efficient rate is implied. If its production rate were significantly lower than the designated output, then its costs would be higher than optimal, primarily because fixed costs would be amortized over a smaller base.[5] If its production rate were significantly above the designated efficient machinery, third-shift premiums, and added maintenance. This behavior characterizes the U-shaped curve that is theorized in basic economics texts. It is indeed logical that such a curve would exist over the short-run to accommodate a required surge, for example. However, no empirical evidence of such a curve exists because all data studied reflect the long run during which managers make adjustments to increase capacity and restore efficient operations as characterized by the L- shaped curve.

Although production rate is very plant sensitive, much analysis has recently been devoted to generalizing the effect of production rate on cost. Unfortunately, since production-quantity data are more difficult to obtain than buy-quantity data, the assumption has sometimes been made that buy-quantities are a close proxy. This is an incorrect assumption! Consider the buy vs. production quantity data for Sparrow AIM-7F presented in Table 4. Both firms have effectively used the time-lag to smooth out their rates to the extent possible in order to avoid inefficience that would be induced by greatly varying the costs.

Cost Estimating Models

The government has sought a cost estimating methodology for competitive programs that would provide estimates for the budget. Unfortunately, evidence presented in Table 2 has often been overlooked: Sometimes dual-source competition leads to a lower cost, and sometimes to a higher cost. Models have proliferated based upon the underlying assumption that the second source will always be more efficient than the initial source. (Catchy descriptions of this imagined behavior have enen been coind that have more relevance tothe Top 40 than to economics).

—They are derived from a combination of winner-take-all and split-buy competition data and the cases included have been selected to avoid instances of higher estimated costs.

—If one accepts these models, then the message to acquisition policymakers is clear: Establish a second source and terminate the initial source to take advantage of scale economies to provide lower overall costs.

Conclusions

Annual winner-take-all competitions should be held whenever feasible. Dual-source competitions, on the other hand, should be implemented only following comprehensive analysis of their probable effects. At a minimum such analyses should consider:

— The item involved—its design and manufacturing complexities, the planned procurement schedule and quantity, the status and ownership of technical data, and availability of technical assistance.

Table 4. SPARROW AIM-7F BUY VS. PRODUCTION QUANTITIES

FY	RAYTHEON		GENERAL DYNAMICS	
	Buy	Production	Buy	Production
1972	100*	—	—	—
1973/74	225	24	15*	—
1975	600	167	70	—
1976	880	332	210	—
1977	1110	925	210	70
1978	1400	1086	750	395
1979	900	1077	1310	391
1980	1144	1000	300	1027
1981	—	722	—	961
1982	—	881	—	—
1983	—	41	—	—
Total	6359	6255**	2865	2844**

*Not included in production quantities. Note: First lots may be development units.

**For Raytheon, the difference between the total buy and the total production quantity is because the production quantity does not include the first buy of 100 units and the FY 73/74 and FY78 production data supplied by NAVAIR were each missing two units.

**For General Dynamics, the difference between the total buy and the total prodution quantity is because the production quantity does not include the first buy of 15 units and the FY78 and FY80 production data supplied by NAVAIR were in net error of minus six units.

— The structure—of the relevant industry segment—the number of capable firms, traditional rivalries, and overall capacity utilization.

— The ability of the program office to manage effectively an additional contractor and its ability to negotiate effectively with a sole source.

— The added non-recurring costs required to establish a second source and the probability of achieving recurring cost savings to offset them given the findings from the above points.

— Clearly, a decision to implement dual-source competition should not be a foregone condlusion; however, under the appropriate set of circumstances, it may lead to desirable results. ■

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NOTES

1. "All else being equal" is critical because factors other than design changes may influence learning-curve slopes. Such factors include the manufacturing process employed (if it was changed to substitute equipment for hand labor, a shallower slope would be anticipated because capital does not learn—and the opposite is also true); production interruptions (delays or rate reductions have been shown to affect learning undesirably, as labor "forgets" and fixed overhead charges are allocated over a smaller base); and the marketing strategy employed (the most significant feature of dual-source competition is that both firms are guaranteed a portion of the buy and therefore have alternative means available for maximizing profit (i.e., they do not have to be the low bidder to benefit).

2. According to NAVAIR personnel at the time this was written, DCAA will investigate this matter.

3. An example of this is the Bendix Corporation decision to close its Guidance Systems Division largely because of the government's decision regarding a HARM second source. At the same time the threat of competition on HARM is credited by many as causing the sole source to significantly lower its price. A rhetorical question is raised: Is a long-term decline in the defense industrial base an accepted price for achieving short-term cost savings, or are the only marginally efficient producers being eliminated by this process?

4. In a leader/follower situation rivalry will exist only as long as both firms attempt to be the leader; i.e., low bidder. Each of the other three possible outcomes has an undesirable result from the government's point of view.

5. The following example may explain some of the apparent savings that have resulted from dual-source competition. The government capitalizes sole-source Firm A to produce 1,000 units per year. The program is cut back and A produces only 600 units a year. Its costs are higher than estimated. The government established Firm B as a second source to product up to 60 percent of the annual buy (360 units). Because it is capitalized for the appropriate rate, B bids lower than A and wins the larger share of the initial split-buy competition causing a savings to be credited. Would A's cost have been lower than B's if it had a capacity of 360 rather than 1,000 units?

"One man with courage makes a majority."

—Andrew Jackson

Decision-Making Environment of a Program Office

Paul O. Ballou, Jr.

Decision-making in the federal government is a complex process. Some participating in the process consider it a management art. Successful program managers are members of an unsung fraternity of decision-makers whose cry could be:

"Those who tend the stables ride not the horses; those who hone the sword feel only its point; those who craft the decision glory but in its beauty."

Author anonymous

Wallace S. Sayre identifies nine sets of actors or power structures involved in the federal decision-making system. Each actor is considered a sub-system directly influencing program policy and procedure decisions. Figure 1 is the model diagram setting forth each actor, the power structure span, and representative relationships.[1] A program manager must understand the interests, motivations and values of each actor to work effectively within the power structure.

Figure 1 emphasizes the pluralistic nature of the federal decision-making process. A program manager must develop working relationships with key people in each subsystem to facilitate efficient program management. Problem areas must be negotiated with the key people until integrative solutions can be found that are satisfactory to all.

