Chapter 8

Lab to Field: Why So Long?

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Lab to Field: Why So Long?

INTRODUCTION

This nation's military strategy depends upon maintaining a technological lead in fielded military weapons systems, both to take advantage of the strong U.S. technological capability and to compensate for a numerical disadvantage relative to the Soviet Union in many categories of weapons. Nevertheless, leading defense officials are concerned that the technological level of operational U.S. weapon systems lags considerably behind the state of the art.

Some of this discrepancy is unavoidable. Many systems now in the field have been there a long time. Those just now entering service had their designs substantially frozen years ago, while the level of technology in the laboratory has continued to advance.

The inherent time lag between lab and field notwithstanding, the length of time it takes for new technology to be fielded in U.S. military systems is disturbing. According to the Department of Defense (DoD),

> The Soviets are methodically and efficiently transitioning new technologies into their vast arsenal, oftentimes more rapidly than the West . . . Consequently, the Soviets, although lagging the West in technology, frequently field systems that are sufficiently well-engineered to meet or exceed the capabilities of counterpart Western systems. [1]

A 1987 study by the Defense Science Board (DSB)—a panel advising the Secretary of Defense on technical matters-found that the inability to move technology rapidly from research and development (R&D) programs to systems and products ''is a primary contributor to the growing crisis in military competition as Soviet weapons system performance approaches and, in some cases exceeds, that of U.S. and Allied forces. "[2]

Figure 4 shows when several technologies now in use in Air Force systems first started to be developed in the laboratory. Some of the apparent lead times are exaggerated, since the Air Force systems shown are not necessarily the first ones to use the technology. (For example, since the B-1 was not the first plane with a variable swept wing, the 20-year lead time shown in figure 4 is not an accurate measure of the time needed to get this technology into the field.) Nevertheless, this illustration does suggest that typical technologies now being fielded in military systems began their development 10 to 15 years ago.

The lead time needed to field new technology can be reduced in three ways: a nation can, by spending more or by spending more efficiently, increase the rate at which military systems are modernized; it can hasten the rate at which new technologies are included in proposed system designs; and it can speed up the acquisition process by which any particular new system gets into the field. Although these different aspects—affordability, insertion, and acquisition—are discussed separately in this chapter, it is important not to treat them in isolation. Even though the strategy of the United States depends upon maintaining a technological advantage, that advantage can be realized only when technology leads to increased military capability. Introducing new state-of-the-art technology into a military system has no benefit if the system cannot be developed, if it cannot be supported and maintained in the field, or if it is prohibitively expensive.

This chapter first looks at the affordability issue, one which cuts across all activities of DoD and is a critical determinant of the rate at which forces are modernized. It then examines factors that influence the selection of new technologies when upgrade decisions are made, and it concludes with a discussion of the DoD acquisition system itself—the process by which decisions to modernize are implemented.

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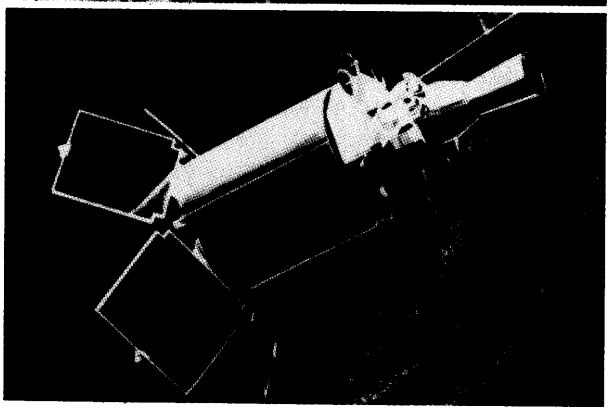
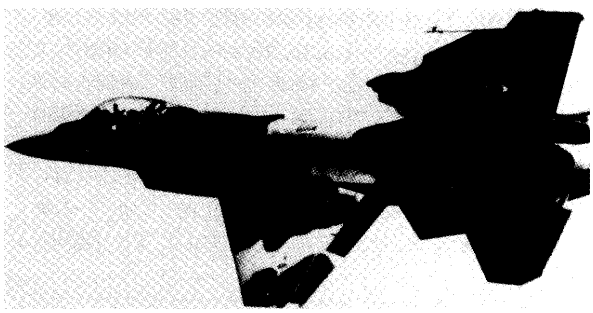
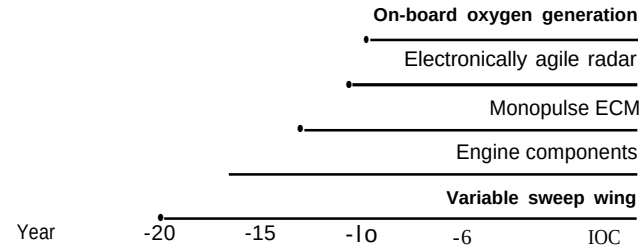
[1] U.S. Department of Defense, "Soviet Military Power: An Assessment of the Threat, 1988," 1988, p. 149.

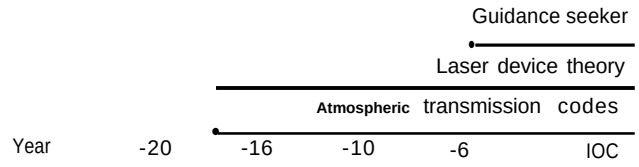
[2] Defense Science Board, "Report of the Defense Science Board 1987 Summer Study on Technology Base Management," prepared for the Office of the Under Secretary of Defense for Acquisition, December 1987, p. E.2.

