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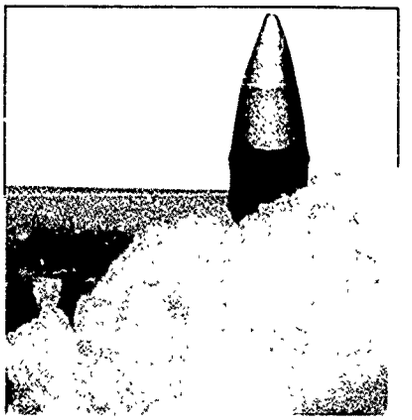

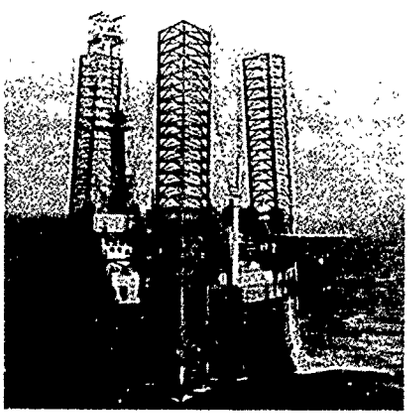

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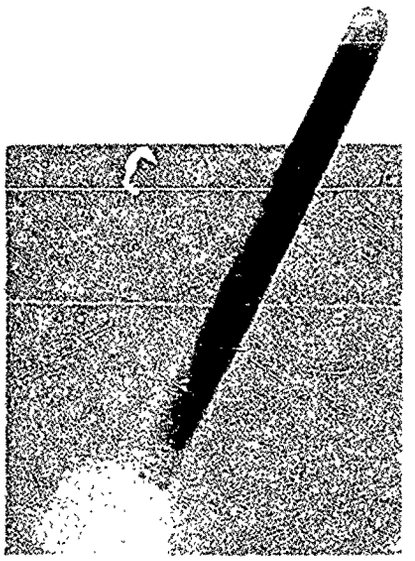

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OUR AMERICAN INDUSTRIAL BASE

Where Is It Headed? Is It on the Right Track?

David D. Acker

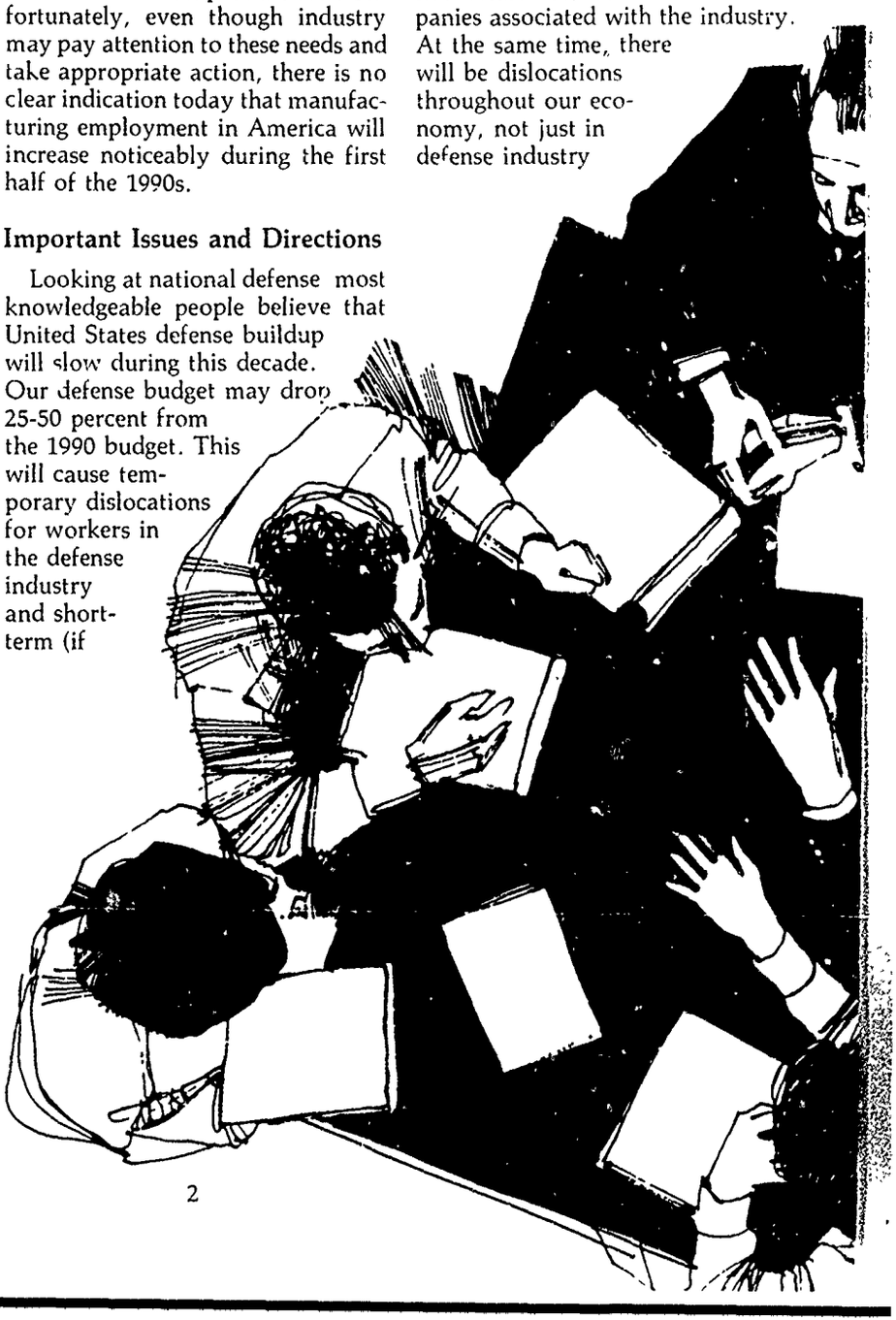
This decade is critical to the growth and survival of the American industrial base, which has been facing unprecedented worldwide competition. We have lost our place as the world's technological and industrial leader. Factors like high overhead, separation of product and process design, and delays in decision-making contributed to our leadership loss. To survive, we must face the situation head-on and reverse the direction.

To regain our position in the world manufacturing community, we must concentrate on things like manufacturing processes, product quality, and increasing market share. A survey conducted recently by the East Coast Manufacturing Group of Price Waterhouse ranked functional areas that companies believed would offer the best opportunity to achieve a competitive edge. Results of this confidential mail survey indicated 50 percent of respondents identified manufacturing processes as number one. Quality control and sales ranked second and third, respectively.

It seems to me, in addition to placing our attention on these three areas, our manufacturing industry must take positive steps to promote productivity of human and capital resources, employment of the latest technology available, and flexibility of manufacturing methods/facilities, as well as minimize product cost. Unfortunately, even though industry may pay attention to these needs and take appropriate action, there is no clear indication today that manufacturing employment in America will increase noticeably during the first half of the 1990s.

Important Issues and Directions

Looking at national defense most knowledgeable people believe that United States defense buildup will slow during this decade. Our defense budget may drop 25-50 percent from the 1990 budget. This will cause temporary dislocations for workers in the defense industry and short-term (if not disastrous) setbacks for companies associated with the industry. At the same time, there will be dislocations throughout our economy, not just in defense industry



Mr. Acker is a Professor of Management at the Defense Systems Management College.

The Honorable Donald J. Atwood, Deputy Secretary of Defense,[1] speaking to the National Forum Foundation, said "deterioration of America's industrial base is one of the most pressing issues facing the Department of Defense (DoD)...." Because the DOD buys manufactured goods from more than a quarter of a million firms, encompassing more than 215 industries, the Department's interest in the defense industrial base is inseparable from its interest in the American industrial base. "Indeed," he said, "they are one and the same."

It is absolutely necessary that we maintain a strong, competitive industrial and economic base to sustain our deterrent capability. When the unified European Economic Community arrives in 1992 (generally referred to as EC 92), American and European defense industries surely will become more competitive. American industry can ill afford to be out-managed. Hal Sperlich[2] believes the American auto industry lost its competitive edge and one-third of its business during the last 30 years to Japan. He claims our country has been "out-managed." Superior Japanese management skills and dedication to a goal of economic superiority over the United States brought this about.

Recognizing the growing loss of American preeminence in a number of industries and technological areas, the Congress asked the DOD in 1988 to identify technologies considered critical to the long-term viability of national defense. Twenty-two technologies were identified, including semi-conductor materials and microelectronics, computers, propulsion, composite materials, and superconductivity. A DOD Critical Technologies Plan (CTP) will be published annually and it should become a valuable tool for national dialogue and industry planning.

What's Happening on the Hill?

Let's review what has been happening in the Congress relative to the defense arena. The procurement reform provisions contained in Title VII of the Department of Defense Authorization Bill (Public Law 101-501) have directions that will impact on the defense industry.

Section 824 states DOD acquisition regulations are to encourage contractors to undertake research and development work that (1) strengthens the defense industrial base, (2) enhances U.S. industrial competitiveness, (3) promotes the development of critical technologies, (4) increases the development of technologies useful for both the private commercial sector and the public sector.

Section 810 directs that DOD adopt streamlined procedures for the acquisition of non-developmental items (NDIs).

Section 821 requires that DOD (in its annual report to the Congress on critical technologies) identify each program element within the budget that supports development of one or more of these critical technologies, the allocation of funds to individual technologies within that program element, and a comparison with the allocation of funds the previous year.

It is interesting to note that Section 822 calls for the establishment of a Critical Technologies Institute as a Federally Funded Research and Development Center (FFRDC).

Finally, Section 823 requires that DOD, in consultation with the Departments of Commerce and Energy, and other relevant federal agencies, develop a National Defense Manufacturing Technology Plan. These appear to be steps in the right direction. The challenge will be to take them as intended.

Adversarial Relationship

One of the key factors contributing to the erosion of our industrial base has been the adversarial relationship between the DOD and its contractors. To terminate this type of relationship, DOD must recognize that it is right and proper for industry to make a reasonable profit on goods and services it sells to the government. On the other hand, industry needs an incentive to invest in high-technology equipment and associated facilities, but the DOD can ill afford to encourage American manufacturers to "overfacilitize." Without some incentive, the industrial base will lose any drive it has.

Fortunately, Deputy Secretary Atwood believes the government must expedite the "transfer of leading edge technologies produced in our defense and national laboratories to United States industry." Further, he believes "the DOD should develop policies that encourage competition among different technologies as well as among companies."

If DOD does as Deputy Secretary Atwood proposes, contractors treated fairly and offered proper incentives will generate the most value for their investments, thus improving our industrial base. In the past, the false-competition factor (misuse of evaluation criteria in judging proposals) and misuse of second-sourcing (creation of competition for a relatively small production run and/or forcing facilitization of a second source for production quantities that do not justify such facilitizations) had a negative impact on our industrial base.

Findings in Three Recent Studies

—Harbor Research, Inc., Study

The American industrial base—including the defense industrial base just alluded to—is facing tremendous challenges that will result in major

changes during this decade. This period will be critical to the overall development and survival of American industry.

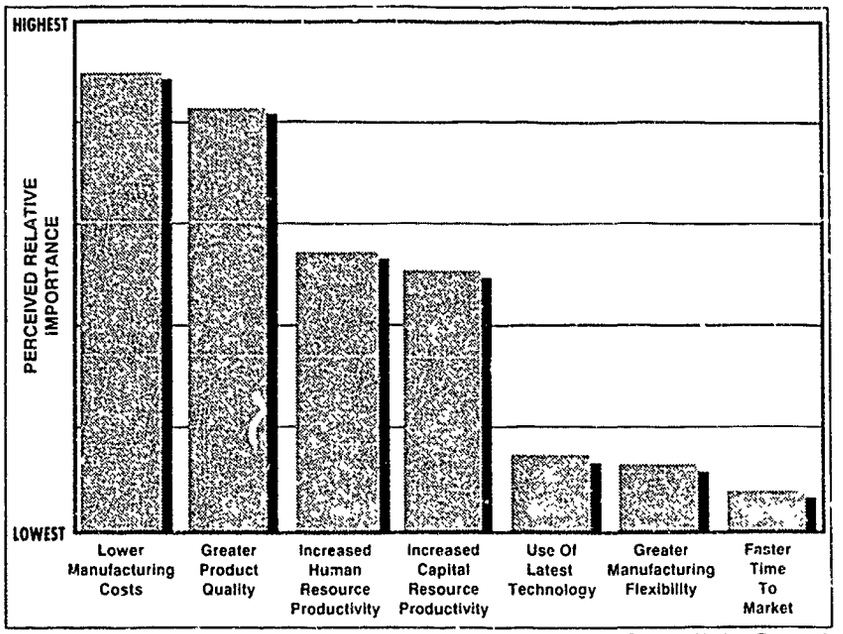
According to Glen Allmendinger of Harbor Research, Inc.,[3] 'The world manufacturing industry is beginning a decade of unprecedented competitive displacement, a decade that will require bold new business strategies." American manufacturers are no longer the world's technological leaders. Manufacturing competitiveness has its roots in management decision-making, philosophies and biases. Competitiveness is not as deeply rooted in technology challenges, unfair competition, and blue-collar work rules. Allmendinger believes that overhead, slow decision-making, and separation of product and process design are symptoms of a "bureaucracy that is eating itself alive."

Results of a survey of 80 senior engineering, manufacturing, and operations managers by Harbor Research are worthy of consideration. The survey determined that increasing product quality is the principal reason for automating; however, based on investment drivers, lowering manufacturing costs are usually easier to justify. See Figures 1 and 2. The close ranking of cost and quality indicates manufacturers understand that building the product right the first time lowers cost.

Harbor Research recommends radical strategy changes in six areas to reconcile manufacturing competitiveness with investment; namely, management approach, organizational structure, product realization and innovation, operations philosophy, automation technologies and investment, and education and training. Let's consider each area.

1. **Management Approach.** American management will have to develop real team approaches—tightly knit organizations that create responsiveness and company-wide ownership of ideas. Further, management will have to reduce key decision cycles by cutting extraneous levels and setting up new standards. Management will have to decentralize information flow. In this way, the company will be able to process more information and make faster (and hopefully better) decisions

FIGURE 1. INVESTMENT DRIVERS



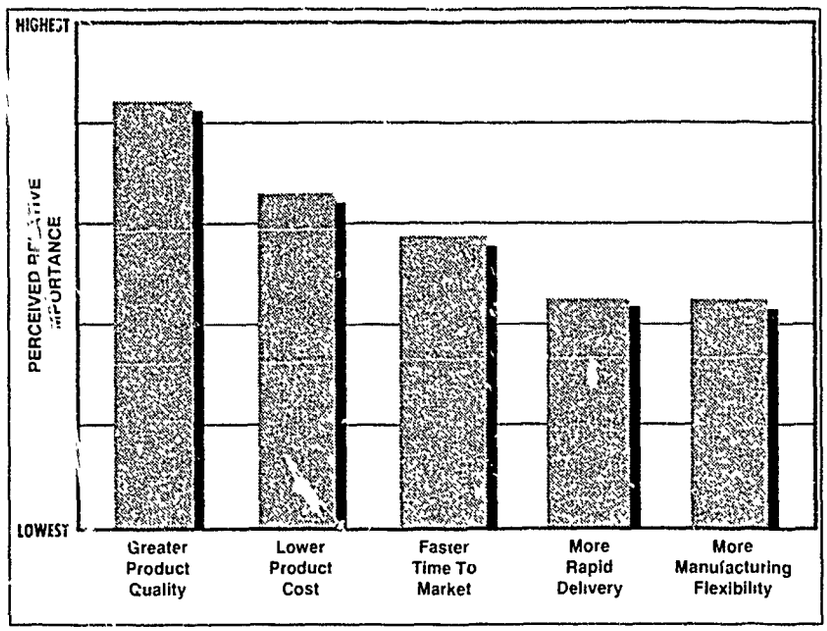
Source: Harbor Research

2. **Organizational Structure.** According to Harbor Research, "The move toward greater simplicity is a do-or-die necessity." Without structural flexibility, American industry will be unable to respond to the global market's quickening demand for innovative products and services. American companies will have to instigate *ad hoc* team approaches and develop multidisciplinary managers to survive.

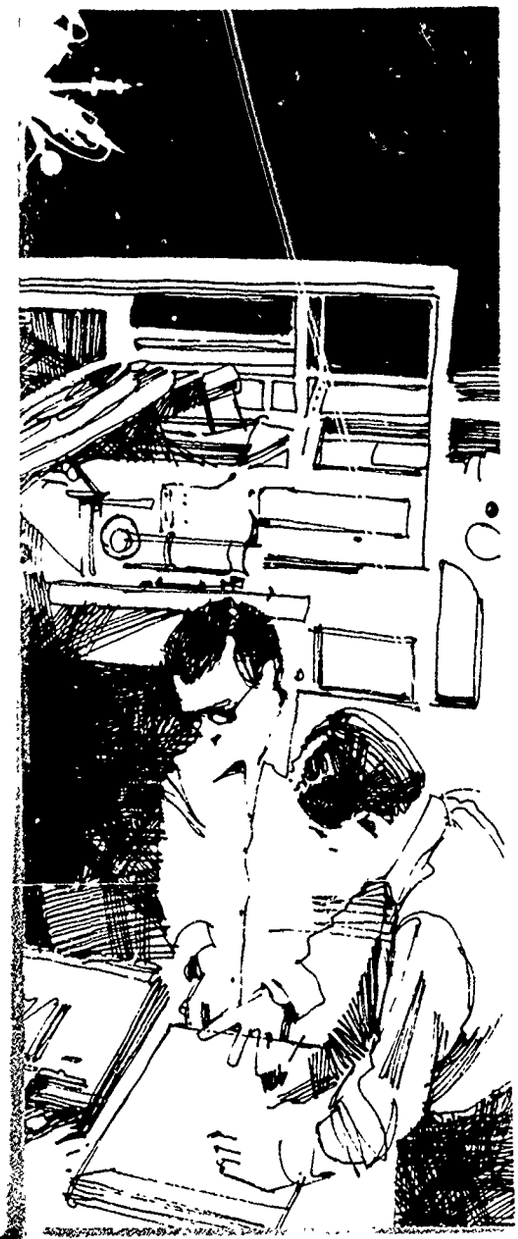
3. **Product Realization and Innovation.** Offshore manufacturers are continuing to decrease turnaround, thus creating competitive advantages over American counterparts. American companies will have to integrate product specification and process design through a team-oriented approach.

4. **Operations Philosophy.** Current operations philosophies rely on outdated assumptions like high-volume and stable markets, stable product mixes, and stable currency. These assumptions have promoted rigid functional boundaries and management incentives based on span-of-control performance rather than on performance of the whole enterprise. The new philosophies American industry adopts must result

FIGURE 2. COMPETITIVENESS DRIVERS



Source: Harbor Research



in producing high quality goods at the lowest cost and with optimum long-range flexibility.

5. **Automation Technologies and Investment.** Past American manufacturing strategy presumed that continuous bandaging and minor improvements of facilities and processes would protect capital investment. Today, progressive American companies are investing in flexible, integrated technologies to broaden their range of products beyond those which a single facility or production line can build. Flexible automation is permitting them to reconfigure quickly and to engage in lower profitable product runs.

6. **Education and Training.** Education and training are musts in the 1990s in America. The Harbor Research report notes, "In a period of rapid changes, education becomes a critical success factor. If management and workers cannot find an effective way to apply new philosophies and automation tools, no amount of technology will solve the manufacturing challenge."

—Ernst and Young Study

According to results of a study by Ernst and Young,[4] of 277 manufacturers located primarily in the Great Lakes area, 72 percent of the companies surveyed will hold, but not improve their current competitive position. Seventeen percent will lose ground. Fortunately, it appears that most of the companies are taking the necessary steps to improve.

Ernst and Young found that successful American manufacturers use the following common strategies:

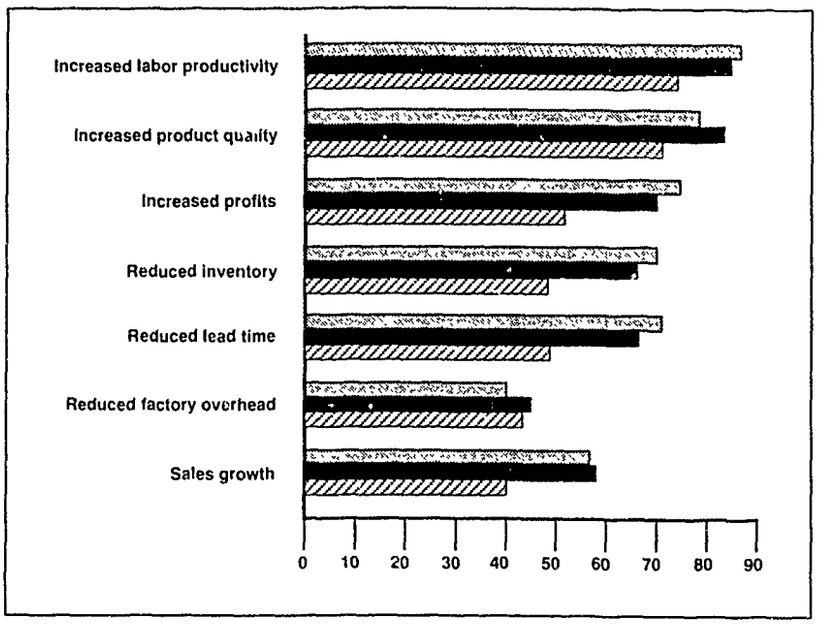
—Place decision-making authority at the operating level
—Focus on quality improvement rather than on cost reduction (and achieve both)
—Invest significantly in human resource development and technology
—Focus on planning processes including their internal organization and their external competition
—Use operating measures extending beyond traditional manufacturing views
—Offer broad product lines upgraded through continuous innovation and, thereby, gain a good reputation for products and services
—Integrate vertically, become involved in international markets, and are less involved in markets where customer bargaining power is cause of change.

—Deloitte & Touche Study

According to findings, the survey conducted by Deloitte & Touche[5] of 759 manufacturing executives, quality will be the critical factor for success in the 1990s. It will be only the price of admission in the global market. Findings revealed that customer service will become a competitive battleground and American manufacturers must establish good customer service to gain a desirable edge.

Gregory M. Seal, a manufacturing consulting services partner at Deloitte & Touche, indicated that service includes ease of product repair, presales technical support, and aftersales support. Most survey respondents said they plan to improve their business infrastructure by making a strong commitment to human resources, vendor quality, labor/management relations and worker safety. Less than 30 percent of the respondents believe they are receiving significant benefits from their investments in advanced

FIGURE 3. PERCEIVED BENEFITS OF TECHNOLOGY



technology. See Figure 3. Only 25 percent of the manufacturing executives surveyed claimed their companies were operating at the state-of-the-art level in manufacturing technology.

Impact of European Economic Community

This paper would not be complete without comments on EC 92, mentioned earlier. The EC 92 comprises 12 European countries planning to take some 300 legislative actions to remove trade barriers and create an internal market by 1992. The European Community includes the United Kingdom, Germany, France, Belgium, Denmark, the Netherlands, Spain, Portugal, Italy, Greece, Luxembourg and Ireland. The European countries of Austria, Finland, Iceland, Norway, Sweden and Switzerland did not join EC. They have been grouped into the European Free Trade Association for more than 25 years and prefer independence rather than alignment with the EC They are receiving many EC benefits without incurring the costs of membership.