A program manager's functions and activities are identified in the components of the governing process. The decision-making system is accomplished during the governing process, which is influenced by subsystem actors in Sayre's model and the program characteristics. Each actor's power and influence is dynamic in each program environment.

The National Defense Stockpile program is an example of the decision-making process. Program characteristics must be considered in the analysis, but those characteristics do not describe how they are to be applied in the process. A comprehensive system analysis will consider central program issues, forces of each subsystem actor, and program characteristics. Within the system of pluralism, I will describe the program actors and identify the two tending to be the most and the least supportive.

Program Background

The United States is dependent on foreign sources for vital materials required for national defense and for our major industries during periods of national emergency. Senator Barry Goldwater of Arizona indicated that the United States was "more than 50 percent dependent on foreign sources for 23 of the 40 critical materials most essential to our $2.3 trillion economy."[2] The United States is close to 100 percent dependent for cobalt, chromium, columbium, manganese and tantalum, which are vital materials for aerospace.

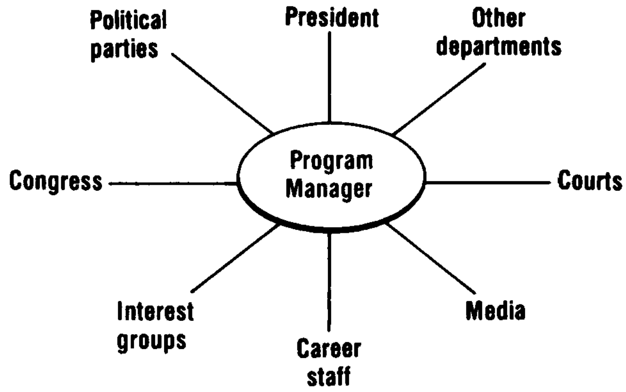
To prevent a dangerous and costly dependence on foreign supply sources during a crisis, the United States maintains a national defense stockpile of non-fuel materials to avoid military setbacks and economic damage during national emergencies. The first major federal program to stockpile strategic and critical materials was authorized and initiated under a 1939 act and was amended by the Strategic and Critical Materials Stock Piling Revision Act of 1979.

The Congress stated its purpose for enacting the law was "to provide for the acquisition and retention of certain strategic and critical materials and to decrease and to preclude, when possible, a dangerous and costly dependence by the United States upon foreign sources for supplies of such materials in times of national emergency."[3]

The national defense stockpile consists of 93 commodities whose total value was approximately $11 billion at the end of December 1984. These materials are stored at more than 100 locations nationwide. Operation of these storage facilities represents an enormous warehousing operation involving millions of tons of material, most of which were acquired in the 1940s and 1950s. Changes in technology have made large quantities of the inventory obsolete for modern industry requirements; thus, major restructuring of the stockpile inventory is now necessary. Some materials have deteriorated and require rotation, while others need to be refined or processed into forms suitable for current needs. Materials in the inventory are woefully inadequate to meet our current requirements. As a result, the U.S. capability to conduct a major conventional war for more than a few months is limited.[4]

To stockpile a 3-year (wartime) supply of the materials in accordance with national policy would require a purchase totaling approximately $10 billion. On March 31, 1981, the White House announced the start of the first purchase program for the stockpile in over 20 years. The acquisition program is the first step in restructuring the stockpile. Other program activities will include rotation, reprocessing, refining, and disposal of excess materials. President Reagan has stated that "It is the policy of this Administration to decrease America's minerals vulnerability by taking positive action that

Figure 1. DECISION-MAKING SYSTEM



will promote our national security, help ensure a healthy and vigorous economy, create American jobs, and protect America's natural resources and environment."[5]

Actors and Their Influences

President Reagan is taking an active role in the program. His policy statement April 5, 1982, clarifies program goals and objectives. Two specific presidential directives have been issued concerning the acquisition program. Other directives have been implemented by the National Security Council and the Office of Management and Budget. However, there is an anomaly between the policy and its implementation. Economic and international policies result in conflicting forces with defense policy.

The Congress

The Committees on Armed Services of the Senate and House of Representatives have a very active role in program execution. Legislation is required before excess material can be sold. The Annual Material Plan must be submitted for congressional approval before material can be acquired. Any deviation to established acquisition procedures must be submitted to the committees for approval.

Congressional oversight committees frequently call for hearings on stockpile goals, materials management, use of U.S. flag vessels, domestic production capabilities, quality of stockpile materials, and acquisition policies and procedures. Members of the Congress frequently are calling for GAO investigations of stockpile policy and operation. The Congress frequently has called for improved stockpile management by proposing changes to the implementing laws. The Congress is very critical of this and prior administrations for using the stockpile for economic and budget balancing purposes.

Courts

Program activities are confronted by the courts in both buying and selling. The law requires that acquisitions and disposals be accomplished to avoid undue disruption of the usual markets of producers, processors and consumers of the materials. Legal counsel is sought from the Department of Justice, General Service Administration (GSA), Federal Emergency Management Agency (FEMA), and other involved agencies. Program activities conflict with many areas of the economy and result in restraining orders and other legal actions to prevent stockpile transactions.

Other Bureaus

The GSA is responsible for allocation of resources and program implementation. The FEMA is responsible for program planning and programming. The Departments of Interior, Commerce, State, Defense, Energy, and Agriculture each have a vested interest in the program. Inputs from the other agencies involved include technical, economic, and marketing data and analysis of factors such as supply, demand, consumption, prices, specifications and quality requirements. These inputs support the development of marketing, acquisition, and disposal plans.

The stockpile program affects other agencies' abilities to meet their goals. Defense and Energy must have the materials for national defense. Material transactions affect international markets that, in turn, influence international relationships which are of primary concern to the State Department.

The program dichotomy creates checks and balances and conflicts among involved agencies and the program goals.

Political Parties

In general, there is a limited capability to produce critical and strategic materials in the United States. Only a few Western states are involved in producing materials. Accordingly, the program does not have a national constituency that exerts pressure through national political parties. Each new political administration does appoint administrators and secretaries who directly influence program policy.