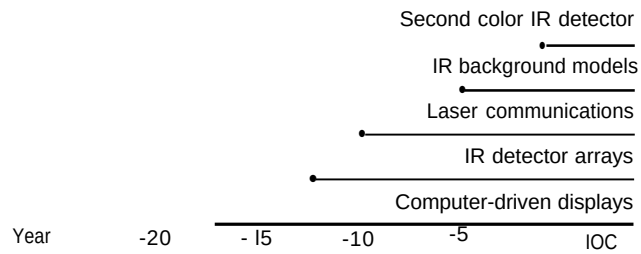
Figure 4—Technological Lead Times

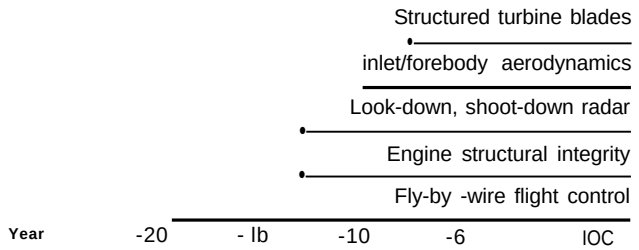












SOURCE. U.S. Air Force, Headquarters Air Force Systems Command, Deputy Chief of Staff/Technology and Requirements Planning. The *Air Force Science & Technology and Development Planning Program,* June *22,* 1988,

AFFORDABILITY

Funding Shortfalls

The biggest impediment to fielding state-of-the-art technology in future weapons systems may not be getting the technology into the design; it may not even be getting the design through the acquisition process and into the field. The biggest problem may be finding the money to buy the new system in the first place.

After undergoing unprecedented peacetime growth during the early part of the Reagan Administration, the DoD budget faces equally unprecedented shortfalls in future years as existing plans far exceed likely available funding. Two factors are leading to this squeeze. One is the "bow wave," representing the bills yet to be paid for weapon systems that are now undergoing development or entering production. The second, termed the ''stern wave, " represents the rising cost of supporting and maintaining weapons that have already been delivered. DoD data show that operations and support (O&S) expenditures for new generations of weapon systems often exceed those of the systems that are being replaced. Although technological improvements sometimes actually reduce O&S costs, the Comptroller General of the United States has stated that expectations to this effect generally "are not being fulfilled. "[3]

Then Secretary of Defense Carlucci stated that between $174 billion and $300 billion will have to be cut from the planned DoD program for fiscal years 1990 to 1993,[4] assuming that the defense budget will rise at a rate of 2 percent over the inflation rate. Given the present $140 billion budget deficit, the Gramm-Rudman-Hollings spending limits, and other Federal obligations such as cleaning up years of environmental neglect in the nuclear weapons production complex, these increases in the DoD budget may not be realized. A DoD budget that only keeps track with inflation will fall short of one with 2 percent real growth by another $36 billion over the next 4 years; one that only remains level in current (not constant) dollars falls short by much more. Clearly, as the Comptroller General has said, "'the services have too many systems chasing too few dollars. "[5]

Much of the problem is that the cost of new systems is increasing at a rate that consistently exceeds inflation. This does not necessarily mean that the money is being wasted, since the quality and performance of these systems is going up as well. However, given fiscal constraints, this cost growth will severely limit the quantities of new systems that can be purchased. Norman Augustine, president and chief operating officer of a major aerospace firm, drives this point home in a striking way. Extrapolating current trends in tactical aircraft cost growth (figure 5), he finds that the U.S. defense budget will be able to afford only one plane in the year 2054, and that the plane's successor some 75 years later will consume the entire Gross National Product (GNP).

Aging Inventories

Inability to complete ongoing modernization programs at planned rates----even given the recent budget buildup-aggravates what is already a slow recapitalization rate within DoD. According to Leonard Sullivan in an analysis conducted for the Center for Strategic and International Studies '(CSIS) Defense Acquisition Study:

> The total fiscal year 1986 replacement value of all DoD facilities and properties ran just under $3 trillion-about 75 percent of the U.S. GNP. Based on current [in 1985] acquisition plans, DoD is ''rolling over" its weapon and support systems roughly once every 25 years and its fixed facilities once every 50 years. No commercial enterprise operates with such slow turnover. It would appear difficult if not impossible to keep defense at high readiness and near the leading edge technologically with this poor replacement rate.[6]

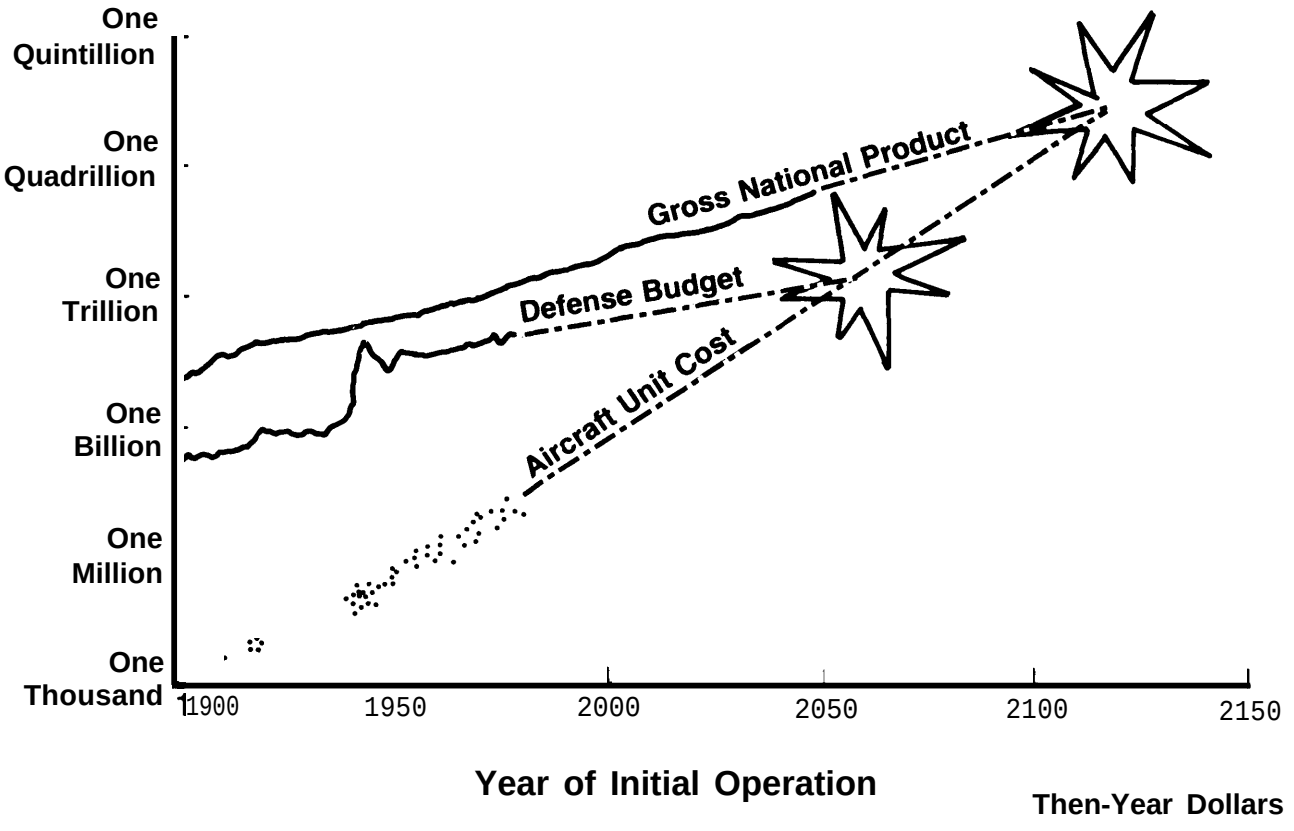
[3]Charles A. Bowsher, Comptroller General of the United States, quoted in George C. Wilson, "Pentagon Bracing for Two Waves: Rising Costs Threaten Weapons, Readiness, " *The Washington Post, Nov.* 13,1988, p. Al.