To date, only about half of the measures issued by the EC Council of Ministers to eliminate trade barriers and deal with regulations governing testing and certification of industrial products, agreements relating to patents, and a general system of mutual recognition of diplomas issued for higher education have been enacted. Areas of primary concern to the United States are the potential impact of the EC actions on standards, standards development and implementation, and the procedures being written to test and certify regulated products marketed in Europe. Most observers agree that the EC will not wipe out cultural distinctions and the economic changes will not result in a United Europe similar to the United States.

One week before President George Bush met with European leaders in Paris in the fall of 1990 for the Conference on Security and Cooperation, he signed a statement aimed at formalizing ties between the United States and the EC. The statement called for more frequent meetings between United States officials and EC leaders. This appears to be a good move because business leaders on both sides of the Atlantic have been taking a great interest in the developing community of European nations.

Many American small- and mid-size companies have been concerned about how foreign competition will affect their businesses. According to a survey by Peat Marwick in 1989, a majority of the American companies will be "called to action" if companies in the EC become a more competitive force in the United States. American industry speculates that as the companies in the EC of nations grow stronger, they will compete in our market and have a direct impact on the American manufacturing community.

To date, many small and mid-size American companies had mixed success in exporting products. On the other hand, many wholly owned subsidiaries or branches of multinational corporations have been successful. It appears that small- and mid-size American companies will have to develop offensive and defensive strategies to meet and survive this new competition. It is of paramount

importance that these American companies learn quickly how they may be affected. Their continuing existence may depend on making informed decisions about whether or not to expand their market globally.

American Education

Investment in education must become a national priority. One major cause of decline in our industrial and economic competitiveness is related to our educational system. Colby H. Chandler,[6] believes the education gap between the United States and its competitors is alarming. He says "We are failing as a nation to provide this country with a properly educated work force....Our failure to provide manufacturing with an educated and skilled workforce may not seem serious today. However, the full extent of the problem will become evident when economic times get tough." It is his conviction that an extraordinary manufacturing capability is essential if we are to avoid massive dollar appreciation as the means to balance America's external accounts. A poorly educated work force will undoubtedly keep our country from achieving that capability.

The trouble with our times is that the future is not what it used to be.

—Paul Valery

If America does not adequately educate the engineers and technicians who will be called upon to support advanced manufacturing requirements, our country will not be able to develop or maintain a world-class manufacturing environment. Deputy Secretary Atwood recognized this. He said "The challenges in this area are enormous, but the opportunities are equally great."[7]

Program Manager

Closing Thoughts

American companies possessing the knowledge and experience required for survival of our industrial base—knowledge and experience that can't be duplicated easily by a foreign company—must concentrate on things they do best and team with other companies in their industry, or form joint ventures to remain competitive in today's global environment. The Congress must pay close attention to the erosion of the American industrial base. It may have to relieve some of the tax burden on American industry, the kind of burden not imposed on foreign firms selling products in the United States.

It would be appropriate, it seems to me, for the Congress to establish incentives for long-term investment in the modernization of our industrial base, as well as in technological development. While doing so, of course, efforts of the Congress, and the Executive Branch, to strengthen the American industrial base should in no way be politicized.

It appears to be clear to me that by the beginning of the next century, there will be three highly competitive manufacturing and trading areas in the world; namely, the United States, the European Economic Community, and the Far East countries (often referred to as "Pacific Rim" countries). The Far East countries probably will be led by Japan. The great markets of the world will no longer be defined by national borders. Leaders in the global market will be what we refer to today as "World Class," companies competitive internationally. To attain this status, these companies will set a reasonable price for their products, offer high quality products, and assure products are available on a timely basis.

The Final Showdown

In the final showdown, deterrent strategy of the United States depends on maintenance of a healthy industrial base that is technically advanced, efficient, and sufficiently flexible to respond to any crisis. In the United States in the future, joint ventures and merges will probably gain greater importance than in the past. Undoubtedly, the new European Economic Community with 320 million people, the largest single market in the industrialized world, will provide challenges for American industry, as will the Pacific Rim countries. There also will be new opportunities for growth and success in the world market.

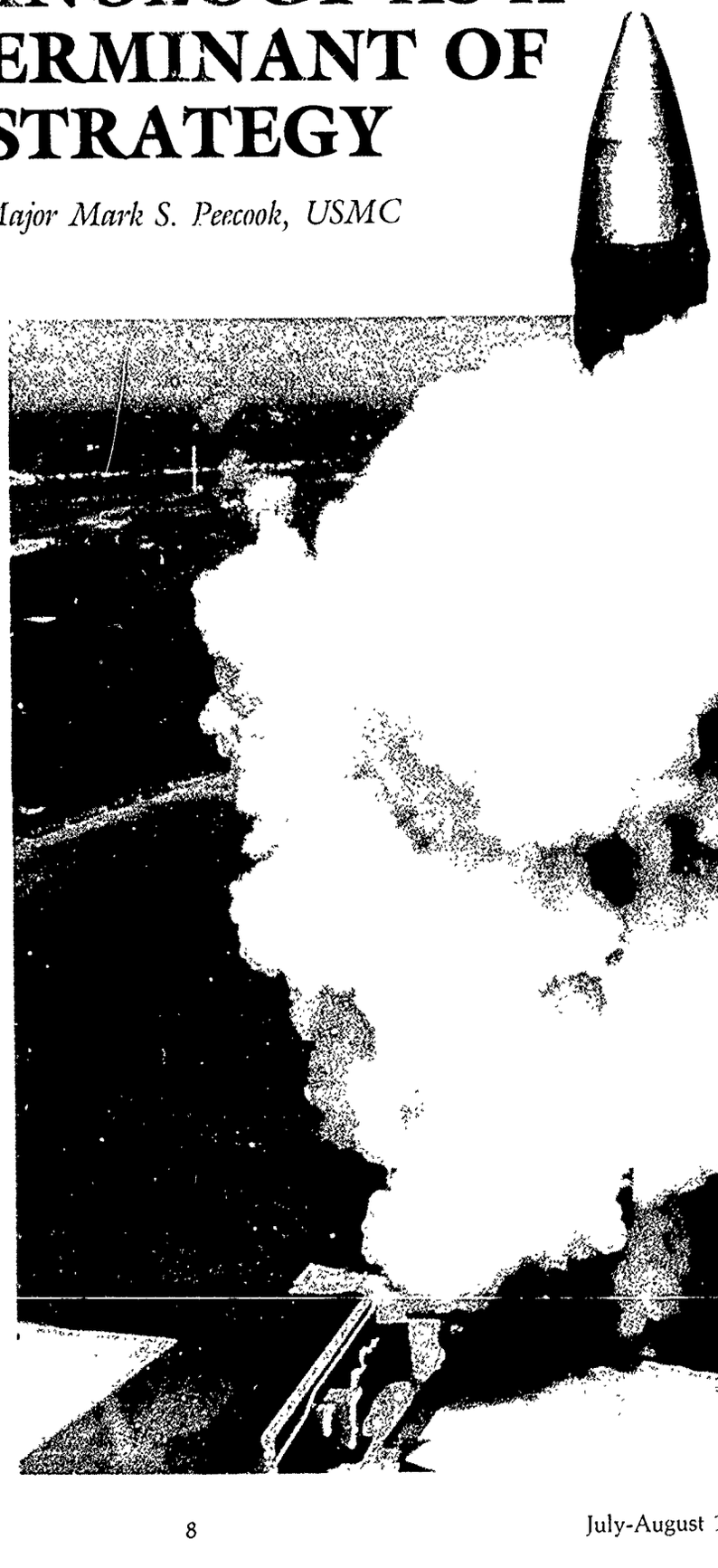
Many people believe that today's developing country will be the manufacturing leader tomorrow. The question that we as a nation have to answer is: "Do we have a national resolve to correct our mistakes and meet the challenges to be overcome before we can become a world-class technological and industrial leader?" Without such a resolve, without an unrelenting commitment to excellence, we may never regain the position of leadership once held in the industrial world.

Paul Valery[8] left us this food for thought: "The trouble with our times is that the future is not what it used to be."

(Continued on page 11)

TECHNOLOGY AS A DETERMINANT OF STRATEGY

Major Mark S. Peecook, USMC



Thinking is the hardest work there is, which is the probable reason why so few engage in it.

Henry Ford
1929

The necessity for thinking about America's national strategy is more important now than during the Cold War, when our threat and responses to that threat fit into well-established doctrine. Spurred primarily by vast increases in the refinement and application of computer- and science-related technologies, a qualitative reformation has taken place in the lethality of weapon systems, rivaling in its impact on thinking about warfare such earlier innovations as the rifle, tank, or satellite. This reformation spans the entire spectrum of weaponry and has elevated the role of technological advances within the strategy-making process to the point that, in some cases, technological possibility has become the main determinant of strategy for dealing with a real or perceived threat. Although there appears to be a reduced quantitative threat from the Soviet Union, the United States must maintain its technological edge because it is the ultimate strategic determinant.

These are heady times in the Soviet Union. The once cherished principles of Marxist/Leninist doctrine, established as the foundation of the

Major Peecook, Command and Staff College, Marine Corps University, MCCDC, Quantico, Va., is on the J-3 staff, HQTRS, CINC PAC.

A Peacekeeper missile lifts off from its modified Minuteman silo at Vandenberg Air Force Base, Calif., in a series of test flights. Peacekeeper is the first U.S. intercontinental ballistic missile to use the cold launch method in which a gas generator under the missile ejects the 195,000 pound missile out of the silo to a height of about 100 feet. The missile's first stage rocket motor then ignites, sending the missile to a range in excess of 5,000 miles. (U.S. Air Force photo released by the Department of Defense.)

Soviet Communist state, are being denounced by the liberalizing initiatives of Executive President Mikhail S. Gorbachev. Although the possibility of conflict between the United States and Soviet Union has diminished, instability within the Soviet Union due to economic collapse, ethnic dissent, and internal political strife remains a distressing prospect as United States political and military leaders develop future strategy. Even with these instabilities, it would be foolhardy to discount the Soviet Union's military muscle or its willingness to flex it in support of its national policy objectives.

Strategic Weaponry

Soviet military might has not shrunk as a result of Gorbachev's political, economic and military reforms. In fact, the possibility of unauthorized or accidental discharge of chemical or nuclear weapons has been heightened by turmoil and tension in the Soviet Union. Soviet strategic forces are still massive, and will remain so even if all reductions under Strategic Arms Reduction Talks (START) are fully implemented. In April 1990, Senator Sam Nunn, Chairman of the Senate Armed Services Committee, described the START reductions during a floor speech. The much-touted 50 percent reduction in both intercontinental ballistic missiles (ICBM) and sea-launched cruise missiles is actually less than 30 percent of the total. Senator Nunn said "The Soviet Union can retain a force of 9,000 strategic nuclear warheads targeted at the United States under START."

Complete modernization of Soviet strategic weapon systems has made them more reliable, accurate and survivable. By 1999, the Pentagon predicts, two-thirds of the Soviet ICBM Force will be mobile SS-24 rail, and SS-25 truck-mounted ICBM launchers (*Military Space*, June 1990, Vol. 7, No. 12). The newly fielded 10 warhead SS-18 gives the Soviets a hard-target-kill capability against United States Peacekeeper and Minuteman silos. Additionally, the single warhead version of the SS-18 can be used against central launch and command and control centers. Bomber force modernization has occurred as AS-15 and AS-19 air launched cruise missiles (ALCM) have entered service with a 3,000-mile range. All of North America is now within ALCM range.

In an October 9, 1990, presentation to the United States Marine Corps Command and Staff College, Mr. Dolf Drogue, Agency For International Development, detailed the current world status of the ICBM threat. Presently, 15 nations have ICBMs. The Soviet Union still launches a new nuclear ballistic missile submarine every seven weeks.

Arms Control

As a result of continued buildup and modernization, one logical choice to this extension of the arms race would be Arms Control Treaties. Soviet cheating on existing arms control agreements remains a source of grave concern for the United States. In the Pentagon publication, *Soviet Military Power—Prospects For Change 1989*, there are almost 20 instances of Soviet treaty violations, including the Antiballistic Missile (ABM) Treaty, Strategic Arms Limitation Talks (SALT) I and II, the Biological Weapons Convention, and the Geneva Protocol on Chemical Weapons. The Soviet radar site at Krasnoyarsk is a clear violation of the ABM Treaty. The basic precept underlying United States arms control policy is that all parties must comply with the agreements. Based upon Soviet violations, future treaties for satellite or emerging space system technology will have little meaning and will have questionable contribution to national security, or global stability.

Technology Transfer

The Soviets have exploited the opening of relations with the West. Participation in Western exchanges results in technology transfer heavily in favor of the Soviet defense industry. According to the June 7, 1990, *Aviation Week & Space Technology*, technology transfer, both legally and illegally, contributed to the initial success of the Soviet's space shuttle, "Buran." The Buran, a clone of the American shuttle, made its first orbital flight in November 1988. Moreover, operation of naval versions of the SU-27 Flanker B, and MIG-29 Fulcrum aircraft from the

Tbilisi-class aircraft carrier, expected to join the Northern Fleet this year, has been reported (*Aviation Week and Space Technology*, October 8, 1990). Both Flanker B and Fulcrum are strikingly similar to United States advanced tactical aircraft. The Soviets have incorporated an optical-carrier landing system and steam catapult/arresting system closely approximating American systems. Soviet fighter-bombers have been modernized under Gorbachev to increase antiship strike capabilities and to provide air support for amphibious forces. Finally, the first full sized aircraft carrier is under construction.

A Declining Threat?

The most glaring discrepancy of the 1990 update of the Pentagon's *Soviet Military Power* is that it contains no information on the next generation of Soviet aircraft. According to *Aviation News and Space Technology* (October 8, 1990), the air superiority fighter (ASF) and counterair fighter (CAF) will be operational within 8 years, and will incorporate advanced glass cockpits (cathode ray tube displays), stealth characteristics, digital fly-by-wire, and other Western emerging technologies.

President Gorbachev has admitted spending 15 percent of the nation's gross national product on defense. This spending is still higher than when he came to power and does not include military related space programs (*NASA-Military Space*, April 9, 1990). Is the Soviet Union actually a polar bear in sheep's clothing?

The United States no longer has a "corner" on key strategic technologies. Our budget deficit reduces the money available for research and development (R&D). The Soviet Union has outspent the United States in R&D every year for the last two decades, according to the National Defense University Publication, *America Plans For Space*. Additionally, American allies are researching, developing, and marketing advanced weapon technologies of their own for Third World consumption, thereby contributing to weapons proliferation and regional instability. Note the proliferation of Soviet Union and Western weapons technology throughout Southwest Asia today.

In the 1990 *Congressional Research Service Report For Congress*, United States analysts place the Soviet Union ahead of the United States in pulsed power that could result in directed energy weapons, kinetic energy weapons, surveillance, and target identification for antisatellite (ASAT) weaponry. The Soviets have fielded the world's only ASAT system, which, although rudimentary, would still be effective in destroying our communication, navigation, and intelligence gathering capability (*ASPEN Strategy Group Report—ASAT and U.S. Military Space Policy*). The Soviet Cosmos 1,870 radar spacecraft has demonstrated the capability to image the ocean floor to depths as great as 1,000 feet. United States antisubmarine warfare (ASW) officials are quoted in *Aviation Week & Space Technology* (October 8, 1990) as being amazed at the detailed images of the Puget Sound sea floor where United States Pacific Fleet submarines are based. It would be naive to think that the Soviets are not using this technology to track submarines of the United States and Western allies.

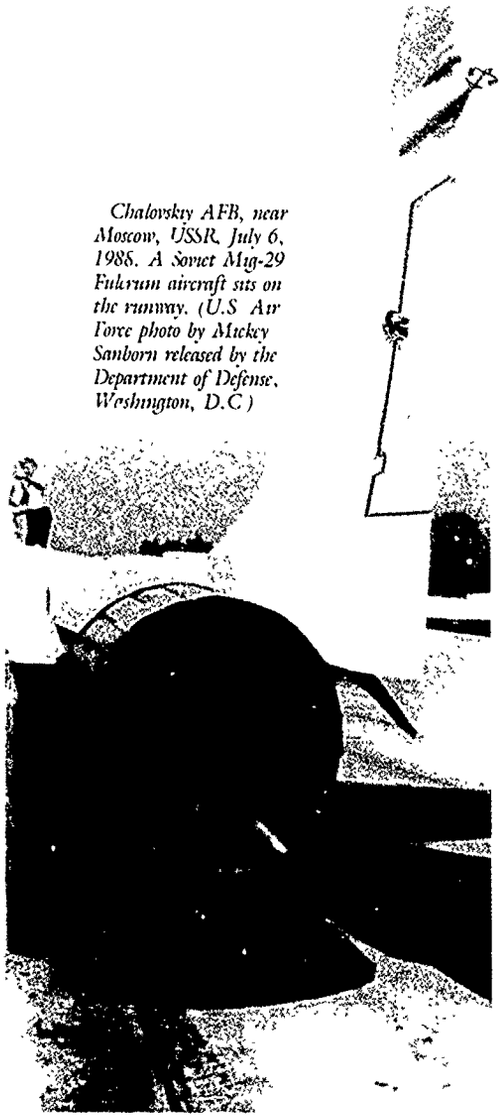
Recognition by the Soviets that the United States is ahead on stealth technology has encouraged the Soviets to excel far beyond the United States in technologies countering that threat. High power microwaves, electrothermal guns, ultra-wide band radars, charged particle beams, electromagnetic launchers, and neutral particle beams are aimed at reducing American stealth effectiveness.

For the first time in more than a decade, Japan's annual defense "white paper" omits the sentence, "The Soviet Force in the Far East is a potential threat for Japan." Instead, the paper indicates Soviet forces in the Far East have been reduced in quantity, but significantly improved in quality. *Aviation Week and Space Technology* (October 1, 1990) estimates tactical aircraft and ships operating in the Far East have been reduced by approximately 10 percent; however, in every category the equipment was updated with state-of-the-art technology. Almost 70 percent of all Soviet Far East forces are stationed surrounding Japan. Although the Soviet Union would find it troublesome to take hostile action against other countries in view of current international events, the military situation around Japan generates ominous security concerns.

Perestroika, Glasnost, and Demokracia?

Qualitative technological refinements to the entire arsenal of Soviet weaponry has more than made up for their numerical reductions. In the book, *The Eagles Talons, The American Experience at War*, the authors point out:

> ...the technological explosion during the last half of the twentieth century made warfare the



Chalovsky AFB, near Moscow, USSR, July 6, 1985. A Soviet Mig-29 Fulcrum aircraft sits on the runway. (U.S Air Force photo by Mickey Sanborn released by the Department of Defense, Washington, D.C.)

...the United States is not faced with the degree of change the Soviets are experiencing under their reform program of openness, restructuring, and democracy.

battle of brains. It would seem that Voltaire has been turned on his ear as God now seems to favor the best technology.

As a result of deterring Soviet threat to Western security, the United States has formulated strategy traditionally relying on a qualitative edge to offset a Soviet quantitative edge. If history is any indication, complex technology sectors of our nation's industrial base will prove even more vital to national security. Should the United States prove unable to be a leader in areas of sophisticated technologies, it would incur severe economic and security consequences such as the loss of export markets, further erosion of the industrial base, and even more dependence on overseas technology for our defense.

In the past, the Soviet Union countered high-technology weapons by producing vast quantities of durable, lower-technology weapons. As shown, however, many of the Soviet's most modern weapons are technologically more advanced than America's. Vigilance, therefore, dictates that the United States significantly increase money devoted to R&D, guard against lopsided technology transfer, and closely monitor Soviet capabilities which threaten America's security.

Fortunately, the United States is not faced with the degree of change the Soviets are experiencing under their reform programs of openness, restructuring, and democracy. Ensuring Soviet actions resemble their stated peaceful intentions could be America's most life-enhancing strategic decision.

ACKER

(Continued from page 7)

Endnotes

1. Remarks by the Honorable Donald J. Atwood, Deputy Secretary of Defense, National Forum Foundation, Washington, D.C., November 6, 1989.

2. Hal Sperlich, President, Chrysler Corporation (1984-1988), and a 20-year employee with the Ford Motor Company.

3. Glen Allmendinger, President, Harbor Research, Inc., Boston.

4. "The American Competitiveness Study," by Ernst and Young, Cleveland, Ohio, 1990.

5. "Survey of North American Manufacturing Technology," Deloitte & Touche, Cleveland, Ohio, 1990.

6. Remarks, Colby H. Chandler, Chairman and Chief Executive Officer, Eastman Kodak Company, 1989.

7. Atwood.

8. Paul Valery (1871-1945). He succeeded to the chair of Anatole France at the French Academy.

AAWS-M GUIDED MISSILE FLIGHT

The advanced Anti-tank Weapons System-Medium (AAWS-M) completed its second guided flight test in less than 30 days. It was launched successfully from Redstone Arsenal test facilities, Huntsville, Ala., in May and achieved test objectives. The AAWS-M is in full-scale development by a joint venture comprising Texas Instruments Defense Systems & Electronics Group (DSEG) of Denton, Texas, and Martin Marietta Electronics Information & Missiles Group of Orlando, Fla.

The AAWS-M is a man-portable, antiarmor system capable of defeating current and projected armor threats in robust battlefield environments.

SUBCONTRACT MANAGEMENT

A Key Function in Acquisition Process

Earl V. Mooney, Jr.

The ever-increasing technical complexity and higher costs of major weapon systems within the Department of Defense (DOD) created the need for more effective and efficient management approaches and techniques for weapon system procurement and manufacturing surveillance. In the early 1950s, prime contractors subcontracted as little as 9 percent of the total procurement funds. In recent years, however, subcontracting often constitutes 50-75 percent of the total hardware build effort. The growth of subcontracting of DOD programs can be seen in Figure 1.[1]

A vast amount of work on major programs is being performed by subcontractors, creating opportunity for management. Subcontractor management is a key function in the acquisition process. Enhancements in subcontractor management by prime contractors and the government can positively influence these portions of a major system. As the overall work performed by subcontractors has increased, that portion/share of subcontracted work in electronics has increased. Therefore, emphasis on the management of electronics subsystems can provide significant returns for time spent.

With the growth in percentage of subcontracted work and increased

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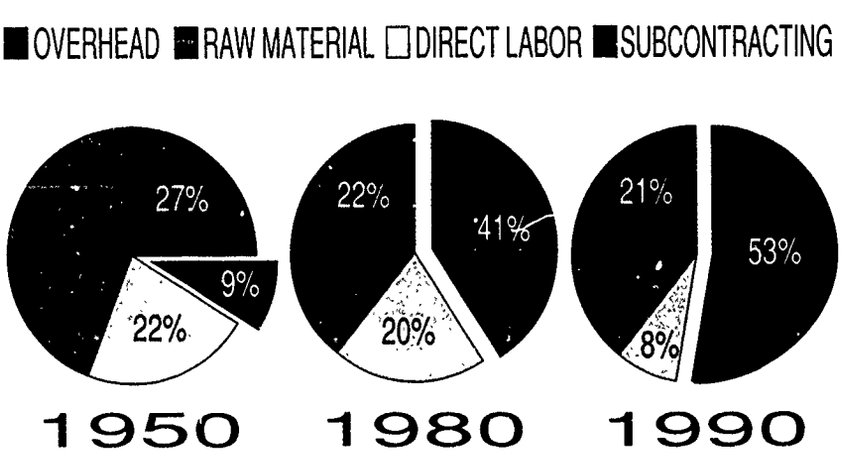
electronic content, subcontractors for major system acquisitions programs are situated widely throughout the United States. For example, on the Air Force Systems Command (AFSC) Airborne Warning and Control System (AWACS) program, subcontractors produce components and subsystems in 50 states. This geographic dispersion introduces a risk to the hardware shipment schedule to the prime contractor.