Media

There are several producer and consumer publications interested in stockpile transactions. National policy issues are reported by national and international publications. Other media have interest in specific issues such as national defense, international trade, environment, and economics.

Favorable media coverage of the program is vital to its success in accomplishing goals; unfavorable media reaction results in audits, investigations, and delays. The program's appearance to the public is a mirror reflection of its actual condition. There is program support in the decision-making system if it is perceived as a successful program.

Interest Groups

Organized interest groups promote the development of sources of materials within the United States and lobby for domestic restrictions on foreign materials. The Defense Production Act authorizes non-competitive procurement action to assist U.S. producers in expanding their capabilities.

International interest groups bring pressure—through political and economic channels—to influence stockpile transactions to either buy their materials, or to refrain from selling excess stockpile materials that are in competition within their domestic production.

Organized interest groups promote the development of sources of materials within the United States and lobby for domestic restrictions on foreign materials.

The program manager finds that any action he takes will be criticized by some interest group. A foreign acquisition will be opposed by both domestic producers and other foreign countries; any sale will be opposed by both domestic and foreign producers. Producers object to the stockpile because it represents an overhang on the market. There is no satisfactory answer to the interest groups—only compromise.

Career Staff

Many people's careers have been spent working on the program for more than 25 years. Their goals have been related with program goals; their successes have been directly related to program successes. To a large degree, program decisions affect the career employee emotionally and economically.

There is a conflict of interest among career employees and program needs when joint success is interdependent. Program decisions are influenced by personal considerations and past experiences. Objective evaluations of problem areas tend to become automatic decisions based upon subjective or obsolete criteria and employees' goals.

Supportive Subsystems

The Congress and government bureaus are the two subsystems most supportive of the National Defense Stockpile program. The Congress has supported the program through its interest, legislative goals, and program evaluations. Congressional action has been motivated by constituency action through interest groups and the expressed requirements of the Departments of Defense, Agriculture, and Energy.

People of the United States believe that freedom can be retained only through a strong national defense—the stockpile is a cornerstone for defense in times of national emergency. The media report on our nation's capability, thereby keeping the public informed; unfavorable reports produce political pressure that results in congressional action.

The strategy and tactics used by the program manager to deal with the Congress involves providing information to key congressmen and congressional committee staff members through formal and informal channels. Congressional needs are satisfied by the program manager in various ways including clarification of media questions, data for constituents, meeting action schedules, acknowledgements, and personal associations. Compromises are negotiated on disposal authorization materials and quantities, appropriation amounts, goal accomplishment schedules, and changes to legislation that will benefit the program.

Government bureaus are supportive of the stockpile due to their interrelated goals with the program. The Departments of Defense and Energy have major roles due to their needs in times of national emergency. If the materials are not available in wartime, the nation's ability to produce arms will be eliminated; the availability of critical and strategic materials may be the difference between winning or losing. The FEMA assists because of responsibilities for stockpile policy and national emergency management. The State Department program support involves the international aspect of buying and selling materials. The Departments of Commerce and Interior provide support as a result of their larger roles in foreign trade and the development of U.S. producing industries.

The stockpile meets needs of other government bureaus at the same time accomplishments are satisfying program managers' requirements. Strategy and tactics are realized through interagency committees for planning and implementing the program, and requirements and transactions are tailored to consider multiple needs of all involved. Personal relationships have been developed among interagency committee members and program managers; and trade-offs are made among material priority, technical configuration, quantities, and market considerations.

Public interests are considered in the decision-making process. Goals of the Congress, government bureaus, and program managers are common toward national defense and freedom. Day-to-day decisions affect total program goals; individuals do not make decisions based upon a specific statement of public interest, but it is considered in overall program objectives.

Least Supportive Subsystems

The least support a subsystem actor could give a program manager may take the form of no actions or no objections. It is almost impossible to make effective program decisions without some support from every actor. The executive office of the president and interest groups are the two least supportive subsystems of the stockpile program.

The Office of Management and Budget (OMB) within the executive office, opposes stockpile acquisitions from several prospectives. First, expenditures increase the federal budget at a point in time when every effort is being made to lower outlays. Second, income received from the sale of excess materials can be used to reduce the requirement to borrow additional funds to run the government. Last, the stockpile size is used to justify other federal expenditures that could be reduced if the stockpile were reduced. To the extent U.S. producers can be encouraged to develop domestic capacity for the materials, there will be a reduction in federal expenditures with an increase in business and jobs in the domestic economy. The current OMB objective is to reduce outlays, increase income, and expand the domestic economy. Acquisitions for the stockpile program conflict directly with the OMB objectives. Accordingly, the acquisition budget has been reduced to a rate that, if continued at the current amount, the stockpile will take more than 100 years to restructure.

Domestic and international interest groups are organized to benefit their constituents. By definition, stockpile materials are strategic and critical and are not available in adequate supply in the United States. Domestic interest groups want preferred treatment for their constituents at the expense of U.S. taxpayers. Foreign governments want to make sales to strengthen their business base and improve their balance of payments with the United States. Our national interest is improved if domestic production can become internationally competitive in the long-term. As a result of conflicting goals, domestic restrictions are placed on some materials, resulting in higher prices, delayed delivery, and reduced quality. Other acquisitions are directed sole source to certain foreign countries based upon foreign policy considerations. The sales of excess materials are withheld or made at reduced rates due to the influence of domestic and international interest groups representing producers and consumers.

The general strategy of coping with OMB is to be a good employee and follow the manager's direction. Tactics employed by the program manager against OMB include encouraging members of the Congress to bring pressure at appropriate times; using other government bureau members to pressure OMB for their goals, which benefit the stockpile; and encouraging the National Security Council to intercede at critical times to resolve problem areas.

A major problem in the decision-making process is a general lack of support interest for the program, which reduces effectiveness. David B. Truman emphasized the importance of an iron triangle if federal programs are to be successful. One tactic calls for an industry meeting to seek advice on what to buy and sell and under what terms and conditions; another tactic restricts transactions to U.S. firms, and they, in turn, acquire materials from foreign sources. A strategy being considered is to establish a quasi-government corporation to manage the program. A strategy during World War II and the Korean Conflict was to place the program "mover" on the president's White House staff.