[4]The Secretary of Defense's remarks are referred to in the Statement by Charles A. Bowshcr, Comptroller General of the United States, before the Senate Committee on Armed Services, Mar. 14, 1988, p. 9.

[5]Ibid.

[6]Leonard Sullivan, Jr., ''Characterizing the Acquisition Process," paper presented at the Center for Strategic and International Studies Conference on U.S. Defense Acquisition, November 1986, Washington, DC, pp. 2-3. (Commissioned for U.S. Defense Acquisition: A Process in Trouble, the CSIS Defense Acquisition Study).

Figure 5-Projected Future Costs of Tactical Aircraft



SOURCE: Norman R. Augustine, Augustine's *Law (New* York, NY: Penguin Books, 1983), p. 142,

Sullivan also points out that major systems—at least platforms such as aircraft and ships-can easily still be in service 40 years after they entered full-scale development. With systems replaced, on average, every 25 years, aging systems remain in active service for a long time.

A study done by the DSB in 1984, during the peak of the Reagan buildup, concluded that:

> . . . many major equipment inventories will experience a steady aging during the remainder of this century, [and] *an increasing share of the necessary force modernization of the future must occur through the upgrading of equipment already in inventory or already committed to production.*[7]

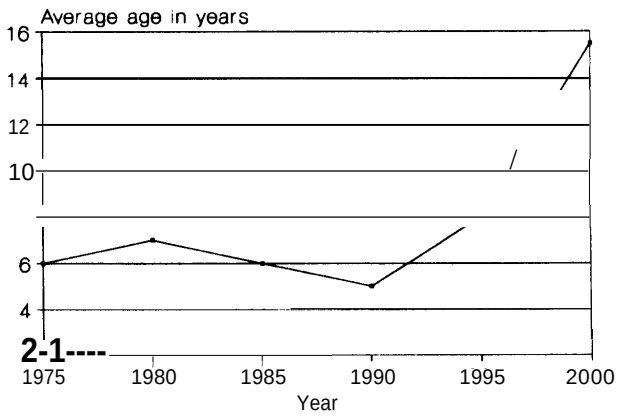
Figures 6, 7, and 8 show the increasing average age of Army tanks and attack helicopters and Air Force cargo aircraft.[8] Many other weapons categories-although certainly not all—also show increasing average ages.

The DSB study, while basically optimistic about the potential for upgrades, did identify some areas

[7]U.S. Department of Defense, *Improved Defense Through Equipment Upgrades. The U.S. and Its Security Partners*, Final Report of the 1984 Defense Science Board Summer Study on Upgrading Current Inventory Equipment, November 1984, p. 2. (Emphasis in original.)

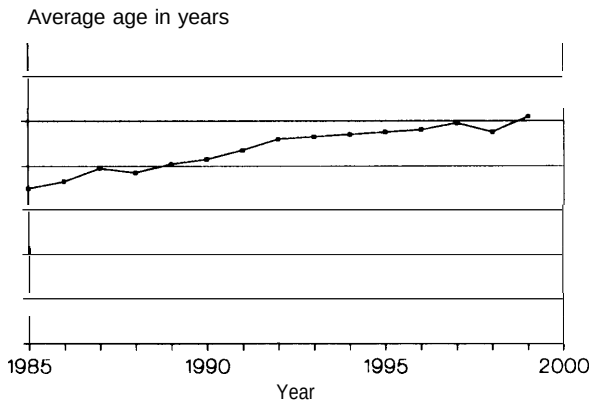
[8]Although the DSB study did not give the source of the data from which these graphs were derived, the office of Donald Rice (president and Chief Executive Officer of the Rand Corporation), who chaired the study, confirmed that they were calculated from the long-range Extended Planning Annexes of the Services. In the past, such long-range plans have tended to overestimate future weapons purchases, duc both to underestimating weapon cost and to overestimating available funds.