Most of the prime contractor make-or-buy decisions are based on hard economics. Manufacturing capability, production capacity, material and process technology, and design capability are reasons for the increasing significance of subcontracting the build effort within major hardware acquisitions. Sometimes, subcontractors specialize and produce electronics more cost effectively. Using subcontractors often enables prime contractors to broaden their business bases. As a result of subcontracting, many aerospace prime contractors evolved from being fabricators to integrators specializing in systems and assembly. This changing environment is shown in Figure 2.

FIGURE 1. GROWTH OF SUBCONTRACTING



However, subcontractor failures to fulfill contractual manufacturing and quality assurance (QA) commitments to prime contractors have led to technical problems, schedule delays, costly growth poor reliability in the field, and supportability concerns on major defense acquisition programs. Late deliveries of subcontracted hardware to support final assemblies of major systems caused prime contractors to build-to-shortages and out of sequence. Schedule slips cause "workarounds" at the prime contractor's plant and may increase price of the end-item. Problems are caused by deficiencies in supportability planning resulting in lack of support equipment, spare parts, and technical orders. Dependence on certain subcontractors for manufacturing specialized/critical elements of systems causes a greater need for more government involvement in subcontracting management.

Privity of Contract

The government has no contractual means for directly monitoring problems at the subcontractor's manufacturing plant. Government involvement in subcontract management is indirect because it is conducted through prime contractors responsible for managing their subcontractors. The DOD has no sanctioned contractual avenue for directly addressing problems at the subcontract level. This DOD policy is called the privity of contract doctrine, which is defined as "...the legal relationship between two parties of the same contract. The government has privity of contract with the prime contractor. The prime contractor has privity of contract with the subcontractor"[2]

Restrictions of DOD control under privity of contract apply to relationships between a prime contractor and a first-tier subcontractor, between a first-tier subcontractor and a second-tier subcontractor, and so on, as shown in the communications network in Figure 3.

Participants

The consensus among most government acquisition managers and their critics is that the government must be involved in subcontracting management and that the present level of involvement is inadequate. Close teamwork between system program offices (SPOs) and contract administration services (CAS) organizations is necessary for effective subcontracting management. The SPO subcontract management is conducted through the prime contractor.

FIGURE 2. AEROSPACE/DEFENSE TRENDS

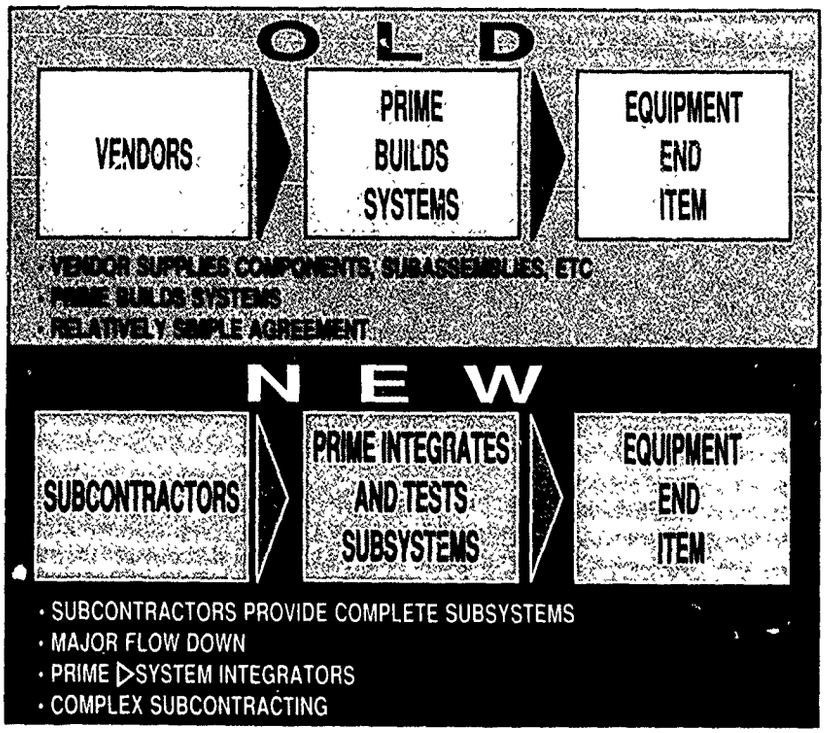
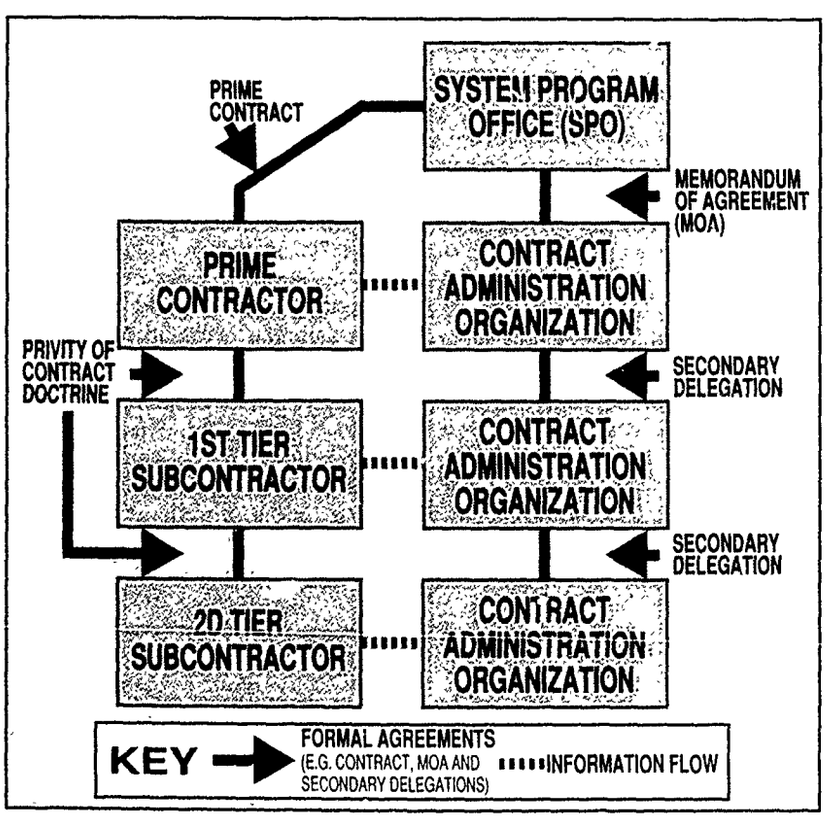


FIGURE 3. COMMUNICATIONS NETWORK



The contract administration organization monitors the prime contractor's management effort of its subcontractors and the performance of the prime, as shown in Figure 4

After selecting a subcontractor, time locks in the subcontractor, just as it does a prime contractor. To enhance the subcontractor selection process, the criteria for selection of the prime should include an evaluation of the prime's policy and procedures for subcontractor management. The prime contractor's experience in subcontract management, which is manifested in the prime's past performance, must be addressed.

Another tool available to the DOD and government procurement activities providing preliminary information about contractor subcontractor performance is the Defense Logistics Agency (DLA) Contractor Alert List (CAL). The DLA policy advises buying activities of contractors, who should be elevated and who should be requested to demonstrate affirmatively their responsibility and, when necessary, responsibility of their prospective subcontractors before being awarded contracts.

Program managers must ensure required contractors performance by assigning individuals within the System Program Office to be responsible for coordinating subcontracting efforts among SPO and CAS organizations. A program memoranda of agreement should be developed by the System Program Office identifying specific SPO and CAS required tasks. A key ingredient in effective subcontractor control is good communication among the government prime contractor and subcontractors.

The MIL-STD-1528A, *Manufacturing Management Program* prescribes that the contractor's procedures to provide continuous management visibility and control of subcontractors, vendors and suppliers shall assure that the requirements of the military standard flow down and are effectively implemented. The military standard states "these procedures shall specify contractor review of subcontractor manufacturing management plans, systems, and production facilities....Routine use of contractor manufacturing organization special-

ized disciplines to assist in the selection and management of subcontractors, vendors, and suppliers is necessary to perform this requirement. Government representatives may attend these reviews as observers." With coordination of the cognizant Contract Administration Office (CAO), the SPO focal point should schedule these visits during crucial program phases. The SPO and CAO organizations must ensure prime contractors perform subcontracting functions efficiently and effectively, stressing contractual compliance with technical, cost, schedule, and supportability requirements on major system acquisitions.

Lessons Learned

A recent DOD major program subcontracted 65 percent of the program production hardware build effort to six subcontractors. The program lacked sufficient flow-down of manufacturing and QA contractual requirements to the major subcontractors. Consequently, the six subcontractors utilized by the prime produced hardware that exhibited poor quality and workmanship.

To resolve the problem, the program office manufacturing and QA engineer teamed with the prime contractor and performed production readiness reviews (PRRs) at the subcontractor level. The PRRs were fully sanctioned by the prime contractor. The prime readiness review is a formal review to determine whether a system or product under development is ready for efficient and economical quantity production, important production engineering problems encountered during development have been resolved, and the contractor has accomplished adequate planning for the production phase. The production readiness review provides program management with quantitative information to ensure that the decision to proceed with production be made without incurring unacceptable risk to the program in terms of cost, schedule or system performance. It is the risk assessment that provides a significant input to the decision process to proceed with production.

Additionally, the PRR team inspected the quality control system of each subcontractor and made recommendations to the System Program Office. A key step in this venture was the follow-up inspections to ensure subcontractor compliance with prime contractor/government recommendations.

Workmanship quality assurance problems associated with this program were traced to subcontract failures to fulfill program contractual requirements of MIL Q-9858A *Quality Program Requirements*. To help identify and resolve these problems at subcontractor plants, strict compliance with government inspection requirements at subcontractor facilities as stated in MIL-Q-9858A is essential. With the military standard, the CAS quality assurance organization shall recommend secondary delegation of hardware inspection at major, critical subcontract plants to ensure that the contractual quality assurance requirements are being met.

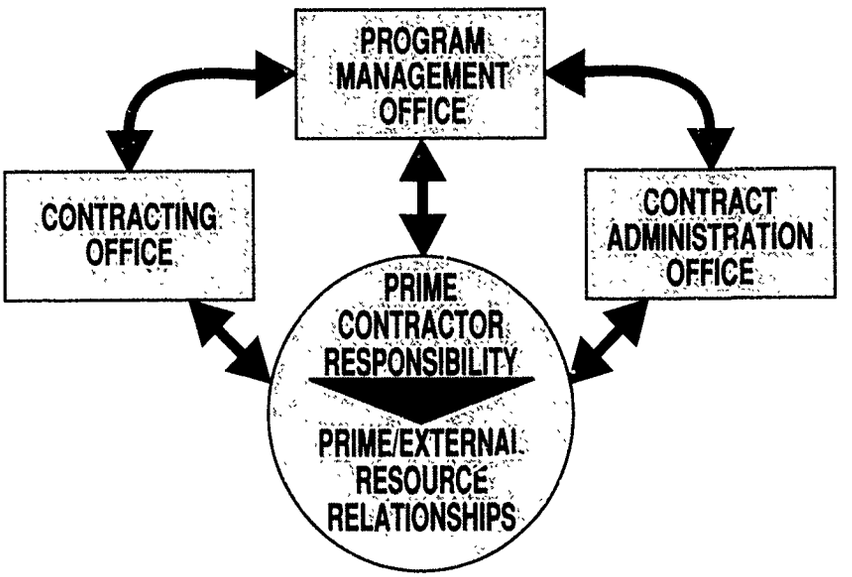
The PRR effort at the subcontractors' plants was accomplished by the prime thoroughly educating the subcontractors regarding key technical elements within the contract. Also, the prime positioned one of his engineers to assist subcontractors at each subcontractor plant. These efforts combined with follow-up inspections by the prime and government enabled this DOD prime contractor to sustain a new production program delivery schedule and also to finish 10 hardware deliveries ahead of schedule.

Experience gained shows that, when subcontractor management receives proper emphasis by the government and the prime contractor, the program hardware quality, reliability and delivery schedule requirement can be met or exceeded.

Concerns about subcontractor management were highlighted by a Defense Logistics Agency (DLA) survey published in the August 4, 1986, issue of *Aviation Week and Space Technology*. The DLA survey of 400 prime contractors found "...75% were not managing their subcontractors at normally accepted business standards. The DLA will continue to press prime manufacturers to promote efficient subcontractor work since between 50-75% of defense contract value is spent at the subcontractor level, with the primes increasingly reverting to an assembly role."[3]

The issue of subcontractor or external resource management is so important that improvement in this area could significantly impact the na-

FIGURE 4. PARTICIPANTS IN THE PROCESS



tional system delivery capability and readiness. The ability of prime contractors to management and integrate their subs, especially the management of major subcontractors, will have a direct bearing on the future success of DOD acquisition programs.

Success 90

Electronic Systems Division, Air Force Systems Command, sponsored an initiative to improve the national capability in managing subcontractors by increasing defense industry awareness of subcontract management.

The Electronic Systems Division within its Industrial Base Planning Group, the Directorate of Manufacturing and Quality, coordinating with Production Divisions and Command Offices of Prime Responsibility (OPRs), defined an approach to identify issues vital to the relationship between primes and subcontractors, the group described the process called "subcontractor management," as it exists today, and identified current inhibitors to achieving an effective process.

This project, known as "Subcontractor Excellence in Supplier Systems for the 1990s (SUCCESS 90), comprised a two-step program. The first step established an awareness and created advocacy within industry and Air Force. The second step created guidance with a "Best Practices" set of program management guidelines focusing on traps, pitfalls and constraints to achieving program objectives through application of subcontractor management.

Working sessions included representatives from McDonnell Douglas, Hughes, Martin Marietta, LTV, TRW, UNISYS, Grumman, Westinghouse, Boeing, Rockwell-Collins, Singer, and Textron Lycoming. Each committed senior managers to achieve an industry consensus. Working session participants were divided into four panels dealing respectively with the topics of management structure, source selection, contractual structure, and working relationships. Each panel, chaired by an industry member, included at least one government participant.

Dynamic improvement initiatives and existing government procedures, policies and regulations must be more aggressively utilized to achieve success in subcontract management.

The management panel focused on program and functional organization alternatives to ensure appropriate management emphasis was given to subcontractor management, and identified the appropriate resources necessary for successful program execution. The source-selection panel identified tools and techniques for management mainstream decisions relating to supplier risk-capability and capacity. Key elements examined by the contractual structure panel included clarity of contract requirements and appropriate application (tailoring) of flowdown provisions, establishing effective lines of communication among players while protecting privity of contract and proprietary data and processes, real-time status reporting, and other tools for managing the technical baseline. The fourth panel focused on necessary interactions and working relationships along with performance measurement techniques to foster the atmosphere of teamwork among customer, prime, and supplier representatives to ensure quality subcontracted systems were developed, produced and delivered in a timely and cost-effective manner.

Panel reports identified key elements and their importance to the management process, the constraints to achieving objectives, and how to deal with the constraints were documented.

The final step developed and published program management guidelines applicable to managing external resources and their unique contractual relationship. Once the group identified issues and impacts, a final version of the guide was published. Advocacy was sought within the management structure by presenting project results to the Air Force System Command.

The guide, *Process Improvement Guide for Subcontractor Program Management*, was presented to General Randolph, AFSC Commander, 1987-90. He supported project results and distributed the guide to industry CEOs, and solicited their comments. General Randolph directed that the guide be an AFSC management and training tool in the subcontracting management course at the AFSC System Acquisition School, Brooks AFB, Texas.

Conclusion

Effective subcontract management is a high payoff activity for DOD acquisition programs. Increased complexity in defense acquisitions in terms of user requirements, technology advancements, and changes in business practices have created a need for greater emphasis on management of resources beyond the corporate walls Dynamic improvement initiatives (i.e., the "SUCCESS 90" project) and existing government procedures, policies and regulations must be more aggressively utilized to achieve future success in the critical area of subcontract management.

Endnotes

1. *Process Improvement Guide for Subcontract Program Management*, November 17, 1989, p. 1-2.

2. "Subcontract Management," AFSC Regulation 800-21, (July 16, 1987), p. 1.

3. "Defense Logistics Agency Survey," *Aviation Week & Space Technology* (August 4, 1986), p. 25.

ATTENTION

ACQUISITION PERSONNEL

Are you required to prepare and/or review the Selected Acquisition Report?

The Defense Systems Management College (DSMC) offers a course designed to provide full understanding of the report requirement and the relationship of its documentation.

What's the SAR Course teaching approach?

Lecture/discussions cover the key elements/concepts of the SAR and apply these in related integrated computer-assisted case studies. Course offerings are scheduled primarily during the first quarter of the fiscal year to support preparation of the annual SAR submission to Congress. Because of the need for computer classroom resources, the course is given primarily at DSMC. Wright-Patterson AFB is also fully equipped, and thus will provide an early November 1991 offering and other DSMC regions will be added as computer classroom facilities can be made available.

New to the acquisition field?

Four classes are designed for new personnel. These classes will provide guidance on completing the SAR formats and on use of the CARS software.

So you've heard about the course or have already taken it!

Now the course has been upgraded to incorporate in-depth "hands-on" training sessions with the Consolidated Acquisition Reporting System (CARS) software. Other recent OUSD(A) content and courseware changes have been made to unify, simplify and facilitate computational aspects. Due to these individualized upgrades, class size has been restricted to 22.

Who should attend?

Attendance is open to all SAR-designated preparers and reviewers as well as service staff personnel with reponsibility for SARs. This includes officers O-2 and above and civilians GS-07 and above. Defense contractors under current contract to support a major SAR program are also eligible to attend, if recommended by that program manager.

Any questions?
For further information, contact the appropriate service training coordinator.

Selected Acquisition Report Course Schedule

FY 1991

*26 Aug - 30 Aug Campus**
9 Sep - 13 Sep Boston
23 Sep - 27 Sep Campus

FY 1992

28 Oct - 1 Nov Campus
4 Nov - 8 Nov WPAFB
*18 Nov - 22 Nov Campus**
9 Dec - 13 Dec Huntsville
*22 Jun - 26 Jun Campus***
*21 Sep - 25 Sep Campus**

FY 1993

19 Oct - 23 Oct Huntsville
26 Oct - 30 Oct WPAFB
2 Nov - 6 Nov St. Louis
*16 Nov - 20 Nov Campus**
30 Nov - 4 Dec Los Angeles
7 Dec - 11 Dec Campus

**Focus on new SAR preparers*
***Pilot class using updated materials*

Points of Contact

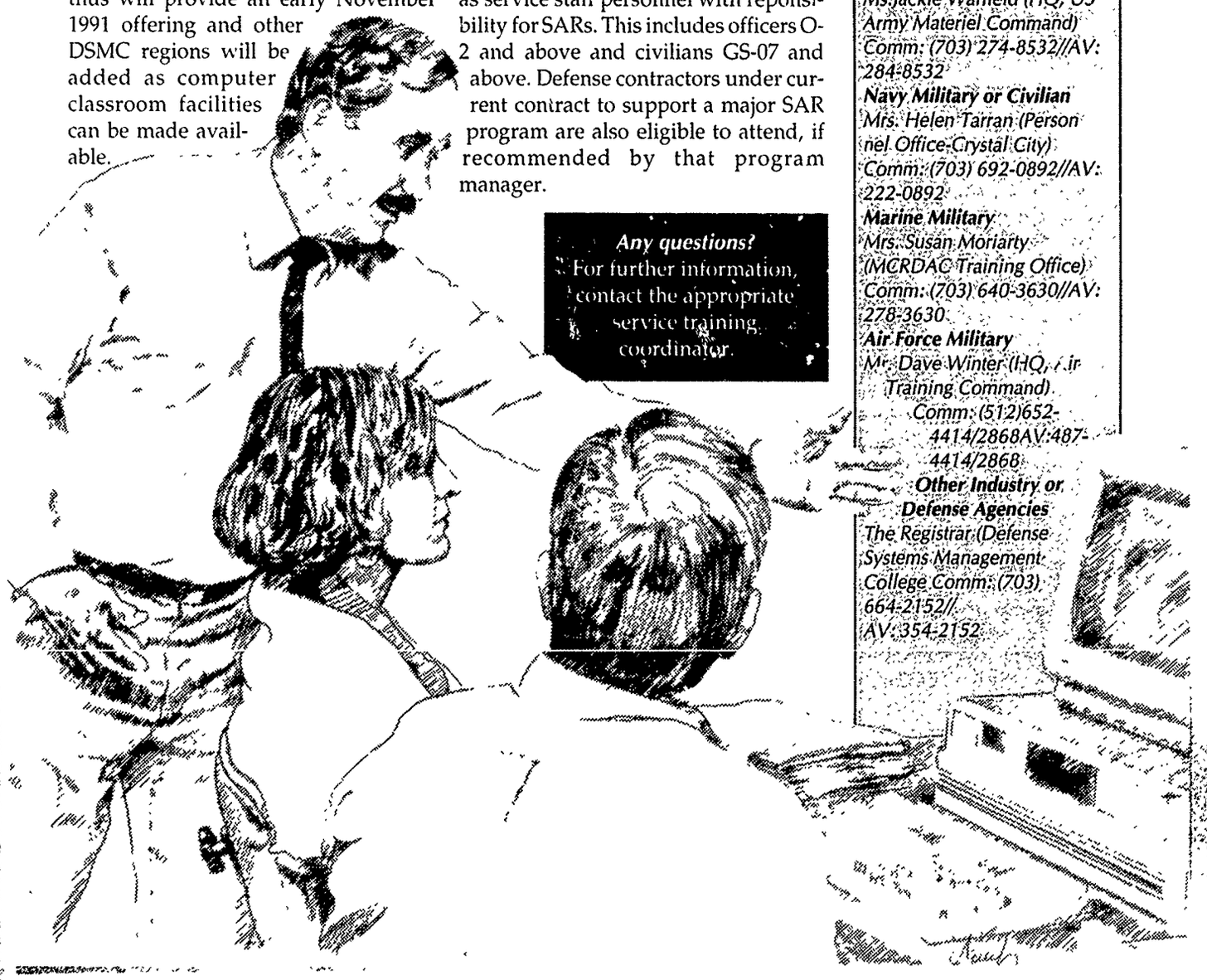
Army Military or Civilian
Ms. Jackie Warfield (HQ, US Army Materiel Command)
Comm: (703) 274-8532//AV: 284-8532

Navy Military or Civilian
Mrs. Helen Tarran (Personnel Office-Crystal City)
Comm: (703) 692-0892//AV: 222-0892

Marine Military
Mrs. Susan Moriarty (MCRDAC Training Office)
Comm: (703) 640-3630//AV: 278-3630

Air Force Military
Mr. Dave Winter (HQ, Air Training Command)
Comm: (512)652-4414/2868AV:487-4414/2868

Other Industry or Defense Agencies
The Registrar (Defense Systems Management College Comm: (703) 664-2152// AV: 354-2152



TOTAL QUALITY MANAGEMENT IN SOFTWARE DEVELOPMENT

Captain Roj Karimi, USAF

The rapid spread of total quality management (TQM) in the Department of Defense to enhance quality, productivity and improve our defense posture has attracted considerable attention, and should continue to gain momentum in future years. The real challenge to people in the acquisition business is how to measure "quality" in TQM quantitative and statistical terms.