Public interest is considered throughout the decision-making process; however, program interest conflicts with public interest (in economic terms) in discussion with OMB about problem areas. Priority of public interest becomes a question among national defense and economic considerations—no one knows if there will be another war, but everyone knows the federal budget is not balanced. Interest groups represent their constituents and not the national interest. The United States is a member of the General Agreement on Trade and Tariff (GATT) and subscribes to free trade; however, interest groups influence the Congress to place domestic restrictions on program acquisition that conflicts with the GATT. Public interest, a subjective conclusion, is determined by what compromise subsystem actors find most feasible.

Conclusion

Subsystem interrelationships are based upon complex goals and activities of the people involved in a program. It is clear that program managers are to serve the public interest, but they often fail due to their desires for accomplishing program goals. Public interest groups introduce forces in the traditional pluralistic bargaining process that encourage decisions to benefit the group—not the public interest.

President James Madison saw communication and an informal electorate as indispensable in a democracy and a popular government. Democracy assumes conflict among the subsystem actors and the public interest within an environment of continuing change. The French statesman, Alexis de Tocqueville, anticipated that special interests could obscure the broad national goals in a democratic society. Subsystem actors have been permitted benefits at the expense of the general public.

Evaluation of the decision-making system in the federal process indicates that short-run interests are often inconsistent with long-run. The system usually does not adequately weigh ultimate costs of irresponsibility against apparent short-run gains. The power to supervise and control expenditures is the heart of the administrative process. A program manager needs critics to remain alert and to avoid the arrogance of overconfidence. Managing to survive should not take precedence over productivity. ■

■ *Mr. Ballou is a professor of financial management in the DSMC Business Management Department. He formerly was the director of acquisition for the National Defense Stockpile Program.*

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Strategic Mobility Begins with Transportability

Billy J. Slinger

America recently observed the 40th anniversary of one of its greatest military challenges and most dramatic successes: the invasion of Normandy. D-Day was a magnificent undertaking by American, British, Canadian and French troops, and the names Utah, Omaha, Gold, Juno, and Sword will long be remembered in the histories of the Allied nations that participated.

The Allies amassed 5,000 ships, 900 transport planes and millions of personnel. They gathered in England and practiced every aspect of the invasion. To get all of those troops and equipment across the English Channel, the Allies used ships, boats, landing craft, and transport planes— whatever was available. The planning and preparation took years.

Would it be possible to mount a similar invasion in today's electronic age? It's doubtful. With today's satellites and other intelligence gathering devices, locations of war materiel and troops can be discovered at almost any time. It would be virtually impossible to amass, stage, practice, and prepare for an invasion like D-Day without being almost instantly detected, photographed and, possibly, counterattacked.

Today, to cut the enemy's reaction time, such an operation would require a very short preparation period. The result would be chaos.

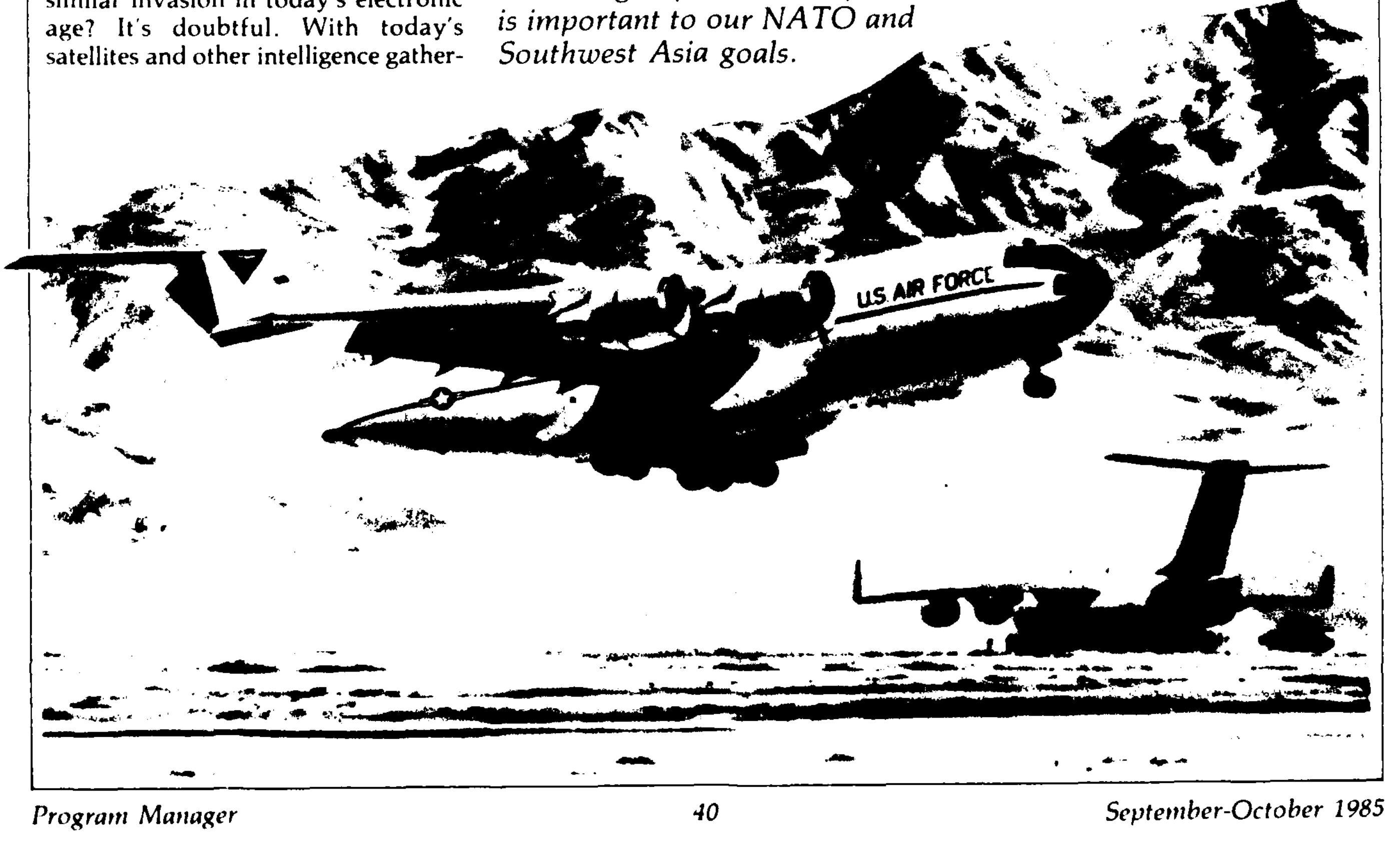
God forbid that we should ever experience another D-Day, but even if we never see anything quite like it again, we still need the ability to project our forces rapidly to distant theaters. With today's intelligence gathering capability, speed becomes the top priority in preparing and moving an invasion force. Any equipment we build must lend itself to quick and easy loading and movement by air or sea, day or night, in any kind of weather. After all, an army that can defeat any enemy is no good if it cannot get to the battlefield on time.