Figure 6-Projected Average Age of U.S. Army Tank Inventory



SOURCE: U.S. Department of Defense, ***Improved Defense Through Equipment*** *Upgrades: The U.S. and Its Security* ***Partners,*** **Final Report of the 1984 Defense Science Board Summer Study on Upgrading Current Inventory Equipment (Alexandria, VA: Defense Technical Information Center, November 1984).**

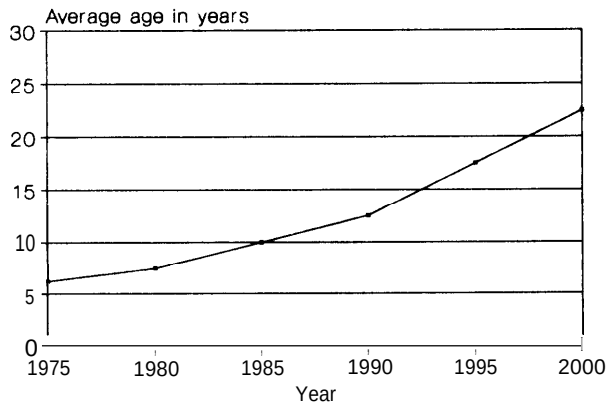
Figure 7—Projected Average Age of USAF Cargo Aircraft Inventory



SOURCE: U.S. Department of Defense, ***Improved Defense Through Equipment Upgrades: The U.S. and Its Security Partners,*** **Final Report of the 1984 Defense Science Board Summer Study on Upgrading Current Inventory Equipment (Alexandria, VA: Defense Technical Information Center, November 1984).**

for improvement.[9] It found that the Services seem reluctant to pursue major upgrades for weapons systems they are trying to replace, and that a "systemic bias" against upgrades results from

Figure 8-Projected Average Age of U.S. Army Attack Helicopters



SOURCE: U.S. Department of Defense, ***Improved*** Defense *Through Equipment Upgrades. The U.S. and Its Security Partners,* **Final Report of the 1984 Defense Science Board Summer Study on Upgrading Currant Inventory Equipment (Alexandria, VA: Defense Technical Information Center, November 1984).**

consistently underestimating system lifetimes. Since the Services are reluctant to upgrade systems that they expect to retire soon, underestimating service lifetimes thwarts upgrades.[10]

The DSB study also concluded that upgrade plans should be part of a comprehensive modernization for an entire equipment category, including upgrades and new starts. Moreover, upgrading is much easier if provided for in the original design of the system to be upgraded.

Policy Options

The future shortfall in procurement funding can be met in the short term only by reducing procurement expenditures or by making cuts elsewhere in the DoD budget. The magnitude of the task, involving cuts of hundreds of billions of dollars from future DoD budgets, will certainly curtail our ability to sustain a technological advantage through force modernization. Moreover, cuts of this magnitude will have effects that go far beyond hindering the introduction of new weapons systems and the upgrade of older ones. They will affect overall national security policy, strategy, and goals that lie

[9]Defense Science Board, op. cit., footnote 7, P. xii.

[10]Every one of the almost 40 helicopters, fighters, attack aircraft, and antisubmarine warfare aircraft fielded by the Navy since the early 1950s has remained in active service longer than planned, some by over 20 years. The study concluded (p. 2) that there is "every reason to believe that this picture reflects the experience of the other Services, too."

far outside the scope of this study. Therefore, this study does not attempt to present a complete discussion of the options facing military planners, but will instead sketch out the implications of some of the choices.

Distinctions must be drawn between short-term and long-term solutions. Solutions that might best improve the situation in the long run, such as improving the efficiency of the acquisition process or restricting the number of new starts, will take years to produce substantial savings and will not help the short-term problem. At the same time, short-term fixes such as deferring or stretching out weapons acquisitions will only make the long-term problem worse.

Short-Term Measures

To balance the procurement budget in the short term, either the cost of new systems must be reduced or else more procurement funds must be made available by cutting other areas. Options for reducing the aggregate cost of new systems involve three different approaches: funding deferral, cancellation, or upgrading existing systems.

Stretchouts or Funding Deferrals-This option has been the traditional choice for handling funding crises in the defense budget. It has the advantage of being politically much easier than canceling programs outright, and it avoids having to write off previous investments. However, it is one of the least attractive solutions for the long run. Not only are costs deferred, rather than eliminated, but those deferred costs are increased due to keeping infrastructure and support on standby, inefficiencies imposed by lowering production rates, changing program plans, and inflation. Stretching out some programs can provide room in the budget for other important modernizations to proceed. However, stretchouts exacerbate program variability, one of the most-cited problems with defense acquisition.

Canceling Programs—Although canceling programs forces writing off sunk costs, at least those costs do not come back to haunt budget planners in future years. Moreover, some of the investment can often be recouped in future programs that draw upon technology developed in the canceled program. The earlier in development a program is canceled, the less the sunk cost will be and the sooner those resources can be directed to other goals.

However, program cancellation is extremely difficult, considering the balancing act of negotiation and compromise within DoD and between DoD and Congress required for programs to be approved in the first place. Ideally, those programs judged to have the lowest military utility of all active programs should be the first ones to be eliminated in times of fiscal constraint. But, there is no universally accepted, objective measure that can help make this determination, Program cancellations-like program approvals—inevitably involve political judgments.

Upgrade Rather Than Replace—The 1984 DSB study cited above recommended that system upgrades, rather than replacements, be emphasized more heavily in the future. To the extent that present system design makes this possible, increasing emphasis on upgrades is likely to be an attractive option for permitting modernization of systems we cannot afford to replace. This option will not work, however, if the military Services see upgrades as threats to their long-term plans for future acquisitions. More realistic estimates of the service lifetimes of existing systems will be needed for making valid upgrade decisions.

To promote upgrades, proposals for new acquisitions could be required to include detailed comparisons of the relative merits of replacing v. upgrading an existing capability. The office of the Under Secretary of Defense for Acquisition [USD(A)] would be an appropriate place for such a review to be conducted, and it could provide inputs independent of the requesting Service.