In the wonderland of the software business, things are seldom what they seem. "Common practice more than often spawns uncommon results," and if simple Pert and Gantt methods were the solution, we wouldn't have existing problems.

As a part of the control of management processes, you need quantitative techniques to get the facts on a process and determine causes of a problem and, then, pursue corrective action in a timely fashion. In the last 2-3 years, new technology emerged that can be used to identify early-on when a project is going astray, to apply corrective action, and to predict new schedules, costs and expected reliability. These new software process improvement techniques are powerful, easy to use, and can be utitilized by management for launching a successful TQM effort.

Captain Karimi is Communications-Computer Systems Manager, Intell. & C3CM Systems, Electronic Systems Division, Hanscom Air Force Base, Mass.

Complex Undertaking

Managing and overseeing development of large-scale software systems is one of the most complex undertakings performed today at any system program office (SPO). It is, therefore, crucial that we use the most effective methods available to manage efficiently this process and to ensure quality products/services. Quality is a life raft to safety in these turbulent economic times. By quality I mean delivering to our users (customers) products that work, that last, and that provide customer satisfaction the first time and every time.

Total Quality Management

Throughout government and industry, it is acknowledged that for the United States to compete effectively, and for the Department of Defense and its contractors to create quality systems for national defense, we must embrace TQM principles.

The concept of total quality management is not new. Henry V, King of England (reigned 1413-1422), is a perfect model of quality conduct according to the Renaissance notion of statecraft and military leadership. He ingeniously defeated the French army at Agincourt (1415) against all odds by turning his weak, hungry, enfeebled and weary soldiers, outnumbered by the French (six to one), into a formidable force, leaving slain 10,000 French soldiers and noblemen but only 29 Englishmen.

Today, results of Japanese commitment to this philosophy during the last 40 years are evident.

What *is* new is our ability to apply these principles and those of Dr. W. Edwards Deming, Thomas J. Peters and Robert H. Waterman to the software management process, using statistical process control techniques in an easy-to-use framework. Total quality management is a good way to wake up a tired system!

Software is critical. Generally speaking, the industry track record has been poor, necessitating action and improvement. The challenge now is to apply our knowledge and

wisdom to improve management techniques in this crucial area. By correcting the process, we can avoid problems before they occur.

For the most part, an organization like the Electronic Systems Division (ESD) has limited leverage on contractors' internal development processes, such as the management environment, skill and experience of its staff, and use of modern tools and technologies. It's up to a wise source-selection panel to choose the best producer for a given system.

As program managers and acquisition managers, we do have leverage to ultimately influence the outcome of a project, and its schedule and cost performance. It is here that we can apply sofware TQM methods to the quantitative management data (software management metrics) which we've defined during the years. Now that we have gone to so much trouble to "get the data," it is important that we use it in a meaningful way.

Software TQM Goals for Program Managers

It's no secret that program managers' goals must be to manage effectively the development of mission-reliable systems within contract schedule, budget and, most importantly, to customers' satisfaction. The program managers must see to it that the job gets done right the first time.

Software management TQM seeks to accomplish this by applying statistical process control to management measures for an ongoing software project. It applies statistical methods to a management process traditionally governed by "gut feel," experience, or intuition. Data-driven improvement is a critical component of TQM, which makes metrics essential.

For software programs at the Electronic Systems Division, this can be applied as an "early warning system" to reduce the risk of contract overruns. It can make us more efficient and better at what we do and allow us, for the first time, to predict more accurately a project's outcome, based on real contractor progress data. This performance-driven approach is critical since it is inherently more objective than promises, which often have emotional overtones and can be unrealistic in some areas. If the predicted outcome based on real data appears unacceptable, corrective action can be identified early enough to have an effect. "Early warning" needs to be emphasized because applying change to a project in its late phases is difficult and has diminishing returns.

The customer comes first—the customer is always right. This is fine but a credo does not make a business. Customers do not want a policy—they want responsible action.

Specifics of Software Control

The basics of software control use four core metrics for schedule, effort, code production and test (software problem reports). Additional progress measures can be used if desired; however, these four define the "minimum set," thus holding criteria to those fundamentally necessary. This avoids the real and potential problem of data overload. The goal is to take ordinary data that are available and identify usable patterns and trends via computer analysis—not add unnecessary requirements and cloud basic objectives.

One objective is to determine in-progress contractor productivity based on actual data. Major breakthroughs in this area resulted from research by Lawrence H. Putnam of Quantitative Software Management, a leading expert on software estimating and control. He developed a computer-based model (SLIM-Control) that helps organizations verify progress and predict finish dates and costs during software development. Using project data, the in-progress efficiency being achieved can be determined. In this manner, the SLIM-Control model "learns" the unique behavior of a given project using expert methods. It is then possible to predict the remaining milestones, when they will occur, how quickly code will be written, the optimal staffing strategies, and expected defect rates during systems tests. These methods are more than simple data extrapolation. They use statistical curve-fitting techniques and take into account fundamental software process behavior. This more accurately reflects the nature of software as a design process. It is the result of years of research and development on thousands of complete projects.

Statistical control limits can be overlaid on the progress charts for each metric. The actual progress data are then plotted against the plan, and if the metrics begin to explode out of the control bounds, early warning is signaled and corrective action can be applied when most effective. This process control technique utilizes the statistical bounds as stopgaps to keep the project on course and minimize management risks. Management "what ifs" can be explored using computer simulation to see the effects of adding or reducing staff, functionality, or by management's actions which improve the productivity being achieved on a project.

Conclusion

Total quality management is a powerful management tool and will change the way defense work is done and give a new vision of reality. Total quality management means no defects, no bad practices and no unsatisfied customers. The goal is to provide customer satisfaction, make progressive improvement and achieve 100 percent quality. "If you don't shoot for 100 percent, you are tolerating mistakes." It is good business to follow these guidelines and when they're thoughtfully applied the results have proved to be extraordinary.

(Continued on page 27)

SCIENCE, TECHNOLOGY AND THE PROGRAM MANAGER

Robert A. Warren
Carleton R. Cooper

Since World War II, high quality weapon systems have been the cornerstone of United States military strength. Their development relies on four principal resources Department of Defense (DOD) management and acquisition skills, private sector engineering and manufacturing capabilities, an extensive DOD test and evaluation network, and the DOD science and technology (S&T) base.

Operating within a complex acquisition process, the typical DOD program manager (PM) controls a technically sophisticated program whose success often depends on the use of increasingly higher performance technology. The PM, whose activity is visible at the highest political level, must develop managerial skills to transition technology effectively into the advanced weapons systems needed to meet the mission in a changing world.

Our purpose in this paper is to describe the scope of the DOD science and technology base, and to suggest how it can be employed by the program manager during the acquisition life cycle.

Mr. Warren is a Professor of Engineering Management at the Defense Systems Management College.

Mr. Cooper, a senior engineer at Information Spectrum, Inc., served 30 years in the U.S. Navy as a naval aviator and aeronautical engineering duty officer.

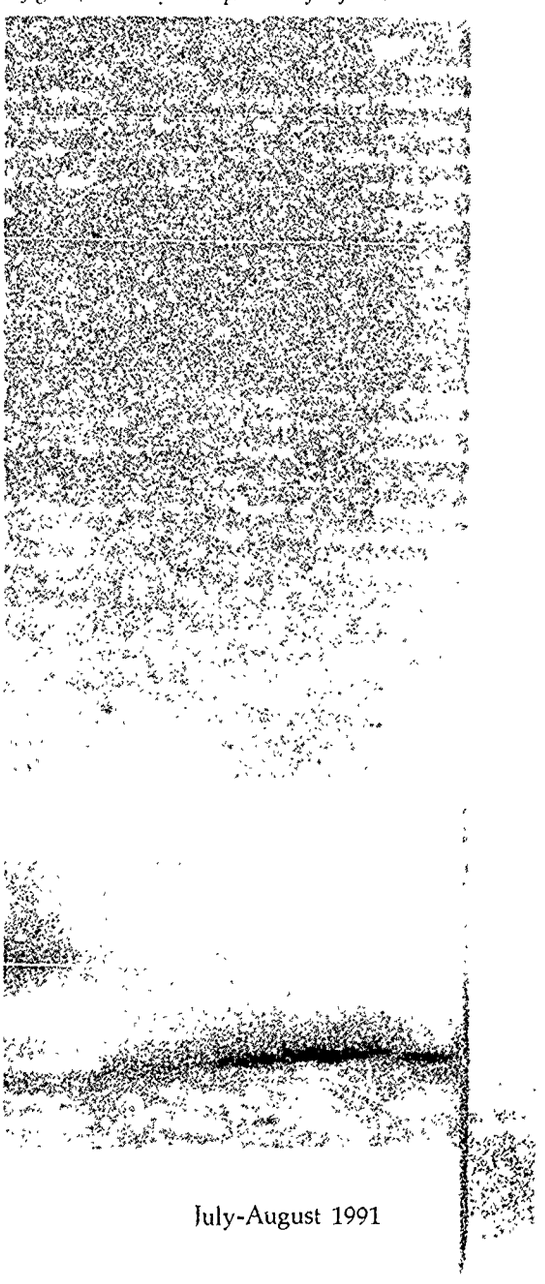
The Science and Technology Community

The Department of Defense S&T community plays a strong role in the acquisition process, even though it is separated from the rest of the acquisition organization by policy.

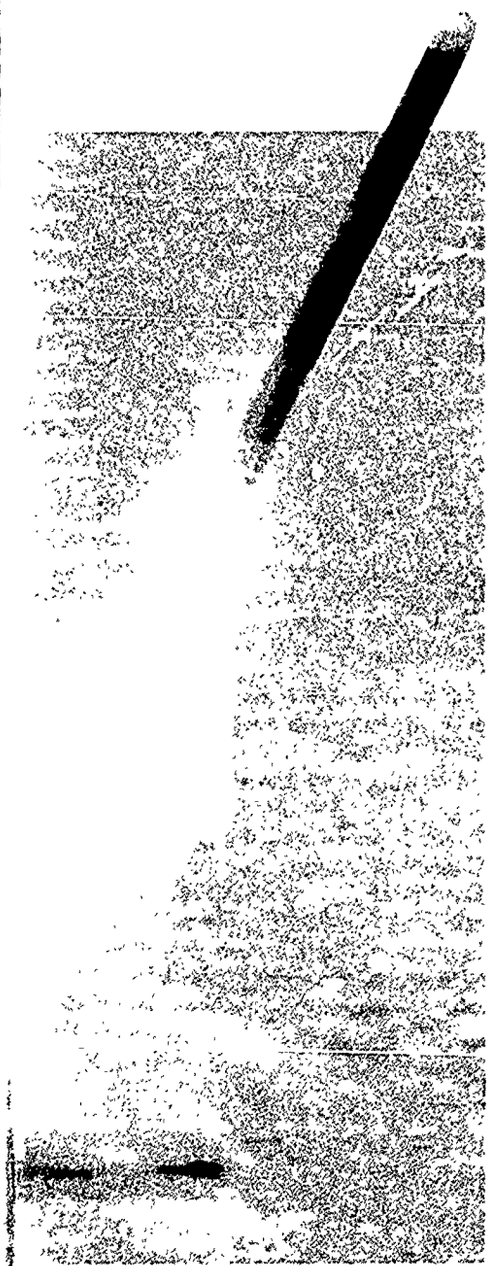
The S&T community operates within the bounds of broad guidance. Management actions attempt to protect the integrity of scientific thinking and to encourage development of leading-edge technical data and methodology. New discoveries or new relationships between ideas often lead to turmoil within the S&T community because they imply major resources and activity shifts. The S&T community maintains relevance to the ultimate military application through the development of prototype components and subsystems, the conduct of advanced technology transition demonstration projects, and contributions to DOD and Service long-range plans.

In comparison, the acquisition community is highly regulated and focused. Because of the significant resources committed, major programs are closely managed and audited by an event-driven DOD acquisition process designed to methodically transition systems to military use. The PM is pressured by a constant stream of demands and crises, and by the continual need to justify and defend the program. His success is measured in terms of pro-

A U S Navy Tomahawk cruise missile is shown in flight. (Released by the Department of Defense)



The PM is pressured by a constant stream of demands and...the continual need to justify and defend the program.



duct cost, schedule and performance results.

Fundamentally, the S&T community focuses on discovery and its potential meaning, while the acquisition community focuses on the delivery of affordable, operationally effective and suitable products to the end-user.

Dimensions. The DOD budget for the S&T activities in fiscal 1991, approximately $9 billion, is spread among OSD-level organizations and approximately 70 Service laboratories and commands. Collectively, DOD in-house S&T facilities occupy approximately 1.3 million acres, including 38 million square feet of laboratory space. These facilities are valued at more than $65 billion, cost nearly $700 million per year to operate exclusive of salaries, and employ 50,000 scientists and engineers to support DOD projects.

Effort Categories. Efforts within the S&T community encompass basic research, exploratory development and the initial stages of advanced development. In DOD funding parlance, these three categories are identified as program categories 6.1, 6.2, and 6.3A, respectively, within the research, development, test and evaluation (RDT&E) appropriation.

Basic Research (category 6.1) is driven by the long-term widely ranging search for knowledge. Science-oriented institutions hire and retain the best scientific minds, including Nobel Prize laureates, who collaborate within the academic community. Although most DOD laboratories have a research department, a substantial portion of DOD's basic research is conducted by contract with colleges and universities. Ideas are the stock and trade of the research scientist. Research to prove or disprove ideas involves extensive theorizing and experimentation. Scientific knowledge usually is advanced on an incremental basis through the dogged pursuit of vaguely understood objectives. Major breakthroughs that radically shift scientific thinking are few and unpredictable.

Exploratory Development (or applied research (category 6.2)), involves examining scientific advances with the mid-term goal of assessing feasibility for use in the military environment. Exploratory development efforts lead to creation of usable, organized data bases and methodologies, and honing of state-of-the-art design tools and specifications for application to future systems. It provides the building blocks to support future demonstration projects. Most exploratory development activity is done in house under close DOD or Service control. It is the in-house part of the S&T base that is most affected by defense politics and infrastructure changes. Activity within this realm is more structured than in basic research, and tends to respond in broad terms to military guidance while maintaining an appropriate distance from an immediately usable end-item.

The intial stage of *Advanced Development* (also known as advanced technology development (category 6.3A)), entails developing special components, subsystems, and functionally representative system-like prototypes, some of which become advanced technology transition demonstration (ATTD) projects. It is the realm in which proofs of principle and concept demonstrations are prosecuted. Advanced technology development planning is driven by known operational deficiencies which have not become formal, validated military requirements. Project emphasis is placed on advancement of the technology base toward a future military capability.

Industry, under contract, plays a strong role in advanced technology development by integrating embryonic hardware and software improvements or breakthroughs into demonstration systems or subsystems, and by conducting related assessments of cost, schedule, performance, support and manufacturing trade-offs and risks. Industry is the primary mechanism for transitioning technology from the laboratory to functional use, since industry typically develops and manufactures weapons systems.

Funding levels for basic research and exploratory development are relatively stable and yield a constant level of effort from year to year. Resources are applied to numerous pro-

jects within a technical area. Activity levels within projects vary, reflecting changes in science and technology priorities and successful breakthroughs. Funding in advanced technology development is the most variable and competitive of the three S&T categories, reflecting significant time and cost commitments associated with most large-scale experiments and special-focus projects undertaken in the later stage of S&T

Potentially Useful Initiatives. Two industry-related government programs operating under the broad umbrella of the S&T community are possible sources of support for the PM. They are the independent research and development (IR&D) program, and the small business innovation research (SBIR) program.

In the IR&D program, commercial and industrial firms doing a sizeable volume of contract business with the defense department and the National Aeronautics and Space Administration (NASA) can obtain matching R&D funds for corp. ate use on military relevant long-term projects. The overall size of the IR&D program is nearly $7 billion annually, of which the government pays $3.5 billion. The program manager cannot direct the use of the IR&D program, but can influence a company to conduct research in an area of importance to the program. This tactic is particularly effective if the contractor can sense a potential market for the R&D result.

The small business innovation research (SBIR) program has emerged as a source of fresh ideas for application to defense systems. Many small businesses are outgrowths of academic research and, accordingly, yield inventive or innovative ideas not necessarily in the mainstream of DOD thinking. Further, the SBIR program encourages DOD relationships with technology specialty shops and incubators that have unique expertise. The DOD organizations have SIBR focal points where a program manager can solicit help and use incoming ideas at no cost to the program.

Consortia exist among federal, state, industrial and/or academic organizations and promote the exchange of ideas in specific science and technology areas. Grants and laboratory equipment aid programs stimulate and modernize academic research. Workshops and symposia on military technology topics are sponsored by laboratories, universities and professional societies.

Key Personnel. Professionals educated in the science and engineering disciplines are keys to the effective use of S&T community resources. Scientists and technologists transition technology by developing ideas and demonstrating them to potentially interested parties. Program managers are required to assess and utilize technology developments, and a program office usually has a technical director to assist.

Scientist and Technologist. The research scientist tends to work at the edge of reality, and is less concerned and constrained by the military need for immediately useful, high-quality products. Because the research scientist often describes scientific advances and breakthroughs in a highly specialized language, communications with individuals outside the scientist's specialty area can be difficult.

Another member of the S&T community is the technologist, whose principal role is to move technology products from the laboratory to appropriate applications outside the S&T community. He is typically an engineer and frequently works as the middle man and translator between the S&T and acquisition communities. The technologist is sensitive to constraints and complexities of the acquisition process and the need for injecting considerations of reliability, maintainability, and other user-oriented system characteristics into technology products and evaluations.

The technologist and scientist can be of great value to the program manager. Each is well versed in the state-of-the-art of a specific field and well connected with S&T colleagues through professional interactions at seminars, peer reviews of published and unpublished papers and articles, and contractual or employment relationships. The technologist, in particular, is aware of the maturity of material, component, subsystem and system interface ideas, and can assist the PM in identifying candidate technologies for use in the acquisition program. Likewise, the technologist can perform assessments of ongoing industry and government technological efforts, either in response to program office tasking or as a member of an evaluation team.

Each Service has one or more laboratories whose chartered responsibilities and expertise align with a particular mission, product and/or technology area. The Service laboratory is the PM window into the S&T base, and provides the leadership for military relevant science and technological efforts regardless of whether such efforts are performed in house or under contract. The Service laboratory is the focal point for assembling relevant advanced system concepts. Whether or not the laboratory has a systems-oriented S&T department, it can and does assemble teams of scientists and technologists to respond to program tasking This laboratory support team can be employed to monitor critical science and technology specialty areas, to participate in program technical reviews and evaluations of test results, and to solve critical problems in conjunction with industry.

The PM should develop and retain a core team of experts to provide sustained technical support during the program life cycle. This core team normally consists of PMO-dedicated or Service Command matrixed engineering support personnel and the laboratory support team.

Program Office Technical Director. The PM needs a top-notch technical director to link the PMO and S&T community. the technical director is the focal point for system engineering efforts within the PMO, and for maintaining the configuration baseline. He is in a position to tap resources in the S&T community and apply them where needed. The PMO technical director should be responsible for maintaining an overview of the rich and diverse market basket of technologies in terms of their applicability to the program. By skillfully tasking S&T personnel to serve as honest brokers or technical experts, the PMO technical director is in a good position to evaluate industry efforts, to address demonstration and development risks, and to

ensure that advanced technologies are properly transitioned into weapons systems.

Science, Technology and Acquisition Cycle

In the following paragraphs, we discuss each phase of the acquisition cycle, focusing on phase objectives and the ways the S&T community can assist the PM in meeting those objectives. Some generalizations are necessary, for we do not intend to discuss the organization and managerial differences among the Services.

Determination of Mission Need

Overall mission relevance investigations are conducted on a continuing basis within the military services and, ultimately, result in a mission area assessment or similar assessment associated with a military need or opportunity. The determination of mission need evolves from the interplay of the user, intelligence and S&T communities. There are experts from the S&T community through continuous probing of the science and technology base and the search for important and relevant advances, who make military planners aware of the implications of enhanced threats and identify S&T breakthroughs having military significance.

Potential material alternatives to meet the mission need emerge from many sources. The military services are an immediate and readily accessible link to existing systems, proposed changes and improvements, and plans for new systems. Information on future science, technology, and acquisition activities often is available from an advanced technology or advanced development planning office, usually found within a systems or materiel command. These planning organizations monitor the S&T base and relate it to broad mission needs and the military infrastructure.

The Office of the Secretary of Defense (OSD) has organizations involved in science, technology, and advanced systems concepts. The Defense Advanced Research Project Agency (DARPA) works on revolutionary technology development and prototype demonstrations, and undertakes high-risk scientific investigations. The Strategic Defense Initiative Organization (SDIO) is repository of advanced technology and unique system concepts associated with ballistic missile defense. The Defense Nuclear Agency (DNA) and the Balanced Technology Initiative Office (BTIO) are sources of potential material alternatives.

Assembly of potential material alternatives and ideas is politically sensitive because it is the time when competing candidates are exposed and begin to vie for future funding.

There are prestigious national laboratories doing extensive DOD business, especially in the nuclear weapons, directed energy, and power generation areas. The National Aeronautics and Space Administration is a crucial resource for aerodynamic studies, wind tunnel tests, and air and space vehicle experiments. Other federal government agencies support DOD in weather forecasting, mapping, information storage and retrieval, transport of equipment and the like.

Potential contractors, sensing new business, assign small marketing and technical teams to begin efforts to place the corporation in a potentially favorable competitive position. The private sector contains nationally recognized technical organizations, corporate laboratories and DOD/Industry interface associations. Prominent individuals and consulting organizations offer advice and counsel.

There is increased emphasis on international cooperation in technology, system development and production. The OSD has a program to evaluate and exploit foreign weapons. The Services maintain science and technology monitoring offices in the Far East and Europe. Scientists and technologists from these offices interact with counterparts in foreign laboratories and industrial concerns, and obtain information which is published in bulletins and reports.

As noted, the Service laboratory is an integral part of the S&T community. In many cases, it is ideal for surveying the universe of existing and potential material alternatives to meet a mission need and for making a comparative analysis of the resulting candidates. The objectivity of the laboratory must be assessed, however, if the laboratory is proposing its own alternative.

Assembly of potential material alternatives and ideas is politically sensitive because it is the time when competing candidates are exposed and begin to vie for future funding.

Concept Exploration & Definition (CE/D)

The CE/D phase of the acquisition process is intended to explore material alternatives to satisfy a mission need, develop appropriate cost, schedule and performance analyses and information, define the most promising system concepts and mitigate the risks of applying associated technology, and articulate initial program objectives and a proposed acquisition strategy.