Engineering for Transportability

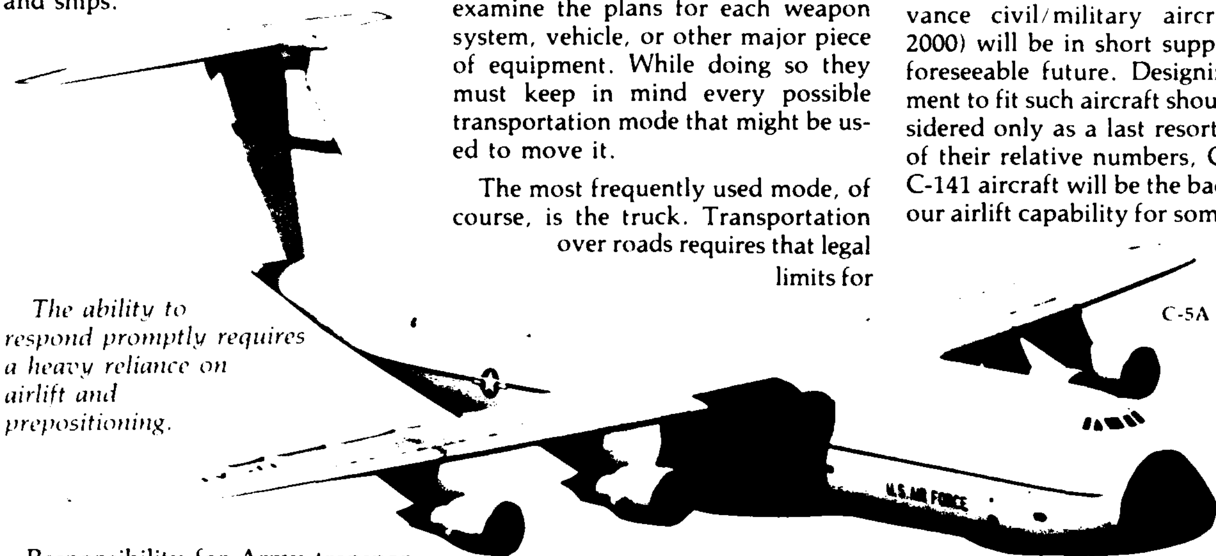
How, then, do we ensure that the materiel we design and build can be transported rapidly?

We do it through the defense department's engineering for transportabili-

C-17 cargo aircraft for unloading ships in austere ports is important to our NATO and Southwest Asia goals.



ty program. But just what is transportability? Transportability is the inherent capability of a piece of equipment to be moved. It is the very foundation of strategic and tactical mobility. Transportation, on the other hand, is the actual movement of equipment by such modes as trucks, airplanes, and ships.



The ability to respond promptly requires a heavy reliance on airlift and prepositioning.

C-5A Galaxy

Responsibility for Army transportability studies belongs to the Military Traffic Management Command (MTMC) and is carried out by the MTMCs Transportation Engineering Agency (TEA). Engineers at TEA measure the limiting constraints of DOD transportation assets (aircraft, ships, semitrailers, railroad flatcars, containers, etc.) and use the measured criteria to develop design standards. Department of Defense project managers then use those standards tc ensure the equipment they design or select will fit the planned transportation asset. Transportability engineers at TEA also develop, for the soldier, written procedures on how to transport each piece of equipment.

Transportability engineering is vital to our national defense, because every hour that a soldier must spend unnecessarily in disassembling, loading, and reassembling equipment adds to our strategic mobility response time. That could mean critical delays when entire units are to be moved to a trouble spot somewhere in the world.

Transportability engineering also is important for other reasons. Unnecessarily large and heavy equipment burns more fuel and requires more aircraft, more ships and more semitrailers to move it, which strains our transportation assets and wastes even more fuel. Equipment that doesn't meet the restrictions of a particular mode of transportation is limited in how it can be moved.

How Transportability Engineering Works at TEA

Transportability engineers at TEA examine the plans for each weapon system, vehicle, or other major piece of equipment. While doing so they must keep in mind every possible transportation mode that might be used to move it.

The most frequently used mode, of course, is the truck. Transportation over roads requires that legal limits for size, gross weight, and axleload be met. Equipment must be designed so that the transport vehicle can move it without costly and time-consuming special routing and permits. The engineeers also must consider physical limitations, such as overhead clearances, turning radii, and bridge weight limits, any of which could make a route totally useless for an essential convoy movement.

Ocean and inland waterway modes are the least restrictive from dimension and weight standpoints, but equipment must have lifting points so it can be loaded into, and unloaded from, breakbulk ships. It also must have tiedown points, so it can be properly secured in the vessel. Finally, it should be reducible; that is, it should be capable of disassembly so that the maximum numbers of items can be loaded into any one ship.

Air transportation is not a requirement for every piece of equipment. When it is, TEA engineers consider the two possible types: fixed wing and rotary wing.

With fixed wing aircraft, TEA strives to have equipment built that will roll on and off the C-130, C-141, and C-5 aircraft without disassembly to minimize loading and unloading time. The equipment also must have sufficient tie-down points that are strong enough to ensure safety in flight.