Besides reducing spending on new systems, funds could be devoted to procurement by making cuts in other areas. Options for cuts elsewhere in the DoD budget include:

Reducing Research, Development, Testing, and Evaluation (RDT&E)—As was pointed out in OTA's previous report on the defense technology base,[11] R&D is always vulnerable to budgetary cuts because its benefits are difficult to measure. More-

[11] U.S. Congress, Office of Technology Assessment, *The Defense Technology Base: Introduction and Overview—A Special Report*, OTA-ISC-374 (Washington, DC: U.S. Government Printing Office, March 1988), especially pp. 3S-36.

over, cutting R&D appropriations in a given fiscal year reduces actual spending that year by much more than the same size cuts in other areas, such as procurement. Cuts in RDT&E funding at first glance would seem to threaten the U.S. strategy of compensating for quantitative inferiority by technological superiority, since that technological superiority has traditionally arisen from the DoD technology base programs. **Upon further examination, however, a military strategy that depends on increasing the technological sophistication of weapons systems to the point where they can no longer be afforded does not provide a sound foundation for national security.** Reevaluating the role that RDT&E plays in national security is a long-term, rather than short-term, measure; accordingly, it is mentioned again in the discussion of "Longer Term Measures. "

Reducing the Operations and Support Budget— Cuts in O&S budgets, like cuts in RDT&E, have the advantage of yielding relatively larger reductions in outlays for that year than cuts in procurement. These cuts are therefore attractive in the short run. However, making effective use of our substantial investment in defense systems and personnel requires that systems be maintained and supported and that people be trained. Therefore, reductions in O&S funding would probably not be the most cost-effective way to reduce the DoD budget in the long run. Components of the O&S budget, however, can certainly be reduced. The General Accounting Office (GAO) has identified improvements that could be made, for example, in logistics and spare part inventories. '2

Reducing Military Forces—in testimony before the Senate Armed Services Committee, the Comptroller General stated that budget restrictions may force the United States into reducing its level of military personnel. "We may also have to rethink some of our worldwide commitments in light of our budgetary resources. " This study will not presume to speculate as to which commitments this country could afford to cut back on. However. any reductions in personnel, operations and support, and procurement might have the effect—planned or otherwisc—of limiting this nation's ability to fulfill its commitments. Reevaluating those commitments in the light of budgetary pressures represents not so much a decision to let budgets drive policy, as a recognition that they do so whether that is desirable or not. It would be preferable to start with the decision to limit obligations and reduce spending accordingly, rather than let budget cuts limit those commitments arbitrarily.

One difficulty with reducing forces to save money is that personnel reductions could involve offering early retirements and redeeming accrued leave, which might actually cost more money in the short run than retaining people on full salary.

Reducing Civilian Personnel—DoD employs over a million civil servants. Without doing a bottom-up review as to how all these personnel are employed, it is difficult to specify where reductions could be made. However, many have suggested that such reductions not only would save money but also would improve DoD operation. The Packard Commission recommended ''a substantial reduction in the total number of personnel in the defense acquisition system, to levels that more nearly compare with commercial acquisition counterparts. "[14] However, the likelihood that personnel reductions may not save much in the short term applies to civilian personnel as well as military.

Longer Term Measures

Reexamine National Defense Commitments— This option is the long-term continuation of the short-term option of "Reducing Military Forces. " This nation's long-term defense needs must-by definition-meet its long-term defense budget. Whether the adjustment is made by lowering commitments or by raising additional funds, a deliberate, well thought-out examination of national priorities may be required. Like any other consensus-building process that sorts out competing interests among constrained resources, this process is inherently political. It would require a continuing effort.

Improve Acquisition Efficiency-Although the defense acquisition system probably does spend more than an acquisition system designed for

[12]Charles A. Bowsher, op. cit., footnote 3, p. 11.

[13]Ibid.

[14]Ibid.

optimum efficiency would, those excess costs are often inherent in the political process surrounding defense acquisition and in other cases are the price we pay for pursuing national goals unrelated to defense. Reducing many of these costs could require Congress and the American public to reexamine the value they currently attach to oversight and review, as well as the cost they are willing to pay to pursue a clean environment, fair labor practices, equal opportunity, and many other objectives.

If savings in the acquisition process could be identified-either through eliminating waste or by choosing to relax various requirements that drive up costs—it would take many years for those savings to result in substantially lower system costs The vast majority of the total life-cycle cost for systems now in development has already been determined.

Reduce or Reevaluate Research, Development, Testing, and Evaluation-The President's Blue Ribbon Commission on Defense Management (the Packard Commission) recommended that "DoD should place a much greater emphasis on using technology to reduce cost—both directly by reducing unit acquisition cost and indirectly by improving the reliability, operability, and maintainability of military equipment. " [15] Cuts in the RDT&E budget, were they selected to address the affordability problem, could be associated with a reevaluation of how well the DoD technology base serves the goal of cost reduction, in addition to-or instead of—the more traditional goal of enhancing performance. Note also that increasing the emphasis placed on simulation, as opposed to hardware development, can reduce RDT&E costs to the extent that the simulations are valid. Increased computational capability, along with growing experimental databases, can improve the validity of simulations.

Enforce Budgetary Discipline-One policy choice here could be to require the Services to make life cycle cost estimates of new systems for longer terms than they do today, and to prevent them from starting new programs unless they provide room in these longer-term budgets to develop, produce, and support the future systems. However, not only would such a requirement demand accurate cost estimates for the operation of systems that have not yet been developed—almost a contradiction in terms—but it would also require dependable projections of future Service budgets, a task that has proven no easier. Moreover, this exercise would be of little use unless pressures within government and industry to underestimate the costs of new systems in order to fit them into future funding requests can be mitigated. These issues are discussed further in the section on acquisition.

Consolidate Missions of Weapon Systems— According to the Comptroller General, greater efficiencies will have to be obtained in a number of areas such as families of equipment that now fulfill common missions. For example, several different types of weapon systems, from shoulder-mounted rockets to tanks to aircraft, in the past have been developed to attack tanks. "While some variety of systems is probably desirable, we must exercise greater restraint in the future because we cannot afford to replace weapon systems on a one-for-one basis. " [16]

Realigning the assignments of weapon systems to missions will involve substantial analysis on the part of the military Services. It may even require readjusting the Services' respective roles and missions, if it is determined that tasks presently assigned to one Service will in the future be accomplished by upgrading or replacing a weapon system operated by another Service. Firm guidance from the Office of the Secretary of Defense (OSD) and the Joint Chiefs of Staff (JCS) will be required to make the necessary trade-offs.