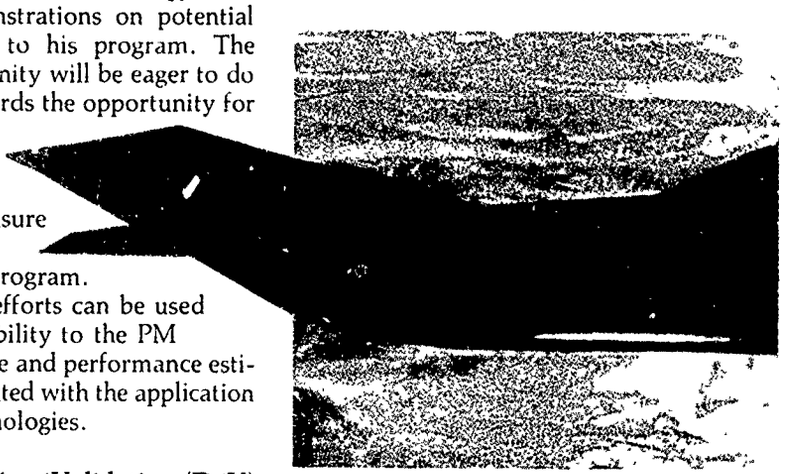
Explore Material Alternatives. The most significant activity of the CE/D phase is conducting alternative concept studies. The PM is supported by the technical community in preparing the request for proposal (RFP) associated with these studies. This team of scientists, technologists and system engineers help monitor resulting contract study activities, participate in reviews, provide technical inputs that help the PM answer contractor questions on what is often a broad mission-oriented specification, and participate in evaluations of the final study products.

There is an important point to be made here. The PM at this stage in the acquisition process does not have a formal charter. Rather, the provisional PMO normally consists of one or a few individuals contained in some larger, more generic group, including "basket" PMOs or military service command S&T or engineering divisions. The PM is dependent on part-time support from functional groups in his own material or systems command and on members of a laboratory support team.

Develop Supporting Analyses and Information. The operational requirements document (ORD) and the integrated program summary (IPS) are prepared during CE/D, and the IPS is the first program roadmap for system development. The broad assessment of opportunities, possibilities and problems emerging from the S&T community as part of Mission Need investigations forms the major source for preparation of the IPS. The program manager should recognize, however, that S&T community strength is related to technical performance, and S&T inputs must be combined with those from other command exerts to address gross affordability, schedule, support, manufacturing and system engineering trade-offs. While it is unlikely that a clear winning concept will or should emerge this early a detailed CE/D phase effort will lead to an understanding of the advantages and disadvantages of potential concepts available to meet the need. The S&T community can assist in structuring test plans to validate potential concepts and reduce design risks.

Define Most Promising Concept When completed CE/D studies are received, the S&T experts within DOD can provide advice, counsel and assessment services to the PM about adequacy of contractor responses and determination of the most promising concepts for future demonstration. Proposed acquisition strategies, which are constrained by affordability considerations, generally include gross estimates of schedule and mission utility. They are critiqued by the laboratory support team and Command experts before presentation at the Milestone I decision briefing. Identification of risks to be addressed during the demonstration and validation (D/V) phase, and creation of the first risk management and risk reduction plans involves extensive team effort.

The PM should understand biases of the laboratory environment which often lead scientists and technologists to discount near-term practicality as they focus on the latest state-of-the-art performance available within a technology area. Proposed technology opportunities must, therefore, be evaluated in terms of their maturity and likely availability for program use within the timeframe of the development program. During this phase, the program manager should collaborate with the S&T community to focus advanced technology transition demonstrations on potential applications to his program. The S&T community will be eager to do this as it affords the opportunity for technology transition, which is the primary measure of success of an S&T program. The ATTD efforts can be used to add credibility to the PM cost, schedule and performance estimates associated with the application of new technologies.



Demonstration/Validation (D/V)

The D/V phase is intended to define better the expected capabilities and critical design characteristics of system concepts, improve understanding of, and confidence in, technologies and processes needed to attain the most promising system concepts, and establish the first development baseline for the emerging system concept.

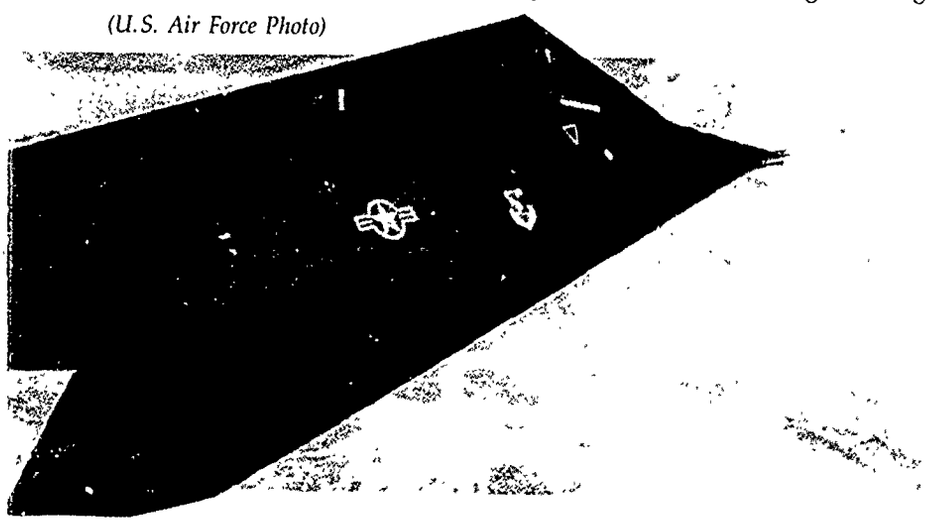
Define Design Capabilities and Characteristics. The D/V phase is normally the first time that the contractual process is used to acquire hardware as opposed to studies and analyses. Such hardware items are acquired for proof of concept or competitive prototype, and are often hand built. The D/V phase gives the program manager an opportunity to ensure the DOD community that concepts emerging from CE/D studies really work. Functions necessary to support the mission are demonstrated. The shape and form of the potential product are clarified. High-risk technology areas are examined in simulations and working models. The product undergoes initial development testing at the component, subsystem and, possibly, system level to determine performance characteristics and reduce program risk.

The PM uses Department of Defense S&T community expertise in the evaluation of D/V concepts and contractors, during periodic and event-driven program reviews, and for assessments of proof of concept or competitive prototype activities. Because of this, the S&T community is active in analyzing initial T&E data. Contractors often request performance deviations and trade-offs among critical parts of the emerging system as D/V unfolds. The S&T team can provide advice on the potential effectiveness and risk implications of changes. Should the contractor allege technical success based on limited data, the S&T team can be useful in verifying such claims by reviewing test data, and suggesting additional experiments or new test approaches.

Improved Technology Understanding and Confidence. At the end of D/V, the PM will have to recommend one of the following actions: proceed into a subsequent acquisition phase, continue with additional D/V efforts, or, terminate the program because of critical mission, operation or system development inadequacies. The Department of Defense S&T community can support the recom-

The F-117A stealth fighter is the world's first operational aircraft designed to exploit low observable stealth technology. It is designed to penetrate dense threat environments and attack high value targets with pinpoint accuracy. The F-117A is flown by the 37th Tactical Fighter Wing at Tonopah Test Range Airfield, Nevada.

(U.S. Air Force Photo)



mendation by assessing both the D/V results and the likelihood that technology advances will be available, or can be made available, to solve currently critical problems.

The PM should recognize his developing system incorporates many technology areas, and that the rate of change among them differs considerably. In areas that are changing rapidly, like electronics and optics (E/O), the continuous assistance of technical experts from the S&T community is vital because breakthroughs could produce a strong and sometimes immediate impact on the PM acquisition program.

Technology areas like composite or advanced structures and high performance engines, while evolving, are unlikely to change radically during short periods. The S&T experts in these areas would likely advise the PM that steady, predictable progress can be anticipated in the near-term.

The laboratory support team can evaluate whether a particular program problem is of general military importance and should, therefore, be the target of special science and technology efforts.

Establishing Configuration Development Baseline. The initial system development baseline generally results from activities of the D/V phase and is approved at Milestone II.

The laboratory support team can be tasked to assess probability that a proof of concept demonstration, during which technology flaws are exposed, can be risk-managed during engineering and manufacturing development (E/MD). In programs involving competitive prototyping, findings of the S&T community are instrumental to the concept selection process and subsequent contract award for the engineering and manufacturing development phase.

The laboratory support team can help the PM determine whether a preplanned product improvement or evolutionary acquisition strategy is appropriate. It can help the PM determine the impact of D/V results on contracting, funding and detailed scheduling of E/MD activities.

Engineering and Manufacturing Development (E/MD)

In the E/MD phase, the most promising D/V concept(s) is translated into a stable, producible, affordable system. Detailed plans are developed for the manufacturing and production process; system capabilities needed to meet mission, contractual and operational commitments are demonstrated through a comprehensive test program.

System Stability. Program emphasis changes during E/MD from system definition to matters involving costs and schedules, and to refinement of the development baseline for a production at Milestone III. The E/MD phase is characterized by a constant stream of detailed tasks tied to user, contractor, political, and interest-group questions and needs. Crisis management is often a necessity, as unforeseen events have an impact on the most carefully crafted development plans. In the E/MD phase, the activity of the S&T community must be focused on the evolving system and the product-oriented efforts of this phase. The PM can accomplish this through a technology prioritization scheme to guide the tasking of the S&T community. The S&T inputs should be clearly sorted into those affecting the current thrust of the program, those with potential for preplanned product improvement, and those whose future use is important but will not be incorporated into the near-term development baseline. The laboratory support team can underpin this activity by linking the needs articulated in weapons system planning documents with the expected outputs displayed in S&T community technology roadmaps and plans. Assuming that the resultant planning network outlines an optimum technology investment mix for the program, the targeted used of small amounts of program management reserve and a clearly stated PM interest in a particular longer term S&T project can keep the pipeline full of program-relevant and timely state-of-the-art technology.

Validate Manufacturing and Production Processes. The DOD has a growing interest in production-related processes; therefore, it sponsors manufacturing technology and critical materials technology programs. These achieve industrial base improvements and cost reductions by inventing different manufacturing control processes and using new and

alternative materials in military applications.

An example is the Rapid Acquisition of Manufactured Parts (RAMP) program wherein DOD has become a major investor in robotics and aritificial intelligence technologies, which are key to linking computer aided design, manufacture and support. As part of the RAMP consortia, which includes industry, the State of South Carolina and the U.S. Department of Commerce, DOD is supporting development of advanced manufacturing cells to produce more rapidly and economically small and highly specialized lots of unique parts and components. As a consequence, the overall technology area known as flexible manufacturing is emerging as a high visibility and critical technology area.

Other high technology programs bearing on process control and total system quality are being explored by the S&T community. The PM should examine the resulting opportunities for potential application to his program.

Demonstration Testing. The S&T community is often a major source of support to the PM and the contractor in structuring development test and evaluation (DT&E) activities. Individuals in the S&T community constantly design experiments and simulations, participate in demonstrations of scientific principles by using breadboards and brassboards, and lead advanced technology transition demonstrations. As a part of these activities, they record and analyze data using measurement devices, from simple hand-held instruments to complex experimental chambers. The S&T community works closely with the test and evaluation community, and knows how to gain access to test ranges and facilities, many of which are co-located with or geographically near DOD and national laboratories. As DT&E proceeds, S&T personnel can work closely with the contractor to improve results of DT&E, solve measurement and test protocol problems and, ultimately, provide early indications of emerging problems and potential ways of fixing them. The decision to transition from DT&E to operational test and evaluation (OT&E) usually involves S&T personnel in the assessment of readiness for such user controlled testing.

Production and Deployment

The Production and Deployment phase is intended to establish a stable and efficient production and support base and deliver an operational capability satisfying the mission need. Follow-on testing to confirm system performance and quality is conducted in this phase.

At this point, the production line is up and running, and equipment is being placed in the field. However, history cautions that the production and deployment process seldom is stable. Despite operational and production testing performed during E/MD and the early stages of production, performance or reliability problems associated with extensive operational use will inevitably surface, and technical modifications to the product will be needed. Further, because of preplanned product improvement and evolutionary acquisition strategies, threat changes, and the trends toward lengthening life cycles associated with systems and equipment, most PMs are responsible for numerous retrofit, configuration change, and modular upgrade packages. In a fundamental sense, the PM is in charge of a collection of related programs of varied maturity. It is the technology base that promotes program continuity, minimizes system risks, and supports long-range investment and acquisition management decisions.

Within the past decade, there have been notable technical setbacks to major weapon systems as they approached or entered production. In cases where a strong, supportive technology base existed, the program manager was able to manage risk through the use of near-term engineering changes that essentially came from on-the-shelf technology These quick technology fixes were then followed by longer-term solutions that did not compromise operational capabilities or radically breach acquisition management thresholds Unfortunately, there have been several programs where the lack of a strong S&T base left the PM with unattractive options, like acceptance of degraded operational performance by a dependent user, or infusion of massive amounts of scarce capital from non-program sources in hopes of recovery, or major schedule page. Consequences of an inadequate S&T underpinning make national headline news when front-line military programs are perceived as costly failure.

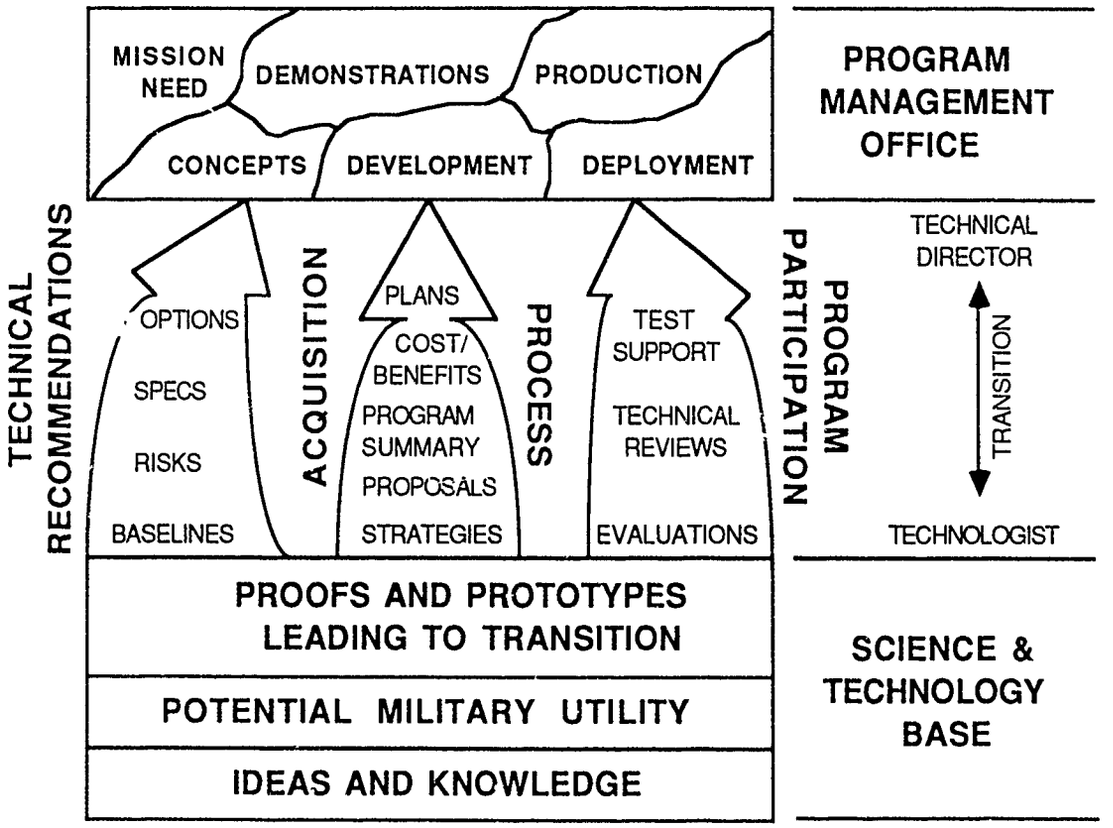
Because of the influence of the S&T base on programmatic success or failure, and increasing international competition for S&T leadership, the Congress enacted legislation in 1989 requiring DOD to submit an "annual plan for developing the technologies considered by the Secretary of Defense and the Secretary of Energy to be the technologies most critical to ensuring the long-term qualitative superiority of United States weapons systems."

The resulting DOD Critical Technologies Plan is a good unclassified reference document written for the layman rather than the scientist or technologist. The PM technical staff can broadly monitor the status of these key technologies and then focus the attention of industry and DOD laboratories on technology areas appearing to have potential program use.

Summary

The DOD program manager has available the best, most diverse technology base in the world today. The S&T base is the source of ideas, proofs, concept demonstrations, prototypes, feasible processes and risk-reduction experiments. It compromises technical experts, laboratories and other organizations, also, state-of-the-art information essential to demonstrate, develop, manufacture and field the weapons and defense systems. The honest broker clearinghouse function of DOD and Service S&T organizations and laboratories, the idea-generating capability of academia, the system design, development, technology integration and manufacturing capability of industry provide opportunities to build and maintain high-quality, affordable, timely, and effective military equipment. Figure 1, "Science, Technology and Program Management Interface," summarizes some

FIGURE 1. SCIENCE, TECHNOLOGY AND THE PROGRAM MANAGEMENT INTERFACE



support the S&T community can provide the PMO.

The PM, as representative of the product-oriented user, must strike a balance among program risks. The fundamental technical risk lies in determining how much new technology to incorporate into the system during its life cycle, and when this should occur. If the program approach is too conservative in the application of new technology, the fielded system may suffer from early obsolescence and lack long-term adaptability. Conversely, if the program approach to using new technology is too aggressive, then the resulting system may contain technical flaws jeopardizing reliability and causing loss of user confidence in operational effectiveness and suitability. Experts from the S&T community can help the PM achieve equilibrium.

KARIMI

(Continued from page 19)

Case studies from industry demonstrated that by adopting the total quality philosophy, organizations can "stay on top of the heap" and can significantly enhance how they perform. The TQM metrics tools such as SLIM-Control can be used by management to track effectively the productivity and qualify in software development. With software management metrics as part of contractor program schedule reports (PSRs), program managers will have the necessary progress data to make effective assessment of program progress and achieve improved efficiency.

For TQM to work, commitment to qualify should become basic principle, not an abstract. Quality should be a well-defined standard pursued daily through well-managed operations. The customer comes first—the customer is always right. This is fine but a credo does not make a business. Customers do not want a policy—they want responsible action. We must constantly seek new and innovative approaches for positive change.

By applying the Deming, Peters and Waterman philosophies and the Putman method to software management, we can improve the quality of management information, and make the most of TQM to do a better job and meet customers' needs.

LAST OF A SERIES

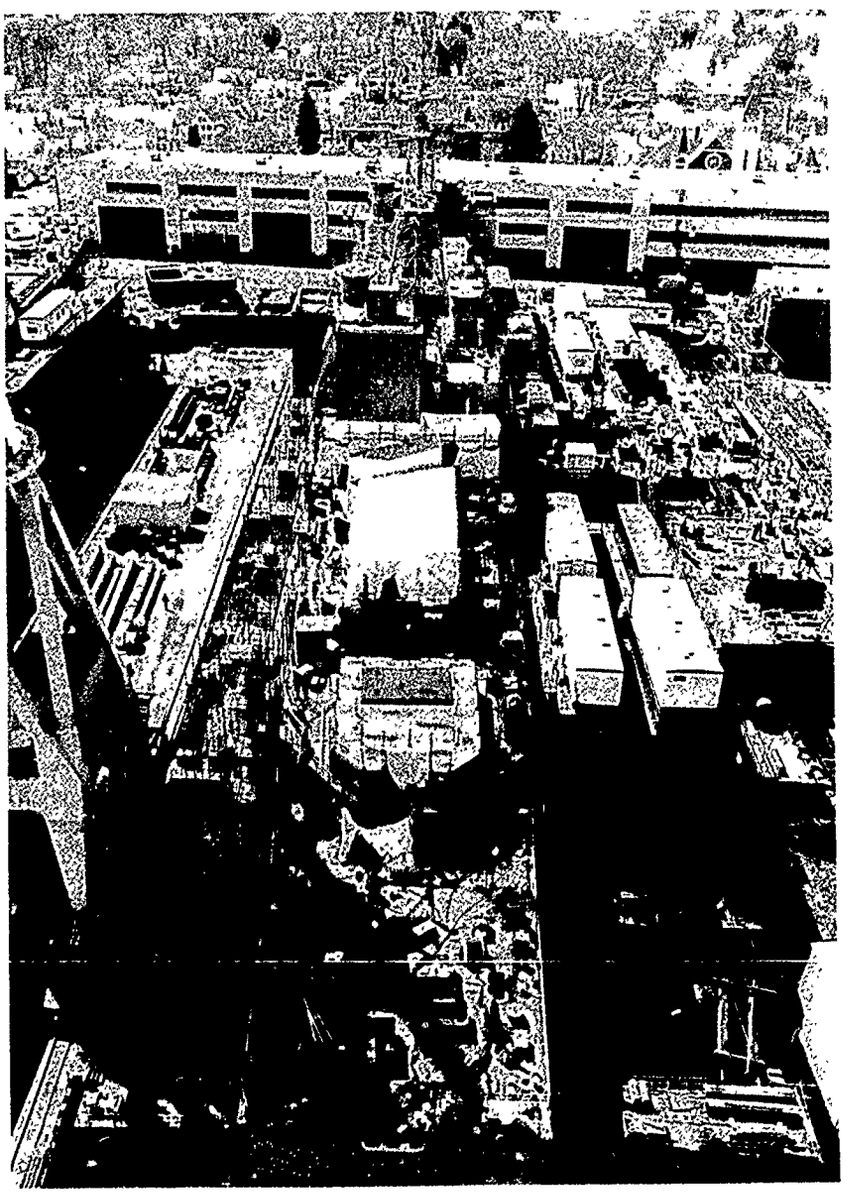
EDUCATION GAPS IN A COMPLEX WORLD

Systems Thinking for Future Collaboration

Rolf Clark

The first two parts of this chapter, which were published in the last two issues of *Program Manager*, argued for the procedural and cultural dimensions of international armament education. Technology transfer, deactivation, coproduction, and security—to name a few—were mentioned as topics that needed to be understood by managers and policy-makers in the international arena. Each is a complex subject. How can good decisions be made, and what policies allow such decisions? Anyone with intellectual integrity will admit that current methods are not adequate for doing so. New education directions are needed

The education process for future decision- and policy-makers must accommodate the changes both in the demand for management and policy skills and the supply of methods for dealing with those demands. We need to review the possibilities.



EDITORS NOTE: *This is Part III of a paper, "The Problem of Training and Educating Defense Officials in the Arena of International Armaments Collaboration." Part I by Richard Kwatnoski and Part II by Dr. Franz A. P. Frisch were in the last two issues of* Program Manager.

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The Demand Side

All modern systems and certainly program management have become more complex, not merely in scale but in kind. Non-linear feedback systems are the norm, yet our education system has provided mainly static methodology for considering these dynamic systems.