One important point project managers should keep in mind when designing equipment that is to be moved by fixed-wing aircraft is that the C-5, the new C-17 (1990s), and the advance civil/military aircraft (year 2000) will be in short supply for the foreseeable future. Designing equipment to fit such aircraft should be considered only as a last resort. Because of their relative numbers, C-130 and C-141 aircraft will be the backbone of our airlift capability for some time, so designers should be working primarily within the limitations of these aircraft.

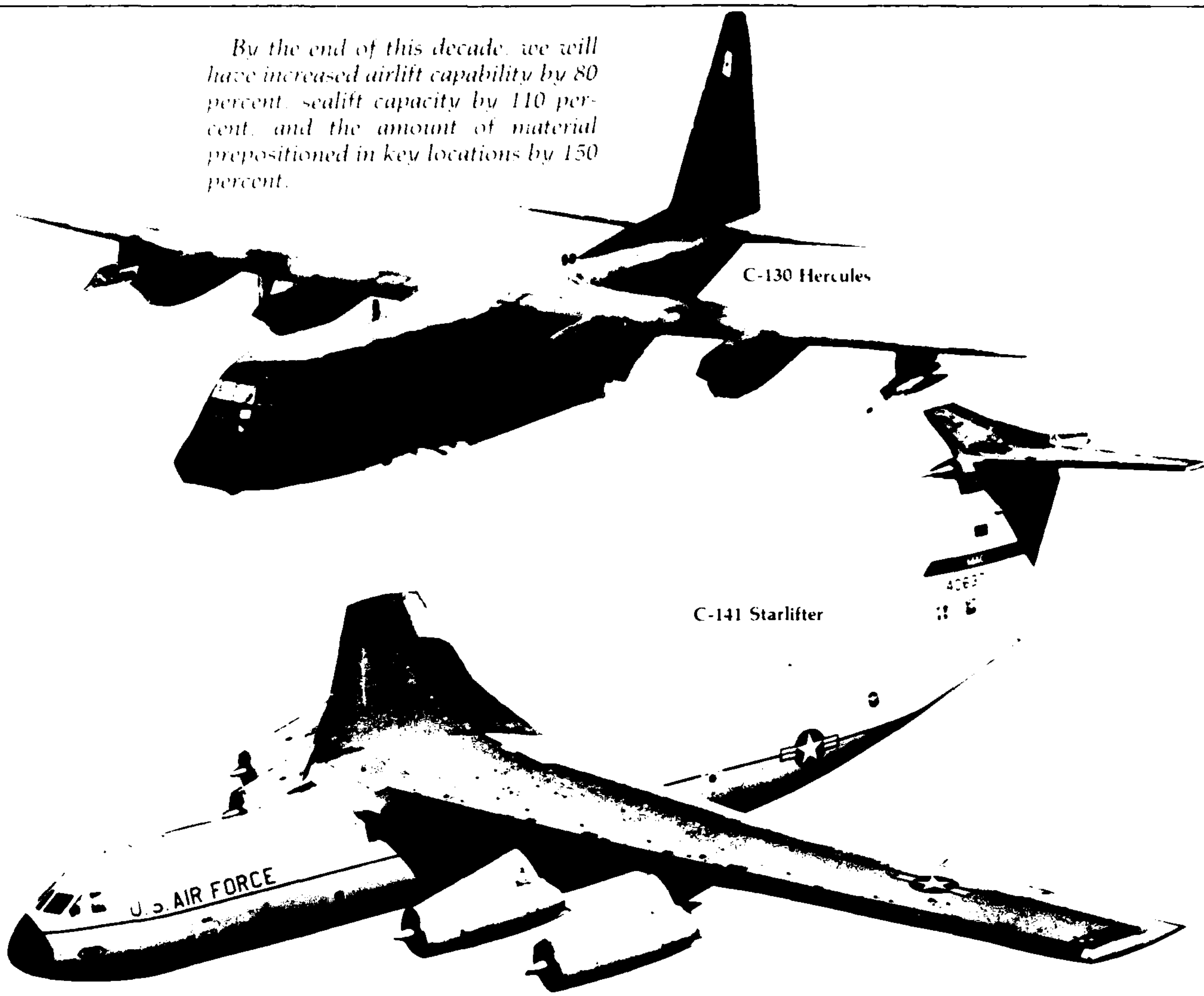
Engineers at TEA must be very familiar with cargo handling and airdrop systems and their limiting factors. Besides military aircraft, we also must ensure that equipment meets the physical limitations of the Civil Reserve Air Fleet. These civilian aircraft provide necessary back-up for military airlift.

Like fixed wing aircraft, helicopters have cargo size and weight limitations. The more weight to be carried, the shorter the helicopter's range, because the fuel load has to be reduced in proportion to the cargo weight; therefore, equipment that is to be carried by helicopter must be kept light.

Lifting points must be provided on equipment that is to be carried by helicopter as an external load, and tiedown points when it is to be carried as an internal load. The transportability engineer also must consider the weight and surface area if the equipment is to be carried by external sling, because these factors determine how stable the load will be in flight.

Another area that TEA engineers must study comes from the continuing trend toward containerization in

By the end of this decade, we will have increased airlift capability by 80 percent, sealift capacity by 110 percent, and the amount of material prepositioned in key locations by 150 percent.



transporting cargo. Containers must meet international standards for size, strength, and lifting points. They must be capable of integration into container handling systems, such as fixed and mobile cranes, forklifts, wheeled vehicles, ships, and airplanes. Another important consideration is the ability to discharge containers from ships in areas where there are no ports, or where movement by over-the-shore operations is restricted.

That, in brief, is how TEA transportability engineers perform their vital role in strategic mobility. But, how does the transportability engineering process actually work when it comes to developing equipment and moving it?

Transportability and Policy Guidance

Engineers at TEA get involved primarily during the early stages of the equipment acquisition process when the item is still on the drawing board. Under the new Army Regulation 70-1, the equipment acquisition cycle probably will be shortened. If, as the regulation recommends, the process is reduced to two acquisition phases (requirements validation and program go-ahead) from the present four, transportability criteria must be firmly established before Phase I review.

Transportability engineers must be a part of that review by providing technical considerations for the requirements document, the acquistion decision document, and all other documents reviewed at that time. Transportability approval must be completed before program-go-ahead, and affirmed as soon as hardware testing is accomplished. Transportability approval means that the transportability agent of the developing service has certified that the hardware item has met all of the transportability needs stated by the user.