TECHNOLOGY INSERTION

Making room in the budget to update or replace a system does not automatically ensure the introduction of the latest technology. In fact, relatively few systems developments or upgrades are undertaken solely to exploit a specific new technological capability:

> Of the many scores of major acquisitions currently in progress, fewer than a handful are responding to genuinely original military needs (such as ASAT [anti-satellite weapons]) or to a truly revolutionary

[15] "A Quest for Excellence: Final Report (o the President," by the President's Blue Ribbon Commission on Defense Management, June 1986, p. 56.
[16] Charles A. Bowsher, op. cit., footnote 4, P. 11

> Soviet threat that challenges U.S. technological prowess. Possibly 95 percent occurrent acquisition programs are basically aimed at making marginal threat-related improvements at the same time that they offset depreciation of aging inventories with something new.[17]

In the majority of cases where the primary motivation for an upgrade or replacement is modernization, the introduction of new technology is neither easy nor automatic. Although there have been significant exceptions, DoD has traditionally not been very successful at taking advantage of new technologies that were promoted by their developers ("technology-push") in the absence of an interested constituency among the technologies' eventual users ("requirements-pull").

Those responsible for planning and developing military systems should ensure that the potential increased capability made possible by new technology justifies the risks-in cost, schedule, and possibility of failure—inherent in that technology's development. In the case of obsolete equipment, for example, putting any replacement at all in the field is usually more important than including the latest technological features. This conservatism poses barriers that must be overcome before new technologies can be fielded.

To the degree that proven technologies are not fielded, or promising technologies are not investigated, those barriers are inappropriate. However, they should not be eliminated completely. It is not, after all, the mission of DoD to deploy new technology for its own sake. Unproven and high-risk technologies that cannot be developed successfully will not improve our military capability no matter what their ultimate potential may be. Moreover, just because a technology is new and effective does not mean that it is the best solution to any particular problem.

The Technology Insertion Process

Technology insertion depends, of course, on the entire acquisition process, which is discussed more generally at the end of the chapter. It refers specifically to the process by which technical developments in the laboratory are selected for use in new weapon systems.

The office of the USD(A) was established in part to combine jurisdiction over research and development with that over production. However, there is a very significant discontinuity between technology base activities and the later stages of full-scale development and production. Technology base activities are undertaken with potential military relevance or application in mind, but they are generally not targeted specifically towards a particular system requirement. Instead, they are managed and directed according to their field of science or technology, and they serve to stock the shelves of the "technology supermarket" from which designers of new systems later draw.

When a requirement for a new military system becomes formalized, at least for major systems, funding and responsibility for that system is assigned to a System Project Office (SPO) dedicated to satisfying that particular requirement. It might be expected that developing a major new weapons platform-ship, aircraft, land vehicle, or spacecraft—would ease the introduction of advanced technology through new generations of subsystems and components; in fact quite the opposite can occur. In today's political environment, where a conspicuous failure can be used to delay or scuttle a new program, proponents may choose to outfit an entire platform with existing systems to minimize the risk of failure. Then to take full advantage of the capability offered by the new platform, its component systems must be upgraded with new ones after the platform becomes operational. Providing for upgrades in advance makes those upgrades easier and more effective. However, technology might be introduced still faster if new platforms were designed to take better advantage of new components and systems from the beginning.

When a new system or subsystem is undergoing development, its funding is generally in budget category 6.4, engineering development, and responsibility for the system lies primarily with the industrial contractor or contractors that won the development contract. **Thus, detailed design of military systems, including the selection of technologies for use, is primarily the responsibility of designers in private industry.** Of course, these designers do not work in isolation; their bids must

[17] Leonard Sullivan, Jr., op. cit., footnote 6, pp. 18-19.

respond to government request, and the bids are evaluated by government employees. SPO obviously has overall direction and responsibility for the project. However, it is significant that the project office personnel are largely separate from the people who fund and execute R&D within government agencies and laboratories.

Several mechanisms help bridge the gap between technology base activities and the design and production of particular military systems. The most indirect might be termed technical diffusion, by which findings and results of (unclassified) technology base funded activities appear in the open literature and become available for use.[18] Interaction between those doing R&D in a generic field of technology and those responsible for designing particular systems is an important transfer mechanism, as is the actual transfer of personnel from technology base activities to systems engineering. Although technical interchange is essential in promoting the development and application of defense technology in this country, there is concern that increased diffusion could also allow this information to pass to potential adversaries. Therefore, the government has attempted to restrict export of technical information, and there is considerable controversy as to the net benefit to the United States of these restrictions.[19]

More direct mechanisms to bridge the "transition gap" include Independent Research and Development (IR&D) conducted by industry and (in the case of defense contractors) partially reimbursed by the government as art allowable charge on government contracts. Through IR&D, industrial scientists and engineers—with feedback from government evaluators-can explore technologies and gain sufficient expertise with them to feel confident enough to prepare bids proposing their use in new systems. Industry retains ownership of intellectual property developed through IR&D.

In contract research and development, the government funds and retains ownership of the development of a particular technology, component, or subsystem. The research findings and technical data resulting from such contracts may be made available to others, subject to classification and export control restrictions. Even without proprietary rights, the contractor winning such a contract benefits directly by developing "hands-on" experience with the technology; other companies benefit indirectly from the reports and technical data and may find themselves forced by competitive pressures to develop an equivalent capability. Much of this type of development is funded through budget categories 6.2 and 6.3.

Perhaps the most direct means for transferring technology from the laboratory into systems is budget category 6.3A, **advanced exploratory development.** Category 6.3A includes funding for non-system-specific prototypes or technology demonstration experiments intended to validate technologies to the satisfaction of those—either within the system project offices or private industry-who will ultimately recommend or select those technologies for use in future systems.

None of these transfer mechanisms resembles what one government laboratory official characterized as the fictitious "midnight loading dock" approach by which a government lab develops a prototype and leaves it out overnight for an industrial contractor to pick up, duplicate, and churn out many identical copies. In reality, the relative roles of government scientists, government project office sponsors, and industrial developers are far more complex. Since the path by which technologies developed in government laboratories end up in system designs is so indirect, it can be difficult to trace the contributions of the labs. Technologies developed in, or whose development is sponsored by, the government laboratories are picked up by industry, where they are further developed, refined, perhaps put to new uses, and eventually incorporated into system designs. By the time they end up in bid proposals, their origins in government-conducted or government-sponsored research may no longer be apparent.