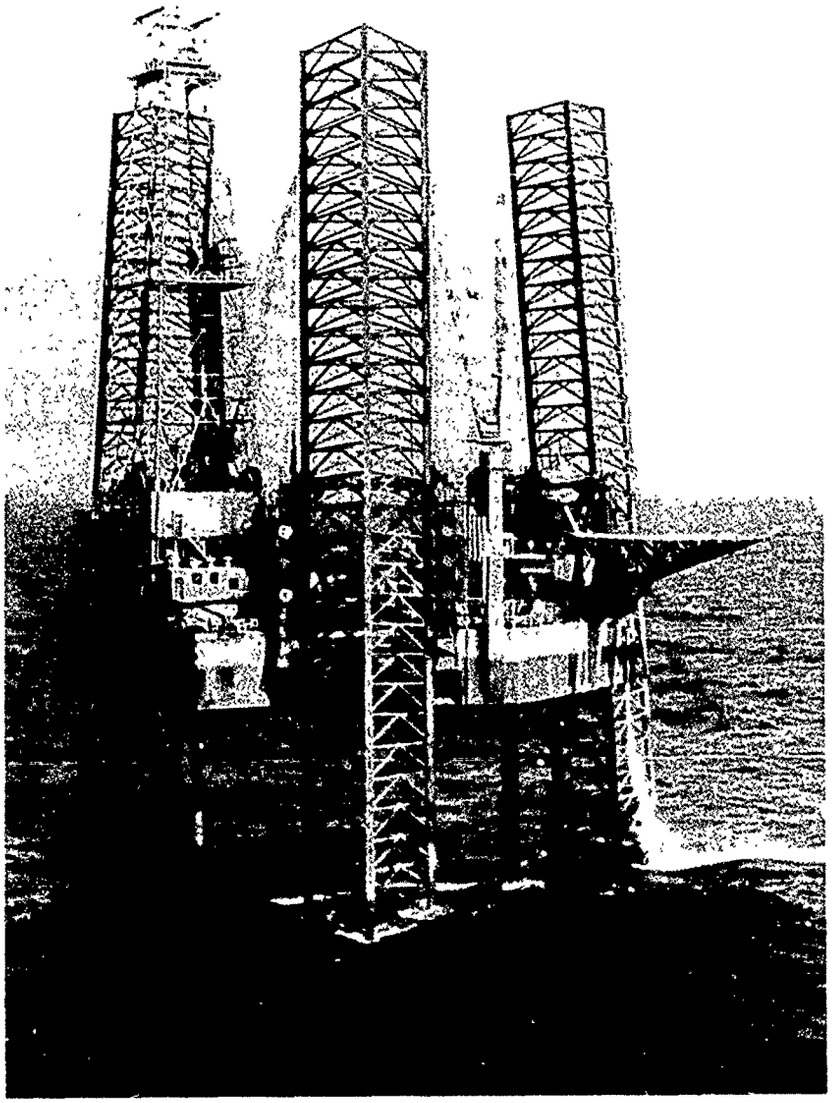
An example of non-linear feedback is when producers use inputs from suppliers that ultimately demand inputs from the producers. A supplier of alloy bearings may need to increase production capacity before being able to accelerate supplies to a machine manufacturer, but increasing capacity may require the machine manufacturer to first supply the bearing supplier with production equipment.

Non-linear feedback systems are the norm, yet our education system has provided mainly static methodology for considering these dynamic systems.

In the international arena the input-output dynamics become even more complex than was the case for purely national programs, which are more complex than the more localized programs which preceded them.

Said another way, the caveman's simple threat-response decisions trying to survive the saber toothed tiger's attack have, over time, yielded to policy decisions needed for long-term feedback systems with causes and effects that seem impossible to link or even understand. The systems seem so complex that we make simplifying assumptions so we can apply our current static methods and feel like part of the solution. But the analytic community loses the respect of the real world.

Left: Ship-building at Bath Iron Works in Maine (Photo courtesy Bath Iron Works Corporation.)



Above: Offshore drilling in the Gulf of Mexico (Photo courtesy of the American Petroleum Institute.)

Complex systems are linked spatially and temporally. Decisions today are difficult enough when filling current needs, but have serious implications over time that cannot be ignored. Nuclear waste, ozone layer, resource depletion, and Third World dynamics are linked to each other. The earth may become imbalanced because polar ice melts as global warming occurs, and that may be linked to Brazilian rain forests and ozone layers.

In defense, programs and policies that call for increased production can cause economic chaos when growth ceases. Increasing a Navy from 510 to 600 ships produces a boom to shipbuilding, but once the growth stops (it needn't turn negative), a bust period will follow. Growing by 90 ships over 10 years requires, roughly, a 40 percent increase in production per year; from 17 to 27, given ships last 30 years. But to stay at 600 ships after the 10 years of growth requires a reduction to building 17 ships a year again—none of the new ships need to be replaced for 30 years. Shipyards must lay off the workers they accumulated. It takes 50 years for the dynamics to settle out to a steady production rate of 20 ships a year. Yet, we make decisions based on the steady state, not the transient.

The Texas oil production industry is an exact analogue. The extreme growth of the '70s can produce a

depression like that of the '80s merely because the growth in demand for U.S. oil steadies. Steadying demand means the demand for producing oil production systems needs to decline drastically, just as the demand for ships is reduced when growth in the Navy stops.

The demand for modern management and policy skills calls for a different kind of thinking. It calls for systems thinking instead of linear, steady state thinking. The methods used to conduct systems thinking are different than those we have become accustomed to, particularly in the defense arena. The traditionally static methods of "systems analyses" and "operations research," which indeed provided us with tremendous advances, now need to be augmented with more dynamic methods relevant to long-term policy analysis. The supply of analytic methods needs analysis.

The Supply Side

A need for new methods does not guarantee the education system will provide them. Education changes slowly. Professors teach what they were taught and academic departments grant tenure based on publications within the department's discipline. Statisticians publish in stochastic methods, economists in trade, engineers in control theory. Social scientists and environmentalists treat their topics too independently of statisticians, economists and engineers What is needed most is an integration of skills. Yet, interdisciplinary programs are almost always given lip service by universities, seldom dedication.

New methodologies, therefore, take generations of academic turnover to evolve. Systems thinking is emerging slowly and only at a few institutions. Even today, when badly needed, it is criticized more than supported.

One reason for the late advent of methods for "systems thinking," dealing with non-linear feedback systems, is the relatively recent invention of computers.

Systemic thinking of the type needed now relies on the computer, for the interrelationships of modern systems are too complex for the human mind. They are too complex for the sophisticated analytic techniques taught in academic institutions as well. We can "solve" systems described by third or at most fourth order differential equations, but we make decisions about 20th or even 50th order systems.

We need to stop trying to "solve" and instead learn to explore.

What's needed is the ability to convert the bits and pieces of mental models that the mind can cope with into a comprehensive whole that can be exercised to explore different policies. Only a combination of the modern computer and the human mind can do that.

What's Needed

The mental models we use to make decisions need to be tested for validity and then explored to form policy. To test them, they must be converted to more formal models. Most mental models will benefit from being transferred to computer models which can simultaneously keep track of all the pieces of knowledge that decision-makers have in their minds. The computer is good at doing that.

Of course, the computer will not exercise a model unless it is internally consistent. The mental models that decision-makers use need to make sense. A system successfully modeled on a computer will have such internal consistency.

Education needs to accommodate those kinds of skills.

What Prevents Systems Thinking?

Barry Richmond, developer of a software package being used in a Department of Education grant to teach systems thinking in high schools across the country[1] says there are four fundamental impediments to the adoption of systems thinking.[2] The first is we are prisoners of our fast-paced frame of reference. We are so engrossed in the daily fray that we are unable to stand back far enough to gain a systems perspective.

Second, because we live in the fray, we have adopted a way of life that requires reacting to the fire at hand. We do not have time to study the system that causes the fires.

The third is that we "see" objects, not relationships. Systems thinking requires seeing relationships.

The fourth is that we evolved through a survival process, and the process required reacting to the saber toothed tigers we saw. We lash out with knee-jerk reactions. As a result, intuition and reflection, basic to systems thinking, lost out. We want a target to shoot at. We admire those who make quick decisions, rather than those who deliberate. Complexity requires being able to deliberate.

Three less fundamental impediments exist according to Richmond. First there is lack of technical expertise, the main concern of this paper. Systems methodology, combined with computer efficiency, will allow rapid deliberations.

Second, there is a natural resistance because systems thinking can be threatening. Answers to problems will lie across broad spectrums of an organization, so people should act together to solve real problems. But acting together means discussing diverse areas of the organization That can reveal knowledge gaps. Sharing information can jeopardize protection of turf.

Third, a person willing to take a systems perspective must feel empowered. No one can control a complex system; the decision-maker must admit to a lack of personal power. To do that, one must feel empowered enough to own up to weakness. Our way of thinking about experts and expertise may need to be changed There needs to be room for "I don't know."

What I have said to now leads to a generalization. We need to educate decision-makers in considering complex problems in their true richness; transient state non-linear feedback problems need to be explored fully. This is the systems dimension

Second, to do that the decision-makers, *people*, need to learn to be empowered enough to authentically develop their mental models. What they think the relationships to be must be based on valid thoughts, not on thoughts hindered by image or position. They need to communicate

authentically with each other on their insights and their uncertainties. This is the personal dimension.

Personal Dimension

We cannot digress here into the domain of personal mastery and empowerment. It is too complex and lengthy. Universities are unlikely to explore areas such as personal integrity—being authentic with oneself. That does not say people are *intentionally* unauthentic. The unauthenticity spoken of here is unknown. A classic example is "There are witches in Salem." People *knew* there were witches, but that was not authentic knowledge.

Today's examples might be "Businessmen in that country can't be trusted." "We can't compete with the Japanese." "We're doing all we can."

While not a part of traditional education, the personal dimension is becoming more prevalent as the quality movement gains momentum. Organizations will have difficulty surviving without paying attention to the domain of personal mastery and empowerment.[3] Peter Senge, author of "The Fifth Discipline," claims there is no more powerful change in an organization than personal mastery—the ability to be authentic with self and others. Suffice it to say that some segment of our education system needs to cope with this issue. It may be on an organizational or even personal basis, but formal education needs to at least consider its role here.

The Systems Dimension

Given authenticity in the mental models of individuals and therefore of organizations, tools exist for converting these into formal models useful in conducting valid policy analyses.

Methods exist to allow realistic systems thinking. The methods, the hardware and software, and the experience in doing so are in place. The other disciplines needed—statistics, computer science, control theory, systems analysis, economics, sociology, psychology too, have been in place for years. The integration has been missing and needs to be added to the education process.

Basic courses in dynamic simulation, and practice in modeling realistic processes using such simulations, are needed. All systems can be realistically represented as made up of stocks and flows—the materials in the system accumulate in "stocks' and the stocks change when the material "flows" between stocks. The flows are controlled through information links to the various system stocks.[4] Social systems controlling international trade, resource allocation, and technology transfer are generically the same as a physical system that controls the temperature in the room. All can be modeled on a computer, tested, and exercised to try out different policies.

Our way of thinking about experts and expertise may need to be changed. There needs to be room for "I don't know."

More important, communication skills using basic stock and flow models of systems need to be practiced. Case studies of dynamic real-world processes need to be made available so that the type of thinking that allows good policy exploration can occur. The art of model building needs to become part of the educational process for policy-makers. There is no way to be a good policy-maker if you can't explore, in a valid way, impacts of policies made.

We need to be able to think authentically about the whole system, and then be able to test different policies on the system.

Explorations for International Program Managers

We are back where we started. The demand for insights into international programs includes matters such as exchange rates and deficits, budget dynamics, capital accumulation for production, logistic problems for foreign production, technology transfer, and international labor exchanges.

Each of these examples requires a systems perspective. Consider exchange rates, which affect the price of components. The demand for components affects the stocks of dollars held abroad, which affects the demand for U.S. goods, including the demand for systems which include the components being supplied. While an international program manager may not wish to explore the dynamics of this trade situation in detail, the policy-maker he someday will become must be able to do so. Policy should reflect the long-term aspects of cooperation with, say, a Third World country.

The dynamics of budget cuts and their effect on a program require simulating the allocation process. Cuts to the U.S. defense budget can get amplified in the procurement accounts. A 10 percent reduction in top-line funding may translate into a 30 percent cut in procurement if non-procurement accounts, like manning and maintaining the existing stocks of weapons, are inelastic with respect to short-term budget changes. Cuts in programs dependent on foreign suppliers may cause bankruptcy in the supplier, and a policy that does not explore these sensitivities is near-sighted and incomplete. National policy-makers may wish to provide aid to a country through international exchange. The long-term effects of increasing the country's capital plant, including the time it takes for that plant to become self-sustaining, is a systems problem.

The dynamics of such problems are complex, and simple models will not suffice.

Coursework

It may be useful to discuss the level of effort required to teach a student systems thinking. Formal education in practical systems modeling is needed. The mechanics can be accomplished in the equivalent of an undergraduate half semester. Expertise in such modeling, however, will require about an additional 1½ semesters.[5]

(Continued on page 33)

FORGING A STRONGER DEFENSE PARTNERSHIP

Let's Work Together

Max E. Bleck

For 20 years, the Defense Systems Management College has played a critical training role in preparing acquisition management professionals. I find it particularly fitting that your commencement occurs on Flag Day, a day reflecting our pride in the United States and its emblem, the Stars and Stripes. This is a year when support for our country, and our military, is visible *everywhere*.

In recent parades, our men and women in uniform drew cheers and so did our defense systems—among them, Patriot, the first missile to intercept a tactical ballistic missile in combat. Patriot stands for the dedication of workers who developed and produced all of the defense systems that performed so effectively in *Desert Storm*.

Our nation's defense systems stand for American technological leadership and are tributes to acquisition professionals and program managers who had faith in the systems, fought for them, and fought for upgrades.

In August of 1990, there were only three PAC-2 Patriot missiles, the missiles capable of defeating tactical ballistic missile warheads. In January of 1991, there were hundreds—a good example of the Army's ability to streamline and initiate flexible contracting to meet a real need, and of industry's ability to respond as a partner by accelerating production.

Now, the challenge is maintaining a strong defense in spite of declining defense budgets.

Do More with Less

As you leave the DSMC campus, you are going to be asked to "do more with less." Quality will help. An emphasis on "doing it right the first time," and continuous improvement is already making a difference. Integrity is also very important.

David Packard, and the people who worked with him to establish DSMC, have been at the forefront to continue to improve defense procurement processes and to embed total integrity in all defense management acquisitions systems. Industry is also promoting the highest ethical standards in the workplace. The defense industry initiative on business ethics and conduct, the first initiative of its kind in this country, demonstrates this commitment to integrity in the procurement process.

Another key factor in maintaining a strong defense is technology. Since *Desert Storm*, there has been agreement that, in addition to the superior performance of our men and women in the armed services, technology played a pivotal role in winning the war. We must preserve this technological leadership.

Secretary of Defense Dick Cheney repeatedly made the point that the systems we develop and acquire *today* will help keep this country, and our allies, secure *tomorrow*. He said:

> It is critical that we maintain the resources devoted to preserving and enhancing our technological edge. The forces that gave us the technological edge that we saw in Operation Desert Storm were developed years, in some cases, decades ago.
>
> The decisions we make today will dictate whether or not we keep pace with the rapid changes in the weapons of war.

Secretary Cheney's words underscore the importance of your work. We need committed acquisition professionals like you and all graduates of DSMC to lead us into the 21st Century.

Forging a Partnership

The spirit of cooperation starts early and must be sustained throughout the life of the program. There ought to be a cooperative exchange in the creation of specifications and statement of work to ensure realistic objectives and timetables.

These remarks are adapted from a speech given by Mr. Bleck at the Defense Systems Management College PMC 91-1 graduation June 14, 1991. Mr. Bleck is president of Raytheon Company.

Acquisition people must commit time to track with the customer and the contractor to see that *contract* dates and *need* dates are the same. We need to maintain dialogue, not rigidity, as we move forward in our production cycles.

Developing and maintaining a spirit of partnership between industry and the government is critical if America is to have the systems and products it wants, and needs, at the best cost.

Recently, we have seen erosion of the defense industrial base as companies have sold their defense businesses. General Colin Powell, USA, recognized this when he told the American Defense Preparedness Association recently: 'The element of greatest concern to the Joint Chiefs of Staff is our industrial capability. The number of producers and suppliers of many critical military items is dwindling drastically and is shrinking to unacceptably low levels."

Although progress payments will rise from 80 percent to 85 percent in July of this year, we must continue to work to bring them back to 90 percent for large businesses and to 95 percent for small businesses.

Other real costs of doing business are independent research and development (IR&D) and bid and proposal (B&P)—costs that commercial businesses regularly recover in their pricing structure. We must eliminate ceilings and strive for full recovery of IR&D and B&P costs. Maintaining technical excellence requires solid support of research and development. We also need higher levels of foreign military sales and financial guarantees to facilitate defense exports to friendly countries. We need tax policies that enhance cash flows by the timing of tax payments.

We live in exciting times. Your decisions affect the security and shape of the world we leave to our children and grandchildren.

Albert Einstein said: "To raise new questions...to regard old problems from a new angle...requires creative imagination." Let's all work together, using "creative imagination" to develop and produce the systems we need to keep America strong.

CLARK

(Continued from page 31)

Case studies and other teaching materials for international armament matters have yet to be developed. Interactive simulations and generic models of exchange behavior need to be explored more fully than they have to date.

The teaching material should be adequate for modeling short-term processes and long-term policies. The former includes processes typical of those studied in the quality control movement, such as production, hiring and inventory processes. Long-term policies are represented more by something like the relative growth of two competing economies, and the role of arms trade on that growth.

International policies will be ineffective if the culture of the foreign trade partner is not reflected accurately.

As discussed earlier, the materials must promote the principles that policy-makers should become familiar with, rather than the specifics of any one historical case. The goal is to enhance the ability to think, not simply to recall past examples.

Training and education in the area of personal mastery should be considered by educational institutions within and outside the defense sector. Currently, such training is accomplished through seminars and programs outside of formal education centers. As the quality movement accelerates, the need for personal mastery will emerge. Processes cannot be improved unless they are seen authentically.

Team building and cooperation are essential to comprehensive policy analysis and they follow from personal mastery. Turf battles and organizational insecurity wane as individuals are abler to share their knowledge, and accept others' knowledge. Educational institutions tend to avoid such training, but corporations and private consultants are responding to the void.

International policies will be ineffective if the culture of the foreign trade partner is not reflected accurately. Courses in customs and culture are essential before managerial and policy models can be explored realistically.

Meanwhile, current subjects must go on. Policy-makers will continue to benefit from economics and policy science, from quantitative statistics and operations research methods, from information systems and computer science, from history and geography.

The details of a new science of international armament policy will not evolve until the policy-makers deciding on the future of policy science choose from the educational alternatives.

Endnotes

1. *An Academic User's Guide to Stella*, Barry Richmond, Steve Peterson and Peter Vescuso, High Performance Systems, Inc., Lyme, N.H., 1987.

2 *Systems Thinking, Four Key Questions*, Paper distributed by High Performance Systems, Inc., 1987.

3. *The Fifth Discipline, The Art and Practice of the Learning Organization*, Peter Senge, Doubleday/Currency, New York, 1990. Chapter 9, entitled "Personal Mastery" is an exceptionally clear statement of the gains available from advancements in this area.

4. *Industrial Dynamics*, Jay W. Forrester, MIT Press, 1961.

5. "System Dynamics and Modeling," Rolf Clark, Operations Research Society of America, 1988, provides and introduction to modeling complex systems.

SURVEY RESULTS

BOSSES PRESSURE CORPORATE FINANCIAL EXECUTIVES TO COMPROMISE ETHICS

Gary L. Richard

More than half of all corporate financial executives receive pressure from their bosses to compromise and/or manipulate principles or ethics. This is the clear and unmistakable conclusion drawn from a recent survey I conducted.

The pressure can be to perform acts as minor as moving profit or loss forward or backward in time, if that is minor, or as grave as breaking the law. The pressure is as subtle as labeling the financial executive as uncooperative, or as drastic as threatening him with demotion or loss of employment.

Source of Information

In November 1990, I completed a thesis paper in connection with a master of science and administration program at Central Michigan University. The paper was entitled "A Study Regarding the Pressure to Compromise Ethics Placed Upon Corporate Financial Executives." It reported on the results of a survey taken with 500 currently active financial executives. Although the actual list is confidential, some were employed by government contractors.

Financial Executives Institute (FEI)

The FEI was founded in 1931 and comprises over 13,400 members em-

Mr. Richard is a Professor of Financial Management at the Defense Systems Management College, and is a member of the Financial Executive Institute (FEI). He received a bachelor's degree in 1960 and an M.S.A. degree in 1990.

ployed by more than 7,000 companies. These companies encompass virtually all first-tier government contractors and most of the second and third tier. The FEI is organized into 91 chapters located in the United States and Canada. Headquartered in Morristown, N.J., it is managed by officers and a board of directors selected, mostly, from members. Within its membership is a high percentage of all of North America's corporate chief financial officers, and many of their first- and second-level reporting staffs. It includes corporate controllers and corporate treasurers, and division, group and other segment controllers. It includes financial chiefs and higher-level financial managers with other titles; also financial executives from giant-, large- and medium-size companies. However, due to minimum-size restrictions, very small companies are not represented. It is organized to include 18 committees, one of which is an Ethics and Eligibility Committee, of 18 members. It has a Code of Ethics, to which all members are subject. This code reads, in part, as follows:

> As a member of FEI, I will conduct my business affairs at all times with honesty and integrity; comply with rules and regulations of federal, state, and local governments, and other appropriate private and public regulatory agencies; and refrain from committing acts discreditable to myself, my employer, FEI or fellow members of the Institute.

About the Survey

The survey was taken by sending a questionnaire to 500 FEI members, selected from the 1989-1990 membership directory. Selection was essentially random but utilized certain ground rules. The survey was mailed August 30, 1990, and responses were cut off at 160 in mid-October, approximately 6 weeks later. Considering sensitivity of the subject, a response of 160 out of 500, or 32 percent is deemed to be respectable. This response is worthy of the attention of all thinking people interested in furthering the cause of honesty and integrity in the conduct of business.

Timeliness

Unethical and unlawful business practices of government contractors has received much attention throughout the years. The recent "ill wind" investigations are the latest of highly publicized events of this nature. Scandals on Wall Street, involving junk bonds and insider trading, and the national disaster in the Savings and Loan Industry, have broadened this attention to the whole business world. White-collar crime seems to be running rampant. In view of the publicity, this survey, its results and this report are appropriately timed.

Regulatory Obligations

Whether or not they are members of FEI, all corporate financial personnel are obligated to keep the books and financial records of their companies according to Generally Accepted Accounting Principles (GAAP), accounting practices, procedures and principles followed by all professional accountants. It is revised from time to time by the Financial Accounting Standards Board (FASB).

In addition, the Securities and Exchange Commission (SEC) has laws and regulations related to accounting and reporting practices, which control and regulate public corporations. Other laws and regulations, Federal Procurement Regulations (FAR), exist to direct and guide the complicated process of U.S. Government

acquisition. Within the FAR are promulgations of the Cost Accounting Standards Board (CASB). This agency, reporting to the U.S. Congress, was established and operated during the 1970s. Its specific purpose was to determine and implement special cost accounting procedures and regulations applicable to government contractors. All of these have the full weight and effect of federal law. A new CASB was begun in 1990 and is in its formation and start-up stage. Finally, federal, state and local governments have a variety of other accounting-related laws and regulations on the books about taxes, and for other purposes.

Author's Motivation

Corporate financial executives sometimes find themselves under explicit or implicit pressure from their superiors to compromise one or more of the above regulatory or legal requirements. This occurs in commercial and government contracting companies. However, the frequency and degree may be greater for government contractors. This is because of the complexity added by FAR and CASB placed on top of all the normal commercial laws and regulations. The pressure is usually conveyed to the financial executive as being "for the overall good of the company." Unfortunately, the pressure might relate to a compromise of Generally Accepted Accounting Principles; an infringement upon sound moral or ethical practices; or an action skirting close to the edge of, or actually crossing over into, a violation of the law. While associated with a number of companies throughout my financial career, I directly felt this pressure, to various degrees, from some of my superiors. Throughout the years, I have talked with other financial executives, representing diverse companies, who have indicated they, too, have been similarly pressured.