The TEA provides transportability guidance to the soldier in three ways. First, guidance, procedures, and other help can be obtained by telephoning TEA (commercial 804-878-4647, AUTOVON 927-4647, FTS 988-4647).

Second, procedures and instructions are published in clearance diagrams. These diagrams are single-sheet procedures for a single-equipment item. Clearance diagrams for all items of equipment are bound together and published in TB 55-55. Plans also are underway to publish clearance diagrams in operator's manuals.

Third, extensive procedures and instructions are published in the 55-series

(See Transportability, inside back cover)

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Management and Productivity

Providing the right people and materiel resources at the right place, at the right time, in the right amounts.

General Larry D. Welch, USAF

The subject that always tops our Air Force priority list and that of the other services is the whole business of attracting, recruiting, training, managing, motivating and retaining the quality people it takes to build and sustain adequate military forces.

Human resources in our military forces is a big subject. Furthermore, it is clear to me that the drivers of human resources planning in the military forces have much in common with private-sector challenges.

While we continue to do well at building quality U.S. military forces manned by quality people, we are, nonetheless, seized with the need to do much better.

Drivers of Personal Planning

Beyond the normal drive to do everything better, there are compelling reasons for our preoccupation. I see three forces demanding better planning and execution in the human resources area. The first two are largely economic. In the armed forces, as in the private sector, a major part of the cost of doing business is people. Secondly, we compete with an increasingly robust economy for the available pool of high-quality people, and that competition will become more, not less, intense.

The third driver is the most immediately compelling and the most frustrating. The increased investment in modernization and growth over the past 4 or 5 years has produced, and will continue to produce, corresponding growth in the demand for both quality and quantity of military and civilian manpower.

But, it's painfully clear that the Congress is not likely to agree to provide that manpower. We see a continuing mismatch between the willingness of the Congress to approve dollars to invest in new equipment and their great reluctance to approve the manpower that must go with that equipment. And that mismatch remains, even as the willingness to provide equipment dollars wanes. We could spend a lot of time on the apparent reasons for that mismatch, but for the moment it's just a fact of life. During the past 4 years, the Air Force has been authorized less than one-half the manpower growth associated with fielding new equipment, and we see clear indications that trend will continue. Those facts alone demand that we find ways to increase productivity. But beyond that, it is as clear to us whose end-products are deterrence and military capability, as it is to those who compete on an economic basis, that nothing can leverage our investment as powerfully as increasing the productivity of our people.

You understand at least as well as I how complex that subject is, but let me mention some factors that seem to me to be the most compelling in my business and then concentrate on just one of those factors.

It's probably useful to define our specific products. I mentioned the overall result is deterrence and warfighting capability; but the most specific, most measurable ingredients that add up to those outcomes in daily operations are equipment readiness and training.

Equipment Readiness and Training

There are obviously lots of essentials that surround those—strategy and tactics, infra-structure, positioning of materials, morale of the force—all very important, but more equipment readiness and training are the most direct, measurable outputs of increased productivity.

This is taken from remarks made by General Welch to the National Forum on Human Resource Planning, Baltimore, Md., the past May.

As to the most directly controllable opportunities to increase productivity in the two areas I've mentioned, the first is the most straightforward—providing the right kinds of people and materiel resources at the right place, at the right time, in the right amounts. We do well in recruiting and initial qualification training of people. We do reasonably well in retaining our experienced people, although further tinkering with compensation—to include retirement—can destroy that overnight. But that's another subject. And we do well in providing the material wherewithal to do the job.

The second factor is setting attainable standards and goals that the producers believe are attainable and necessary. We have work to do there, and doing that is not as useful as it should be until we do better at the third step. And that step is decentralizing authority and responsibility so there is a line individual with the clear authority and responsibility and accountability for a specific piece of our business. I'll come back to that, but the last two factors are also straightforward: measuring how well that business is being accomplished and rewarding success while withholding reward from those who don't succeed. That last point may be self-evident, but it takes some attention to ensure we continue to distinguish between the jewels and crown.

Decentralizing Authority

I presume no one will find fault with any of those factors, but let me focus more specifically on the most key ele-

If the unit completed monthly production 3 days before the end of the month, they could go fishing—if they fell behind, they could work Saturday and Sunday.

ment in my opinion, and that is decentralizing authority and responsibility so there is a line individual with clear authority and responsibility for a specific piece of our business. The private sector has proved over and over again how well that works, so it's not a startling new idea. I single out that factor because there always seems to be a powerful pull to drag authority to higher levels, particularly in large enterprises with layers of management and most particularly in government.

As one element of that pull, we found in Air Force, for example, that what could and should and will be a great boon to productivity—data automation—also had become an unholy force for elevating authority levels. The process, once examined, was simple enough. Data automation makes it possible to provide great volumes of detailed information at the top. That, coupled with the natural arrogance of higher headquarters, led to both the proclivity and the apparent means to make more and more decisions at higher and higher levels. Unfortunately, the resulting micromanagement from higher levels led to more reports and more information flow to the top.

All that was and is aided and abetted by levels outside the services. As just one example, I read in a paper that the Congress tasked DOD for 458 special reports in 1984, on top of more than 1,300 appearances by senior witnesses before 96 committees and subcommittees totaling more than 2,100 hours of testimony. That was along with 85,000 written queries and more than 600,000 phone calls. The result is that we provide levels of detail to the U.S. Congress about such things as wing-level logistics that I didn't need to know as a wing commander.

None of that is intended as an indictment of data automation or the Congress, but simply as an illustration of where events can take us if we lose sight of what drives productivity up and what, on the other hand, stifles the interest and energy of people at the production end of our business.

I am reminded of Cohn's Law, provided me by a friend in the Israeli Air Force:

The more time we spend in reporting on what we are doing, the less time we have to do anything. Stability is achieved when we spend all our time doing nothing but reporting on the nothing we are doing.

Decentralized Execution

To reverse that trend, the U.S. Air Force launched a concerted drive to refocus on decentralized execution, with the very helpful support of the deputy secretary of defense. I say to refocus because U.S. Air Force combat doctrine—inherited from the Army—has always demanded centralized assigning of missions and resources, and very much decentralized direction of the use of those resources to accomplish those missions.