The preceding discussion of technology insertion applies to new system developments in which

[18]Classified findings are also disseminated through classified journals and seminars. However, the audience is restricted to those holding appropriate clearances who can demonstrate a ''need to know" the classified information.

[19]The export control controversy is discussed in depth in a recent study by the National Academy of Sciences: National Research Council, Balancing *the National Interest: U.S. National Security Export Controls and Global Economic Competition* (Washington DC: National Academy Press, 1987).

industry designs and builds a system to meet specific military requirements. To the extent that the military is able to use commercial products, either as they are or with minor modification, it can bypass the lengthy development process and proceed to apply the technology embodied in those commercial products directly to military use. In many areas, commercial technology leads that available in the defense sector. Such an emphasis on **non-developmental items** is discussed in other chapters of this report that analyze dual-use technologies and their relevance to military needs.

Previous Studies

Several prior studies have addressed difficulties in fielding state-of-the-art technology in military systems. The same factors often crop up in analyses done years apart, showing that understanding a problem does not automatically lead to a solution in the face of unwillingness or inability to make changes. In other cases, problems identified in different studies appear to contradict each other.

1981 DSB Study on Technology Base[20]

In 1981, the DSB issued a report on the technology base. In addition to identifying crucial technologies to be emphasized and evaluating the current government technology base investment and operation, this study identified a number of barriers inhibiting successful transition of technology into systems:

- Discontinuity of funding, indecision, and the short-term orientation of many key decision makers.
- The organizational and physical separation within DoD of technology base activities and system development.
- Little emphasis on technology demonstrations that can illuminate risks, costs, and payoffs of using new technology.
- Little emphasis on "test marketing," or developing a constituency among the system developers for using new technological developments.

The study found that "there is a strong incentive to pursue low risk options" and that "incremental improvement is one of the biggest enemies of innovation."[21] It recommended creating an "Advanced Projects Agency" separate from the Defense Advanced Research Projects Agency, or DARPA. This proposed new agency, to be staffed by personnel from the military Services, would develop experiments to quantify the maturity of emerging technology, conduct the "test marketing" experiments mentioned above, and protect funding for these experiments from being tapped for other needs. In the absence of such an agency, the study strongly recommended that more funding be allocated to category 6.3A, in any case, to conduct these experiments. After concluding that DoD does not make effective plans for inserting technology throughout the life of a system, the panel recommended that technology insertion plans be made a basic and fundamental part of program planning.

1985 **DSB Summer Study on Practical, Functional Performance Requirements**[22]

This study examined a number of DoD programs, concentrating on the earliest parts of the acquisition process during which the requirements for systems are determined. In apparent contrast to the 1981 DSB study, which accused system developers of being overly conservative in their choice of technologies, this study concluded that developers tended to reach too far. "The foremost factor associated with unsatisfactory program outcomes was that the technology, usually after the fact, was assessed as being unready for entry into engineering development." Like the 1981 study, however, this DSB panel also highlighted the need for objective measures of maturity. "It is likely that in almost every case of failure the project's initiators *believed* at the time of initiation of engineering development that the technology was, in fact, mature."[23]

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20 Defense Science Board, "Report of the Defense Science Board 1981 Summer Study Panel on the Technology Base," prepared for the Office of the Under Secretary of Defense for Research and Engineering, November 1981.

21 Ibid., pp. IV-3, IV-5.

22 Defense Science Board, "Report of the Defense Science Board 1985 Summer Study on Practical Functional Performance Requirements," prepared for the Office of the Under Secretary for Research and Engineering, March 1986.

23 Ibid., p. 20. (Emphasis in original.)

GAO Letter on Technology Transition, January 1987[24]

Upon concluding its review of the transition of technology base activities into weapons acquisitions, GAO did not issue a formal report or make recommendations. Its Associate Director for National Security and International Affairs did, however, write the Secretary of Defense expressing concern that "early demonstrations of advanced technologies have not received adequate management attention at the Office of the Secretary of Defense level. " GAO found that the "most significant barrier" to effective transition is the lack of emphasis on such demonstrations, and it cited recommendations of the Packard Commission highlighting the benefits of early prototyping. GAO called attention to the low budget priority and decentralized decisionmaking approach given to such demonstrations. In response, the USD(A) agreed with the importance of early technology demonstration, conceding that the budget for such activities had remained level in constant dollars during the period reviewed by GA0.[25] He noted that funding for technology demonstration was projected to double over the next 5 years.

1987 Defense Science Board Summer Study on Technology Base Management[26]

This DSB panel found that "both the Defense Department and commercial industry are seriously deficient in rapid technology transition from R&D to systems and products. " Like the GAO and the two preceding DSB studies, this DSB panel concluded that the "greatest opportunity to improve the rate and effectiveness of this transition process is by increasing focus on the early advanced development phase of the S&T [science and technology] program, that is, Budget Category 6.3 A." According to the panel, 6.3A activities should include building and testing experimental systems in field environments to establish feasibility and utility before a commitment is made to full-scale engineering development.

Army Science Board Summer Study on Technology Insertion[27]

The Assistant Secretary of the Army for Research, Development, and Acquisition asked the Army Science Board (an advisory body to the Secretary of the Army analogous to the Defense Science Board) to survey the Army, DoD, and industrial technology bases to identify candidates for insertion into Army systems, to evaluate the cost and effectiveness of the Army technology insertion process, and to review the Army acquisition process to recommend changes. The panel found that:

- New technology will have to be inserted in a timely manner into fielded systems. Introduction of new systems will be severely limited by future funding pressures and (particularly for the Army) by delays or cancellations of major systems, such as the LHX (Light Helicopter Experimental) and the DIVAD (Division Air Defense gun).
- "To understand how technology insertion can address cost and system effectiveness, technologists must understand operational problems . . . The payoffs from the technology base usually come from combining of technologies by *system developers* who know available technical options and can see how to use them."[28]
- Basing technology selection on acquisition cost alone will always result in selection of the 'low risk, low cost, low technology approach. " New technologies have their biggest payoff in life-cycle, not acquisition, costs.[29]
- Acquisition personnel are insufficiently experienced.
- The budget process is a problem.