Countermeasures

To counter this pressure, depending upon the degree of its intensity, the individual financial executive, operating on his own, usually has little recourse except to threaten resignation or, if that is ineffective, to actually resign. Depending upon the circumstances, that course of action might succeed; however, it is risky. Obviously, it might leave the financial executive unemployed. Further, because of animosity surrounding the severance of relations under these conditions, he might be left without an employment reference. For myriad reasons (personal, family, career), some may succumb to the pressure rather than take these risks.

Corporate financial executives sometimes find themselves under implicit pressure from their superiors to compromise one or more regulatory or legal requirements.

Survey Details

The survey questionnaire consisted of 16 questions. The complete questionnaire is shown in Figure 1, with the actual tabulation of all 160 respondents reflected directly below the answers to each question.

Superior's Background

Question 1 was an attempt to correlate the unethical pressure, if any, to the background of the superior. Summarizing the responses to show groupings of superiors with and without financial backgrounds, resulted in 65, or 41 percent, with and 95, or 59 percent, without financial backgrounds. That proportionate distribution is interesting. However, the analysis failed to show conclusive differences according to the superior's background. Of 30 separate items analyzed, only three (as reflected in Figure 2) showed any substantial differences according to the superior's background. Further, no pattern emerged. Two of the three items favored the former category (superiors with financial background), and one favored the latter (superiors without financial background). All of the other 27 items reflected statistically, insufficient differences upon which to draw conclusions. Therefore, the superior's background was judged to be without significance and was eliminated from further analysis and comment in this report.

Significant Responses

The remaining responses to the questionnaire were deemed to be significant. Results, reflected in Figure 2 under the column Grand Total, apply to the balance of the report. They may be referred to as each question is discussed.

Majority Receive Unethical Pressure

Questions 2, 4, 6 and 8 dealt directly with whether or not the executives had ever received pressure from their superiors to, respectively, breach professional ethics, change financial results to other than those resulting from following GAAP, violate the law, or move profit or loss forward or backward in time. Yes answers to one or more of these questions were received from 83, or 52 percent of the respondents; hence, the lead sentence of this article, "More than half of all corporate financial executives receive pressure from their bosses to compromise and/or manipulate principles or ethics."

Relative Seriousness

These four questions represent varying degrees of seriousness. The highest number of yes answers, 46, or 29 percent, relate to question 8, "moving profit or loss forward or backward in time." This is perceived to be the least serious of the four. However, the most serious, question 6, "violate the law," received 16 yes answers or exactly 10 percent of all respondents. If these statistics can be relied upon, as they relate to the entire FEI membership, it means unethical pressure has been felt by more than 7,000 of the 13,400 members, in over 3,600 of the 7,000 companies

COMPLETED QUESTIONNAIRE

Total of all responses is shown directly below each answer.

1. Is your immediate superior a financial manager, a general manager with an accounting background or a general manager without an accounting background?

a. FM	b. GM W/Acct	c. GM WO/Acct	d. Not Applicable
45	20	90	5

2. Have you ever been pressured by your superior(s) to perform any act which if performed would have been, in your opinion, a breach of professional ethics.

a. Yes	b. No	c. Not Certain	d. Not Applicable
24	131	4	1

3. If yes, how often has this pressure been exerted?

a. Once	b. A Few Times	c. Many Times	d. Not Applicable
6	14	4	136

4. Have you ever been pressured by your superior(s) to change your company's financial results, to other than those which, in your opinion, would result by following GAAP?

a. Yes	b. No	c. Not Certain	d. Not Applicable
24	134	0	2

5. If yes, how often has this pressure been exerted?

a. Once	b A Few Times	c. Many Times	d. Not Applicable
5	18	1	136

6. Have you ever been pressured by your superior(s) to perform any act which if performed would have been, in your opinion, a violation of law.

a. Yes	b. No	c. Not Certain	d. Not Applicable
16	141	2	1

7. If yes, how often has this pressure been exerted?

a. Once	b. A Few Times	c. Many times	d. Not Applicable
5	10	1	144

8. Have you ever been pressured by your superior(s) to find a way to either defer or accelerate profit or loss to a period of time other than would have occurred following your normal practices?

a. Yes	b. No	c. Not Certain	d Not Applicable
72	82	4	2

9. If yes, how often has this pressure been exerted?

a. Once	b. A Few Times	c. Many times	d. Not Applicable
2	57	13	88

10. Have you ever left a job voluntarily because your superior(s) brought pressure upon you to perform unethical, unprincipled or unlawful acts?

a. Yes	b. No	c. Not Certain	d. Not Applicable
14	143	0	3

11. If yes, how often has this occurred?

a. Once	b. Twice	c. More Than Twice	d. Not Applicable
12	1	1	146

12. Have you ever been terminated from a job because you resisted pressure your superior(s) brought upon you to perform unethical, unprincipled or unlawful acts?

a. Yes	b. No	c. Not Certain	d. Not Applicable
4	148	3	5

13. If yes, how often has this occurred?

a. Once	b. Twice	c. More Than Twice	d. Not Applicable
4	0	0	156

14. Whether or not you have personally had a problem of pressure from superiors(s) to compromise ethics or principles do you know of any other financial executives who have?

a. Yes	b. No	c. Not Certain	d. Not Applicable
68	73	18	1

15. If yes, how many?

a. A few	b. Some	c. Many	d. Not Applicable
49	14	5	92

16. Depending upon your viewpoint regarding this subject, what techniques, if any, do you believe should be used in the attempt to rectify it? (circle one or more as you see fit)

29	a.	There is no problem, do nothing.
19	b.	The establishment of an independent body, such as FEI, to act as an ombudsman, to which financial executives could refer disputes with superiors over principles and ethics.
31	c.	The passage of a law protecting financial executives from unethical pressure from their superior(s) and establishing an avenue of appeal to the Security Exchange Commission or some other governmental body.
38	d.	The passage of a "whistle blower's" law which would protect a financial executive from repercussions as a result of reporting a superior for bringing pressure to perform unethical or unprincipled acts.
57	e.	Have the FASB establish a standard written in a manner that a company engaging in the practice would not be able to receive an unqualified certification from their outside audit firm.
51	f.	Other suggestion(s) as follows: (fill out one or more as you see fit)

154 Grand Total responses 16 a-e, Do Nothing and Do Something

125 Total responses 16 b-e, Do Something

69 Total responses for 16 c & d only, Pass a Law

56 Total responses for 16 b & e only, Other Remedies Than Law

QUESTIONNAIRE RESPONSES
SUMMARY COMPARISON

	WITH FIN BKG		W/O FIN BKG		GRAND TOTAL	
TOTAL RESPONDENTS:	#	%	#	%	#	%
	65	41	95	59	160	100
FELT PRESSURE:						
2 Breach of Ethics	11	17	13	14	24	15
4 Change from Gaap	11	17	13	14	24	15
6 Break Law	6	9	10	11	16	10
8 Move Profit	31	48	41	43	72	45
Yes to 2,4,6,8	34	52	49	52	83	52
Opt To Do Nothing	6	18	6	12	12	14
Yes to 8 Only	20	31	26	27	46	29
Yes to Balance	14	22	23	24	37	23
No Yes to 2,4,6,8	31	48	46	48	77	48
Opt To Do Something	15	48	26	57	41	53
HOW MUCH PRESSURE:						
3 Breach Of Ethics	33	51	43	45	76	48
5 Change From GAAP	29	45	37	39	66	41
7 Break Law	20	31	22	23	42	26
9 Move Profit	111	171	153	161	264	165
TERMINATED:						
10 Quit Job	6	9	8	8	14	9
12 Fired	2	3	2	2	4	3
Total Terminated	8	12	10	11	18	11
OTHERS PRESSURED:						
14 Know Others	30	46	38	40	68	43
15 How Many	103	158	115	121	218	136
POSSIBLE SOLUTIONS:						
16a Do Nothing	14	22	15	16	29	18
16a-e Blank	17	26	26	43	43	27
16b-e Do Something	46	71	79	83	125	78
16c & d Pass Law	32	49	37	39	69	43
16b & e Other	14	22	42	44	56	35
0 Remedies	31	48	41	43	72	45
1 Remedy	25	38	36	38	61	38
2 Remedies	6	9	13	14	19	12
3 Remedies	3	5	3	3	6	4
4 Remedies	0	0	2	2	2	1
1-4 Remedies	34	52	54	57	88	55

employing FEI members. Perhaps, even more alarming is the 10 percent pressured to violate a law. This would translate to 1,340 members in 700 companies.

Corrective Action

I suggest this evidence alone is sufficient to warrant immediate corrective action.

Frequency of Pressure

Questions 3, 5, 7 and 9 weigh the frequency that pressures were brought to bear. The answers weigh from 2.6 to 3.7 times per yes answer

and generally follow the seriousness criteria. The least number relates to breaking the law, and the most applies to moving profit or loss.

Resignation or Termination

This brings me to the most serious and distressing part of the analysis. Yes answers were received from 14, or 9 percent, of the respondents to question 10, "have you ever left a job voluntarily because of pressure brought by a superior?" Yes answers were given by 4, or 3 percent, to question 12, "have you ever been terminated because you resisted pressure from a superior?" Hence, a total of 18, or 11 percent, of the respondents believed they had either been required to quit or had been fired, due to resisting unethical pressure. If these percentages can be deemed to apply to the entire FEI membership, they equate to nearly 1,500 of all of the 13,400 members in 770 of the 7,000 employer companies.

Respondents Know Others

Questions 14 and 15 relate to whether the respondents knew others who had received this pressure and, if so, how many. The conclusion drawn from the answers is plain. The pressure to compromise ethics is widely spread, very well known and often discussed between and among financial executives. In spite of this, I believe this analysis is without precedent To my knowledge the subject has never been empirically explored or published until now.

Possible Remedies

The remainder of the analysis relates to question 16: What techniques, if any, do the executives believe should be used to try to rectify the problem.

Some Opt to "Do Nothing"or Abstain

Only 29, or 18 percent, of the respondents selected 16a, "there is no problem, do nothing." An additional 43, or 27 percent, left all the question 16 answers blank. This relatively high number of abstainers might very well reflect the great frustration financial executives feel in groping with this problem. Certainly, professionals would prefer to handle all of their problems inside their companies, without seeking help from others. However, the mere act, in and of itself, of abstaining from selecting 16a, "there is no problem, do nothing," seems to be an admission of the need to do something, if not an actual cry for help.

Have you ever left a job voluntarily because of pressure brought by a superior? Have you ever been terminated because you resisted pressure...

Majority Opt to "Do Something"

While 18 percent voted to do nothing and 27 percent abstained from voting at all, the remaining 55 percent (88 of the respondents) selected one or more of my suggested "do something" ideas shown as 16b, 16c, 16d and 16e. Of these, 61 selected one, 19 picked two, 6 chose three and 2 opted for all four suggestions. As shown in Figures 1 and 2, a total of 125 selections, almost 1.5 per person, were made. Pass a "whistle blower's law," 16d, received 38 votes, or 24 percent, and 16e, "have FASB establish a new financial standard," received 37, or 23 percent, making them, easily, the most popular choices. Passage of a law establishing an avenue of appeal to a governmental body, 16c, was next at 31, or 19 percent; 16b, established an independent body as an ombudsman, and was a distant fourth with 19, or 12 percent.

Majority Versus Minority

The most significant fact to be recognized from these data is that a clear majority (55 percent) of the respondents maintain something should be done, versus a relatively small minority (18 percent) who believe nothing should be done.

Answers Counter to Expectations

It follows, logically, that a financial executive who has felt this pressure, especially one who has lost a job because of it, might wish to "do something" to rectify it. Further, those who had never felt any of this pressure might, reasonably, be expected to opt to "do nothing." However, I felt it might be revealing to explore how many answered counter to normal expectations. I, therefore, compared how people answered, regarding receiving pressure, with how they replied about the suggested remedies. Of 83 people who felt pressure, only 12, or 14 percent, answered 16a, "there is no problem, do nothing." Conversely, of the remaining 77 people, those who did not answer yes to feeling pressure, 41 or 53 percent, chose one or more of the suggested "do something" remedies (16b, 16c, 16d and/or 16e). Thus, very few who directly felt this pressure wish to do nothing and leave the situation as it is. However, a clear majority of those who never felt the pressure at all, believe there is a problem needing correction. They indicated their belief by opting for one or more of the suggested remedies.

Recommended Corrective Action

The result of this partial poll of FEI members is overwhelming. It is imperative that action be taken to resolve the problem once and for all. In this connection, I am directly asking FEI to take immediate corrective action. In descending order of priority, the action alternatives I request are:

—FEI should undertake an immediate and urgent project to complete a 100 percent poll of all members about this vitally important problem.

—FEI should immediately prepare a position paper to send to the Financial Accounting Standards Board, asking it to solve the problem by establishing a new Standard. Some suggested ideas are:

—Require that both the CEO and CFO certify there have been no inappropriate alterations of financial data.

—Require liaison between the CPA, CFO, and Board of Directors Audit Committee to assure no inappropriate alterations of reports have been made.

—Require certification from all corporate financial management that a clearly defined code of ethics exists and has been followed.

—FEI should immediately prepare a position paper to send to the Security and Exchange Commission asking it to solve the problem by passing new laws and/or regulations. Possible candiates are:

—A "whistle blower's" law to protect the financial executive from repercussions as a result of reporting a superior for exerting such pressure.

—A law to protect financial executives from unethical pressure by requiring that they report all such incidents to SEC.

—FEI should immediately address how it might assume an ombudsman role to effectively solve this problem.

When the Boss Is Not Right

The decision required of a financial executive when his superior takes an illegal position on a black and white legal question is relatively clear, if not easy. Either agree with the boss and break the law or disagree and quit or be fired. Neither of these decisions is advocated as right, merely obvious. The grey questions are much more difficult (also much more numerous).

Take, for example, a complicated GAAP or financial regulatory question (FAR or CASB). These can sometimes be so intricate that several different financial experts might arrive at several different interpretations. Who should have the most influence, if not the final say, in the murky area—the company's financial experts, or the general managers (most usually not financial experts) who happen to be the bosses?

Some rules are needed. Procedures, regulations, principles or laws should be established, so that the outcome does not arbitrarily hinge upon who is most persuasive or powerful. There is a well-known maxim, "the boss may not always be right but he is always the boss." I believe it is time to directly confront what must be done in the corporate financial arena, "when the boss is not right."

Best Solution

It is my opinion that the best and clearest solution is to have FASB establish a new Financial Accounting Standard. However, if it takes new laws to protect the jobs of honest and otherwise competent financial executives, I say so be it!

Ethical Conduct Is Vital

Resignation or termination of the financial executive is not a satisfactory answer. Certainly it removes him from the danger of being coerced into fraudulent action. However, in most cases, it merely eliminates the recalcitrant opposition, permitting the boss to go ahead and do what he wanted to do anyway. I once had an intelligent chief inform him that he should separate morality from legality in providing financial advice and leadership to the company. The implication was that it was vital to obey the law but much less so to act morally. The hindsight of over 30 years of experience tells me almost the exact opposite.

The pursuit of moral and ethical conduct in business is a far more important and worthwhile endeavor than merely following the law. Certainly, companies must comply with all laws of the land. Sometimes this is very difficult, as the laws change continuously (every time legislators meet), requiring considerable effort merely to stay current.

Conversely, ethics and morals seldom change. They remain essentially constant, however, they do involve different values and generally go beyond the law. Generally, Accepted Accounting Principles and ethics and morals are alike in many ways. In order for any of them to have real meaning, ways must be found to enforce them more fully, not to cleverly find avenues to get around them. It is not worthy of executive management to see how closely it can skirt along the edges of propriety.

To barely stay legal, to just avoid fraudulent action, to scarcely stay out of jail is not a worthwhile lifetime occupational endeavor. Is it?

NEW DSMC MONOGRAPH

DESIGNING QUALITY INTO DEFENSE SYSTEMS

[by Wilbur V. Arnold]

The total quality management initiative has spawned new emphasis on designing quality into defense products. "Designing quality in" is by far preferred to inspecting in; by far preferred to developing manufacturing processes that cover inadequacies in the design; and, by far preferred to developing operational support activities covering inadequacies in the design.

In short, the design phase must be the beginning of a strategy to *prevent poor quality*. This monograph takes an earlier work, *Designing Defense Systems*, and adds the current spin of variability reduction, robust design, concurrent engineering and quality function deployment, with a specific aim of designing in quality.

Included in the design process description are 13 techniques that minimize equipment failure to meet customer requirements. Related to the process, the impact of modern computer assistance is discussed in terms of the potential for improved designs. Also addressed are process improvement problems of the manager developing an effective design staff.

Special emphasis is on organizing the design process—careful attention to customer requirements and developing specifications, then a work breakdown structure for managing the detail design response. A clear understanding of customer requirements, deployment of those needs into the design strategy and planning, and a structured approach to monitoring progress will lead to effective defense systems designs and will improve efficiency of the design process.

Designing Quality Into Defense Systems by Mr. Arnold has just been published by DSMC and is available free to government personnel. Write Director of Publications, DSMC-DRI-P, Fort Belvoir, VA 22060-5426 or fax 703-780-0447.

1991 ACQUISITION RESEARCH SYMPOSIUM

Acquisition for the Future

The Defense Systems Management College (DSMC) and the Washington D.C. Chapter of the National Contract Management Association (NCMA) were cohosts of the 1991 Acquisition Research Symposium at the Sheraton National, Arlington, June 4-5. More than 275 acquisition personnel attended. Lieutenant Colonel David L. Scibetta, USA, and Ms. Donna Ireton, NCMA, cochaired the conference assisted by program cochairs, Mr. Calvin Brown of DSMC, and Mr. Edwin Phelps of NCMA. Ms. Joan Sable of DSMC was the program coordinator.

The symposium, latest in a series that began in 1972 and last held in 1989, was a great success. Attendees were senior officials, program managers, staff officers, and researchers from the Department of Defense, federal civilian agencies, academia and industry. Papers were written on the latest research and development documented by people involved in the many aspects of acquisition.

Keynote Speaker

Major General Lynn H. Stevens, USA, DSMC Commandant, gave the opening remarks and introduced the keynote speaker, Dr. Malcolm R. Currie, chairman and chief executive officer, Hughes Aircraft Company. Dr. Currie said government and industry should work together to build a relationship based on mutual understanding and trust. He spoke of the reality of a changing Defense Department and the need to "emerge at the end of the decade with a much smaller but innovative, competitive and vital defense industrial base." This "will require a new kind of thinking and a new kind of enlightened leadership," he said.

Mr. Alan Yuspeh, a partner at Miller & Chevalier, spoke on business ethics and conduct. The luncheon speaker, Mr. John Rittenhouse, senior vice president of GE Aerospace, spoke from "a major weapon systems viewpoint, on the current state of the acquisition process," how it can be improved, and the "cooperative effort we must mount to ensure that improvement." Discussing the symposium theme, **Acquisition for the Future--Imagination, Innovation, and Implementation,** he said we need "to bring such attributes to bear in our efforts to improve the acquisition process ...about what the process is really all about, and what our collective responsibilities are in making it work."

The morning session June 5 featured the Service Acquisition Executives Panel comprising The Honorable Gerald A. Cann (Assistant Secretary of the Navy), The Honorable Stephen K. Conver (Assistant Secretary of the Army), and Mr. Daniel S. Rak, (Deputy Assistant Secretary of the Air Force). They discussed their specific areas and fielded queries, with Major General Stevens as moderator

Mr. Don Fuqua, president and general manager of Aerospace Industries Association of America, Inc., gave the luncheon address June 5.

Two Panels

Two panels were held June 6. The first concerned international aspects

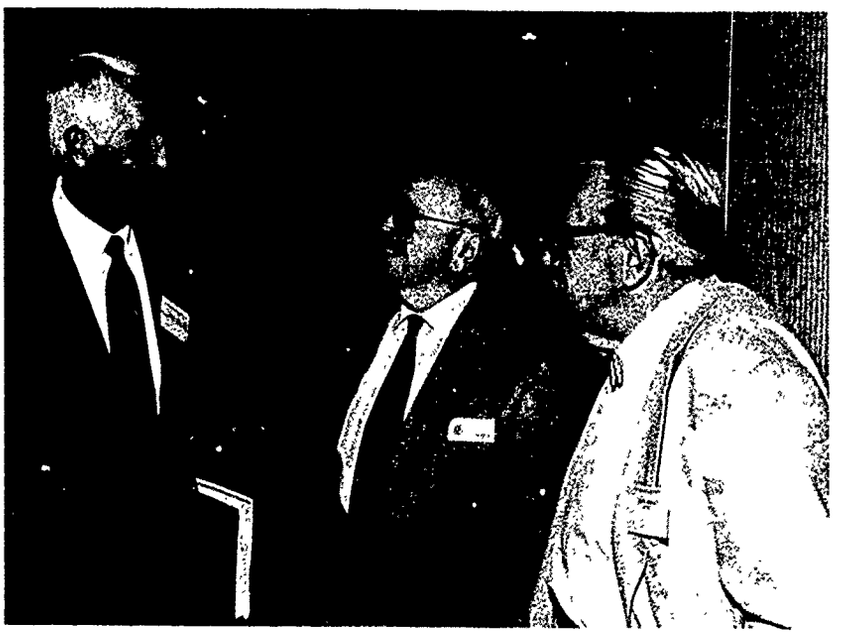
Major General Lynn H. Stevens, USA, then DSMC Commandant, now retired, welcomes featured speakers. Left to right are Gerald A. Cann, Assistant Secretary of the Navy, General Stevens, Stephen K. Conver, Assistant Secretary of the Army, Daniel S. Rak, Deputy Assistant Secretary of the Air Force

The Update on Congress Panel members, left to right, are Eleanor R. Spector, director of Defense Procurement, Colleen Preston, general counsel, House Armed Services Committee, Allan V. Burman, Office of Federal Procurement Policy, and Attorney Stephen M. Ryan

LTC David L. Scibetta, USA, of DSMC, conference cochairman, at the podium.

James D. Bell, Chairman/President of Thompson-CSF, was on the International Aspects of Acquisition Focus Panel. With him are DSMC Professors David D. Acker and Dr. Franz A. P. Frisch.

Donna S. Irton, National Contract Management Association, cochaired the symposium



of acquisition, the second was an update on the aspects of acquisition, and the second was an update on the congressional panel. Ms. Mary Ann Gilleece moderated the international panel with three panelists; Mr. Jim Bell, president of Thomson-CSF, Mr. Jens Peder Jensen, president of TERMA Electronics, and Mr. William Schneider, Jr., president of International Planning Services, Inc. They discussed the unique nature of the acquisition process in the international marketplace. They noted the importance of the impact different cultures have on business operations, and gave views on the progress and prognosis of Europe '92. The congressional panel was moderated by Mr. Steve Ryan, who had experience with the Senate Committee on Governmental Affairs. Panelists addressed all facets of the defense/congressional interface process with Ms. Eleanor Spector, director of defense procurement; Ms. Colleen Preston, general counsel, Committee on Armed Services, and Mr. Allan Burman, administrator for Federal Procurement Policy. The panelists gave insights on key, new legislation that may affect the acquisition process and offered views on the future regarding budgetary and regulatory changes.

Accepted papers and abstracts are printed in two volumes. The DSMC and NCMA selected the 90 papers included in the book of proceedings; of 90 papers, 33 were selected for presentation. Volume 1 is papers presented during the symposium and Volume 2 is other exceptional papers.