We started with a restatement of those principles signed by the secretary of the Air Force and the chief of staff. We invited field commanders to participate much more fully in our programming and budgeting, and therefore our goal-setting process. We started a careful review of the purposes and uses of data automation. For example, we are chasing down the uses of all reports to higher levels. The initial effort was to concentrate on one of our larger bases to track down both ends of the information pipe. You won't be surprised to know that in all too many cases the pipe emptied into emptiness. Someone generated the requirement for information, but no one was using it. In the short time we've been engaged, we've eliminated 268 reports, and I think that's a very weak start. One thing is clear—much of that information flow aided and abetted inappropriate centralizing. It does not add to the quality of decisions and certainly does not add to productivity.

In any case, productivity is not driven nearly so much by the quality of management decisions—important as those may be—as by the quality of the execution. It's the commitment and dedication of the people at the point of execution that drives productivity.

About 6 years ago, one of our field commands, in which I served, began to decentralize authority with vengeance. Among the reasons were continuously declining training output, measured in training sorties, and declining equipment readiness.

The process of doing that was simplicity itself. The approach was to initially adopt as standards those already being met by the best producers. We then filled every unit to full resources until the resources ran out, leaving the remaining two or three units virtually empty. That eliminated a prime excuse for non-performance.

Management concentration was shifted from evaluating the process to measuring the product. And the units were told they could run their business their way within very general guidelines, but they were expected to meet the production standards. They were absolutely accountable for the outcome, and that outcome was carefully measured and evaluated. As a part of proof of accountability, if the unit completed their monthly production, measured in training sorties and equipment readiness, three days before the end of the month, they could go fishing. If they fell behind, they could work Saturday and Sunday.

That gave every man in the unit a direct stake in the outcome and very quickly; goldbrickers became pariahs and the troops worked not only harder but smarter. At the same time, the leadership found ways to provide more professional workplaces on the theory that if we expect a quality performance, we owe a quality workplace.

■ *General Welch is Commander in Chief, Strategic Air Command.*

We provided quicker access to tools and spare parts and all the wherewithal to get the job done, because now the troops, accountable for production, demanded that higher levels of management concentrate on what helped that production, not on what process was used.

I am totally convinced from that and other experiences that we not only get more productivity from decentralizing responsibility and authority, but we also get smarter decisions from the commander or supervisor on the scene. He or she has the most direct stake in the outcome of that decision and can concentrate full attention on the execution of that decision. Furthermore, it builds human resources; nothing builds managers and leaders like responsibility and authority.

Part of the resistance to decentralizing comes, of course, from the layers of intervening managers since they perceive a threat to their functions. They are absolutely right.

Compensation, Force Structure Management

Let me address the overall issue of compensation and force structure management in the armed forces. There are two or three things unique about the armed forces personnel situation other than the oft declared—and absolutely true—matter of unique demands on military people.

One is that we must grow all our own midlevel technicians, managers and leaders, and we need lots of them—some 202,000 staff sergeants through master sergeants and 72,000 captains through lieutenant colonels. Given the time it takes to produce that level of skills and experience, and the number we need, we require large numbers of people with somewhere between 8 and 20 or 27 years experience. We don't need or want the bulk of our people to serve much beyond 21 years. We do need and get a top supervisor and leadership force serving to 30 or 35 years. Hence, we need a system that provides adequate career compensation and force management for large numbers of people serving 20 years and more.

That's what the retirement system does and is supposed to do. It's not a pension. It's an earned entitlement and the key to our force structure management system. It works, and it works at the lowest practical cost. If we mandate longer service, we end up with fewer people in the year groups we need most while raising the cost. If we lower the overall retired pay, we lower the career compensation that long and painful experience has shown is required to retain the people we need when we need them. Those who say the retirement system is too generous are really saying that career compensation is too generous. For those who may believe that, I quote Norman Augustine, former under secretary of the Army.

I'm not sure what 'comparability' means. For example, in my operation we have 16,000 employees performing a variety of important tasks. But I can't quite imagine having recruited them by saying:

> *Now, this job I'd like you to take will require you being on call 24 hours a day, 365 days a year. You will be expected to pick up and move every three years to anywhere in the world you are told, and frequently you will be unable to bring your family with you. Often your family will be required to live in substandard 40-year-old temporary housing and, by the way, I can almost guarantee that if you spend your entire career with us you will at some point be placed in a position where you will be shot at by some people intent on terminating your life prematurely.*

Now the problem I have is what one would consider to be comparable pay for a job like that.

Well, to return to the broader subject of human resources planning, let me just reiterate that quality people properly trained, motivated and compensated are clearly the key to success in our military business, and in yours.■

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

Transportability

(Continued from page 41)

of *Transportability Guidance Technical Manuals.* These manuals explain how to lift, tie down, and restrain equipment on flatcars, trucks and trailers, ships and aircraft.

The Future of Transportability Engineering

The future offers many opportunities for transportability engineering. Project managers are taking the program more seriously, but our defense needs are making the program a real challenge.

To meet the threat, the Army is changing its force structure by adding light divisions and by increasing the firepower of its armor and mechanized divisions with modern, high-tech equipment. This modernization program is giving us a much more capable force but, at the same time, because of the trend to heavy-up our equipment, our strategic mobility assets are being taxed to their limits.

Meeting the threat must be the top priority, but as the Army adds heavier, larger, more sophisticated combat vehicles to its inventory, the transportability engineer's job gets tougher and tougher. What we need to do, whenever possible, is to develop smaller, lighter equipment. Project managers must think small and insist that our equipment be designed so it can be easily transported. That, after all, is the goal of the engineering for transportability program. Improved strategic deployability, through application of transportability engineering principles, is the aim of the Military Traffic Management Command and particularly its Transportation Engineering Agency.

Only with transportability can our increasingly effective military force be projected to distant theaters as crises arise. Only with transportability can we hope to accomplish anything approaching our accomplishment 40 years ago on the beaches of Normandy.■

Did You Know

That the rank of four-star general was created in 1866?

That 1940 was when the first U.S. Army parachute battalion was created?

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