Request these volumes by writing to Defense Systems Management College, ATTN. DRI-P, Fort Belvoir, VA 22060-5426 or fax your request to (703) 780-0447.

OT&E IS THE LYNCHPIN

Acquisition of Effective Weapons Systems

Major Timothy B. Moore, USAF

The B-1B acquisition has experienced problems and cost overruns. The user's representative in test is *Operational Test and Evaluation* (OT&E). This important factor, when addressed regarding concerns, often fell on deaf ears of procurement and test managers.

It is time we understand that OT&E is the lynchpin in the acquisition of effective weapons systems. I will support this assertion by looking at three things.

First, this subject cannot be entertained without understanding the historical evolution of OT&E importance.

Next, with an understanding of this history as a foundation, I will look at OT&E strength in the acquisition process today.

Finally, I will distill from these two elements the direction we must go to place OT&E in a position so that the deaf will hear.

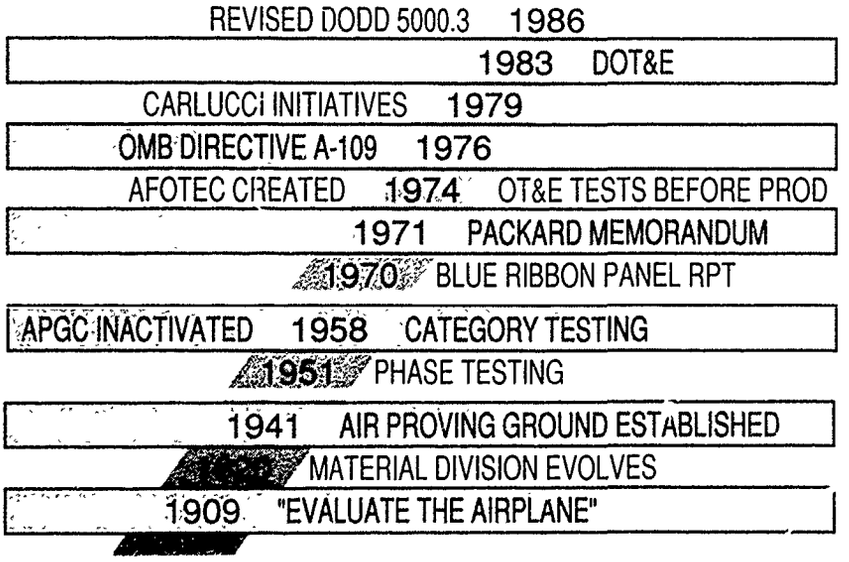
The history of test had important milestones from its beginning at the turn of the century to major reconstructuring in the late 1980s. It is interesting to note OT&E was involved at the onset. Let's look at its gestation. The U.S. Army Signal Corp, grandfather of the Air Force, accepted aeroplane No. 1 into its inventory August 2, 1909. The decision was not made without a demonstration and validation. The following is an eyewitness account of this historical event by Benjamin Foulois.

"The Wrights pushed their machine to the starting rail and made many adjustments to the engine and the guy wires. I put two stop watches around my neck and got into the passenger seat. I strapped a box compass to my left thigh, lashed an aneroid barometer to my right thigh, and jammed a map into my belt.

"Orville warmed up the engine until he was satisfied with it, and climbed aboard....I nodded and gulped...grabbed the edge of the seat with both hands and waited. Orville revved up the engine, released the trigger, and the machine started down the rail. We skimmed over the grass for a few feet to gain speed, and then climbed for altitude. I flicked one stop watch and pointed the exact course we should follow to Shooter's Hill. All twenty-five horses were functioning properly as we skimmed over the treetop....

"We reached Shooter's Hill all right, and I flicked the second stop watch....We rounded the turn and the wing tip was much too close to the tops of the trees. A down draft hit us, and I thought we were going to cartwheel into them for sure. We straightened out, however, and started back for Myer. Going down wind now, our ground speed increased and Orville climbed until we

FIGURE 1. EVOLUTION OF OT&E



Major Moore was graduated in June from the Air Command and Staff College, Maxwell Air Force Base, Ala. He is serving with the 31st Test and Evaluation Squadron, Edwards Air Force Base, California.

reached 400 feet--a world's altitude record. As we neared Myer...I flicked the stop watch off...and relaxed as he made a circle over Arlington Cemetery, cut off the engine, and glided in for a fairly smooth landing amid a cloud of dust.

"We had established three world records for the United States that date: one for a two-man flight at 42.583 miles per hour; another for a cross-country flight of 10 miles; and a third for an altitude record of 400 feet....July 30, 1909, was truly a significant day in American aviation."

However, the first lessons of test came on flight number two, September 17, 1908. This flight was not so successful. It was terminated by a sudden nosedive from 70-100 feet. Lt. Thomas E. Selfridge, U.S. Army, our first operational pilot, was killed. Why did this happen? Before the flight the Wrights installed larger propellers without studying the consequence. The right blade cracked, sheared a stay wire, and caused structural failure. As a result, the Wrights made structural changes which eventually proved the aircraft operationally acceptable.

As seen by this early example, OT&E was a player in the acquisition of our first airplane. Since then OT&E has traveled a long, tough road to reach its current status. Figure 1 presents a view of the major milestones in the evolution of OT&E. Initiatives were developed to improve the acquisition process.

The first initiative was in 1970. Because of the high cost of procurement and extensive post-production modifications, a blue ribbon report proposed three actions

First, the responsibility for test and evaluation (T&E) should be assigned to an assistant secretary of defense for T&E.

Second, there must be separate funding for T&E.

Third, this DOD test agency should supervise the whole test process.

Two years later, the Bolender Committee was formed to make further recommendations.

The history of testing has important milestones since the turn of this century. Here, we see a present-day B-1B aircraft photographed participating in "Business Effort," a Strategic Air Command refueling support program for Edwards Air Force Base flight test operations. (U.S. Air Force photo by MSgt Patrick Nugent released by Department of Defense.)

Addressing these recommendations, the Congress passed Public Law 92-156, which linked funding to OT&E weapon system performance data. In an action to give OT&E more strength, the Air Force created the Operational Test and Evaluation Center (AFOTEC) to manage operational test and represent users' interests. It also provides objective and independent feedback in the acquisition process.

In 1976, the Office of Management and Budget (OMB) distributed Circular A-109 outlining, among other things, the test and evaluation process. The Department of Defense Directive 5000.3 was in response. This directive refined the acquisition process, emphasizing as policy "the primary purpose of all test and evaluation (T&E)...timely development, production, and fielding of systems that meet the user's requirements and are operationally effective and suitable."

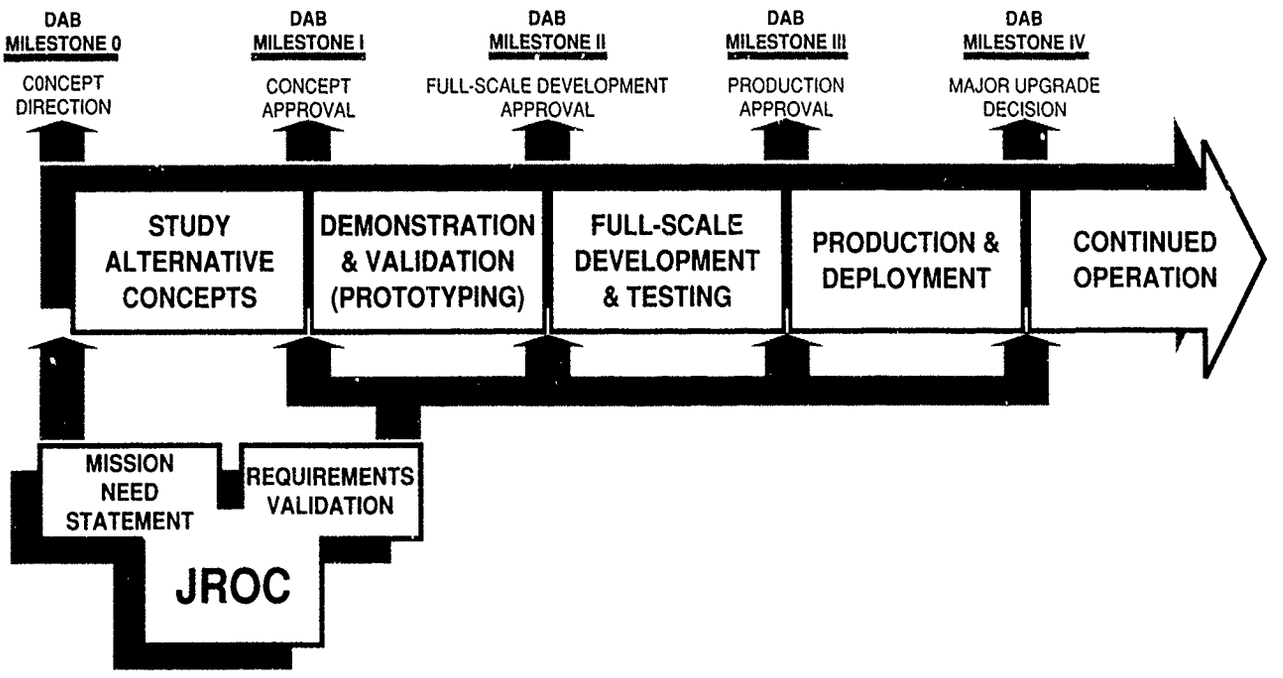
I want to emphasize two important phrases from the above.

First is "the user's requirements." The user refers to the final unit that will operate the weapons system; e.g., the Strategic Air Command is the user for the B-2A. The directive clearly places the testing hammer in the hands of the user who must have decisive inputs in the process.

Second is the phrase "operationally effective and suitable." Regardless of how well the weapon system meets contract specifications, if it is not operationally effective, it is useless.

Although simplistic, the following example, procurement of a vacuum cleaner, is an excellent illustration.

FIGURE 2. ACQUISITION PROCESS



A contract specification requires this vacuum to pick up a paper clip in a shag rug. The machine is tested and found to meet this specification. However, the user has found it too heavy to move, too big to get through the door, and too labor intensive requiring 32 man-hours for simple maintenance. The vacuum was a testing success, but an operational failure. The reality of procurement is by far more complex but this example is not far off the mark.

In the next major step, the Department of Defense established the director for operational test and evaluation at the DOD level in 1983, and OT&E had a seat at the top of the management chain. In 1988, Secretary of Defense Dick Cheney completely reorganized the acquisition process to resolve problems of bringing on expensive complex weapon systems (Figure 2). As an example, the defense budget for fiscal 1991 allocated $1.6 billion for B-2A research, development and testing. These changes strengthened OT&E influence in weapon systems procurement. What do these structural changes mean?

In the past, the testing process has relied too much on contract specifications through developmental test and evaluation (DT&E) rather than user operational requirements through OT&E, as I illustrated in the "vacuum" example. In fact, in testimony before the Congress Armed Services Committee in June 1989, Larry K. Smith, president of Business Executives for National Security, noted that the Fitzhugh Commission, a Blue Ribbon Defense Panel, commissioned to investigate the procurement process, reported "funding (for OT&E) has been and continues to be inadequate...there is no effective method for conducting OT&E that cuts across service lines (and) it is almost impossible to obtain test results that are directly applicable to decisions or useful for analysis." As a result, aircraft meet contract specifications but turn out to have operational inadequacies.

Figure 3 shows how DT&E and OT&E blend during the acquisition process. In order for OT&E to be useful for analysis, DT&E must yield territory in this process to OT&E. However, in order to move OT&E to the left, DT&E must assure the engineering design is complete, and that technology and design problems have been resolved. The concurrence implied by Figure 2 prevents significant program delays and/or increased cost/resources and is appropriate for a smooth transition from development to production. Lack of real concurrence was definitely a contributing factor in the B-1B controversy.

So much for what can be. Today, even with a push for better concurrence (e.g., B-2A), OT&E "suffers because the additional developmental time almost always comes at the expense of operational testing."

I propose the Air Force implement stringent requirements for OT&E to take the lead in the acquisition process. Weapon system DT&E is absolutely necessary, but not at the expense of OT&E. The OT&E earlier involvement and respect in the procurement process will reduce the acquisition risk and post-production modifications cost.

For example, *Air Force* magazine, January 1991, notes a seemingly nontrivial conversion of the B-2A to operate on a different jet fuel will cost $55 million, approximately the cost of two F-15s. Clearly, this modification is not so trivial after all. It is time the test community realizes OT&E is

an essential team member and a critical element of test, without whom effective weapon systems cannot be successfully procured.

Additionally, OT&E is responsible that the user and the people of the United States get the most effective weapon system for their money.

The OT&E has struggled more than 80 years to gain a place in the acquisition food chain. The Legislative and Executive branches place absolute importance in operational utility of procured weapon systems through law and directive. The directive for OT&E is clear. However, the test community must recognize OT&E importance on the team.

We must recognize operational test and evaluation is the lynchpin in the acquisition process.

Bibliography

1. *Air Force*, January 1991, Vol. 74, No. 1.

2. *Air Force Regulation 80-14*, Department of the Air Force, U.S. Government Printing Office, November 3, 1986.

3. *A Plan to Improve the Defense Acquisition Process and Management of the Pentagon*, Dick Cheney, *Defense 89*, Special Issue, pp. 2-19, U.S. Government Press.

B-1B

4. *Integrity of Department of Defense Acquisition System Acquisition System and Its Impact on National Security*, Hearing before the Investigations Subcommittee of the Committee on Armed Services, House of Reprsentatives, 101st Congress, March 8-9, and June 7, 1989, H201-12.

5. *Introduction to Acquisition Management SYS100*, seminar text, Ernest R. Keucher, editor, July 1989, Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio.

6. *Management of United States Air Force Operational Test and Evaluation Flight Test Programs*, Stephen P. Herrilinger, Strategic Systems Combined Test Force, Edwards Air Force Base, Calif.

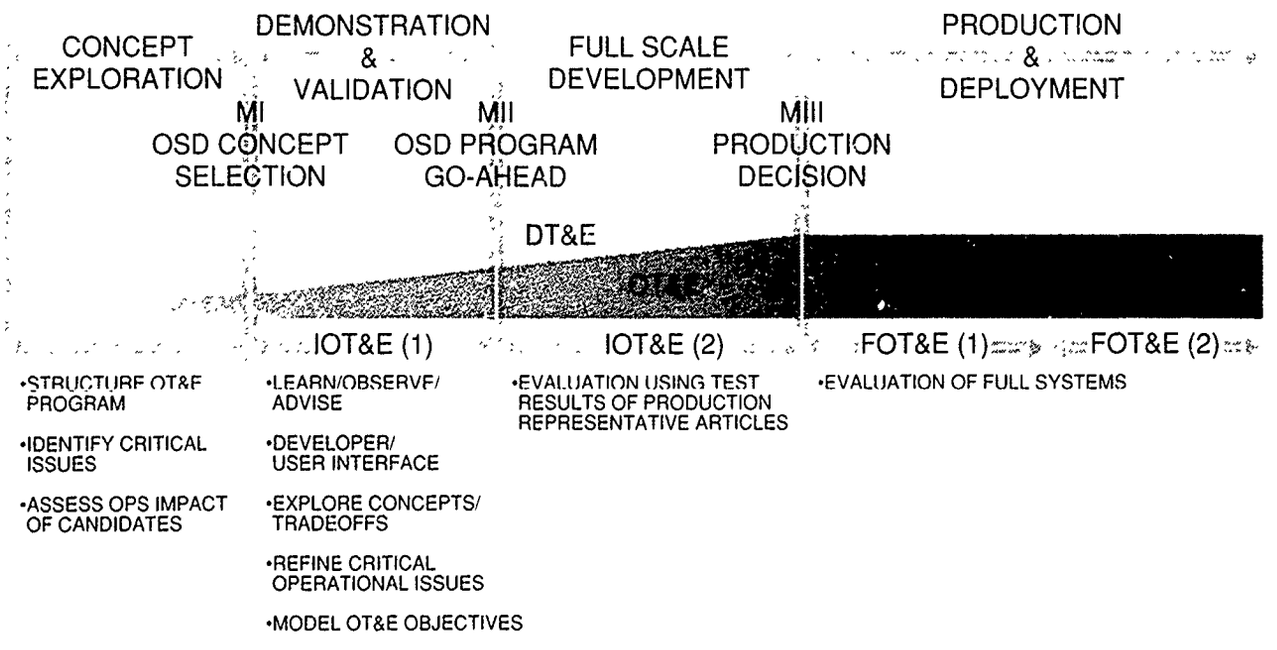
7. *Operational Test and Evaluation: the Quest for Independence*, Robert E. Oertel, Major, United States Air Force, Air University Press, Maxwell Air Force Base, Ala., Dec. 1985.

8. *The Role of Simulation in Operational Test and Evaluation*, Greg A. Mann, Lieutenant Colonel, United States Air Force, Air University Press, Maxwell Air Force Base, Ala., August 1983.

9. *Test Management Theory and Flight Test Techniques*, United States Air Force Test Pilot School, Edwards Air Force Base, Calif., January 1981.

10. *1991 FY Defense Budget*, the 101st Congress.

FIGURE 3. ACQUISITION CYCLE AND OT&E PHASES



DSMC CELEBRATES 20TH ANNIVERSARY

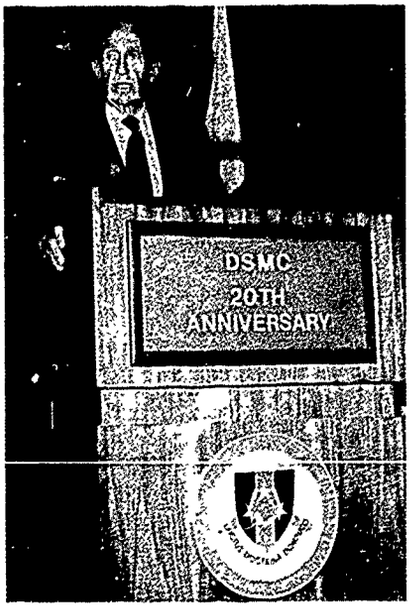
The Honorable Donald J. Yockey, Under Secretary of Defense for Acquisition, spoke to hundreds at the College, which now includes 161 faculty and a support staff of 202.

Some DSMC Commandants and the widow of one, the late BG Winfield S. Scott III, USA, cut the birthday cake. Left to right are: MG John G. Albert, USAF, Colonel Thomas V. Forburger, USA; MG Lynn H. Stevens, USA, recently retired, Mrs. Scott, new DSMC Commandant, Rear Admiral William L. Vincent, USN; BG Benjamin J. Pellegrini, USA, and Colonel John B. Hanby, Jr., USA.

Commandants not pictured: Rear Admiral Roland G. Freeman III, USN, LTG William E. Thurman, USAF, Rear Admiral Roger D. Johnson, USN, and BG Charles P. Cabell, Jr., USAF.

The Defense Systems Management College was established as a "school" July 1, 1971, after Deputy Secretary of Defense David Packard led a group to study aspects of existing acquisition management education.

More than 40,000 military and civilian personnel from all military services, federal agencies, and managers from defense industry have completed one or more courses.



Mr. David Packard, former Deputy Secretary of Defense, founder of DSMC, was the guest speaker at the June festivities. He is the Chairman of the Board, Hewlett-Packard Company.

PROGRAM MANAGER

LETTER TO EDITOR

"CONTRACTOR PAYMENTS"

An article, "Toward More Effective Management and Control of Contractor Payments," in *Program Manager*, January-February 1991, recommends using Cost Performance Report (CPR) or Cost/Schedule Status Report (C/SSR) data to determine program status when conducting payment reviews. While I would concur that using such reports can be useful I believe there are points requiring clarification because the author's use of the term "contractor payments" is misleading.

First, under a cost reimbursable contract (cost plus fixed fee, cost plus award fee, etc.) the contractor is required to deliver "best efforts" toward achieving contract goals. *Success* in achieving contract goals is *not* a requirement for "payment." The government is required to reimburse or "pay" the contractor for allowable cost incurred up to the negotiated cost in the contract. Reduction of award fee *may* be appropriate to get the contractor's attention if the government program office is dissatisfied with performance. However, failure to reimburse the contractor for allowable cost incurred and an appropriate portion of fixed fee in a timely fashion will not reduce government liability and may harm the financial health of the contractor.

Second, under fixed-price type contracts, whether firm-fixed price or fixed-price incentive, the contractor is entitled to "payment" upon delivery of goods or services. There is no need to audit "progress" for payment purposes. It is only when one is reviewing the contracts contractor's request for "progress payments" or fixed-price type that the issue of progress is relevant to the payment review process. Progress payments are, in reality, loans against work-in-process inventory to be repaid by delivery of goods and services. Therefore, it is quite appropriate for the government to seek assurance that the cost of work in process fairly represents progress toward delivery. However, traditional cost accounting systems collect actual cost incurred without regard for schedule or technical progress. Thus, there is a need to monitor progress that may be satisfied by analysis of CPR or C/SSR data *if available*. The C/SCSC is not typically a requirement on firm fixed price contracts; progress payments are.

When C/SCSC reports are available on fixed-price incentive contracts, time can be saved in the progress payment review process if one understands what to look for and how to use the information available. Line 12a on the progress payment request form shows total cost incurred to date. Line 12b shows the contractor's estimated cost to complete the contract. Dividing line 12a by the total of 12a plus 12b will indicate the percent of total estimated contract cost incurred. The government is at risk on its "loan" to the contractor to the extent that percentage exceeds Budgeted Cost of Work Performed (BCWP) as a percent of the Estimate at Completion (EAC) reported under C/SCSC.

As a practical matter, efforts to develop a precise audit trail between cost incurred for progress payment purposes and BCWP or "earned value" may be difficult and frustrating for at least two reasons.

First, C/SCSC reports typically take longer to prepare than progress payment requests. Therefore, the information needed for progress payment request review may not be available until several weeks after the progress payment request has been submitted

Second, progress payment requests are based on costs recorded on the accounting records of the company, whereas BCWP is impacted by the rules for opening and closing cost accounts. Perhaps an example will help make clear the improbability of precise reconciliation. The cost of material purchases solely for a specific contract will most likely be charged directly to that contract upon receipt, even if some or all of the items are placed into a storeroom for future use. Under the rules of C/SCSC, the affected work package(s) might not be opened until the items are physically transferred out of storage. The timing difference between cost incurred and BCWP that could result may be difficult and time-consuming to audit.

In closing, I would emphasize that efficient use of C/SCSC data to validate progress payment status will require a close working relationship between the program office and the contract administration activity since both tend to specialize in their particular area of responsibility and may not fully understand each other's concerns and capabilities. For example, while it is reasonable to expect the sum of lines 12a and 12b (total estimated cost at completion) to complement the estimate at completion available through C/SCSC reports, there are formulas used within the discipline of C/SCSC to test validity of the contractor's estimate. Large variances between the two data points would be cause for concern. Small differences may not. Someone must be charged with making judgment calls when required.

In those cases where C/SCSC is not a contractual requirement, it must fall upon the program office to establish a progress baseline against which the cost of work-in-process inventory can be measured Failure to establish such a baseline will make verification of progress for payment review purposes costly and time-consuming.

Most important, perhaps, is the realization that improper selection of contract type can have devastating repercussions on small and large programs. Dressing a cost-type technical effort in a fixed price contract will not eliminate the government's risk, but may deny the government access to progress measurement tools available under C/SCSC.

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Professor, Financial Management
Defense Systems Management College