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[24]Michael E. Motley, Associate Director, National Security and International Affairs Div ision, General Accounting Office, letter to Caspar Weinberger, Secretary of" Defense, Jan. 16, 1987.

[25]Richard Godwin, Under Secretary of Defense for Acquisition, letter to Michael Motley, Associate Director, National Security and International Affairs Division, General Accounting Office, May 18, 1987.

[26]Report of the Defense Science Board, op. cit., footnote 2, December 1987.

27 Army Science Board, ''Army Science Board 1988 Summer Study on Technology Insertion in Army Systems," prepared for the Assistant Secretary of the Army for Research, Development, and Acquisition, in press.

[28]Ibid., p. 33. (Emphasis in original.)

[29]Ibid., p. 57.

Analysis and Policy Options

The problems identified in the studies cited above fall into three general categories. Those pertaining to the discontinuity of funding, the short-term focus of decision makers, the budget process, and personnel affect the entire acquisition process and are discussed in the concluding section of this chapter (see ''The Defense Acquisition System"). Another set of problems relates to technological overoptimism or extreme conservatism and the consequent need for objective assessments of the maturity of a technology. These issues can be addressed by increasing the emphasis put on prototyping and technology demonstration experiments, as well as by building product improvement cycles into system design. Finally, a third set of problems addresses the organizational separation between technology base activities and systems developers, the lack of "test marketing" new ideas, and the lack of a constituency for technological advances within the "user" communities. These issues can be addressed by an organizational structure that attempts to bridge the gap between the laboratory and the system developer, placing the ultimate users of a technology in more of an "ownership" position and therefore making them more receptive to the use of that technology.

Prototyping and Technology Demonstration

Most of the studies cited above argued for increased reliance on prototyping and technology demonstration. The Packard Commission found that making trade-offs between the risks and benefits of state-of-the-art technology requires reliable information, and that "the only consistently reliable means of getting such information is by building prototypes that embody the new technology. " It recommended that ''prototyping, either at the system or critical subsystem level, be done as a matter of course for all major weapon programs. "[30]

Earlier studies had cautioned against overemphasizing prototypes. Almost 10 years before the Packard Commission reports were issued, a DSB summer study analyzing the acquisition cycle concluded that "the widespread or mandatory use of full-scale system prototypes for all programs up to the production prototype level is frequently wasteful of critical national resources-dollars and manpower as well as time. "[31] This panel was particularly opposed to the contemporary practice of forcing industrial contractors to fund large costly prototypes out of their own resources. However, at the component or subsystem level—rather than the system level—the panel concluded that competitive prototyping could significantly reduce the cost and time needed to make a full-scale development decision. In summary, the report found that prototyping could be ''a sound and useful practice in major system acquisitions provided that the candidates for the use of prototypes are carefully selected, that only those things are prototype which really need verification, and that prototypes are not considered to be some form of free lunch' for the procuring agency [e.g., by forcing contractors to pay for them]. "[32]

Advanced Technology Transition Demonstrations-The 1987 DSB report on technology base management placed a heavy emphasis on Advanced Technology Transition Demonstrations (ATTDs), which it saw as an extension of the Packard Commission prototyping recommendations to include technologies that are not necessarily committed to defined system developments. This distinction is important. Prototypes are test versions of military systems that have been designed to meet particular military requirements. '' Demonstrations," on the other hand, provide opportunities to test technologies that are militarily relevant; but they do not in themselves represent designs of specific systems. The technologies they demonstrate, if successful, could be implemented in future systems. (Note that if a technology demonstration were realistic and successful, there would be less need to prototype a follow-up system using that technology.)

ATTDs, according to the DSB panel, should follow several basic guidelines:

[30] President's Blue Ribbon Commission on Defense Management, ''*A Formula for Action: A Report to the President on Defense Acquisition," April 1986, pp.18-19.

[31] Defense Science Board, "Report of the Acquisition Cycle Task Force 1977 Summer Study, " prepared for the Office of the Under Secretary for Research and Engineering, Mar. 15, 1978, p. 53.

[32] 1 bid., p. 54.

- They should reduce technical risk by demonstrating a technology's potential and maturity in an ''operational,'' rather than ' 'laboratory, '' environment.
- They should show a potential for new or enhanced military capability, or for a significant improvement in cost effectiveness.
- They should be accompanied by a technology transition plan at the outset of the demonstration. That is, potential applications and opportunities to implement the technology should be identified at the start, rather than the conclusion, of the demonstration process.
- They should involve the participation of both the developer of the technology (typically a Service Systems Command) and the system's ultimate user (an Operating Command). The user should serve as sponsor, with the developer as project manager.[33]

According to the DSB panel, a successful ATTD would clarify the definition of the military need that the technology is to meet; stimulate strong acceptance and sponsorship of the innovation among its ultimate users; combine viewpoints of the research, development, production, and operational communities; clearly prove both the maturity of the technology and the satisfaction of a perceived military need; provide visibility to those higher levels within DoD and the Congress that will ultimately approve subsequent developments; and ensure adequate financial support to meet the goals of the project and initiate follow-on development.

Given a limit on resources allowable for such demonstrations, together with the need to provide enough funds to do a meaningful experiment (estimated by the DSB panel as typically $10 million to $100 million over 3 years), ATTD candidates would have to be selected competitively. This competition should ensure that the best ideas get funded. The DSB panel urged that funding for these ATTDs be "fenced off" from other R&D needs so that overruns on large, more immediate demonstrations do not threaten the many smaller, longer-term R&D projects. (What this means in practice, of course, is either that provision should be made in advance for overruns when preparing project budgets, or else that overruns should be covered from somebody else's pot.[34])

The panel urged that these ATTDs be conducted within the existing military Service and defense agency acquisition procedures, and not centralized DoD-wide. The various Services now have somewhat different practices concerning their 6.3A budgets. Most of the $2 billion now spent within 6.3A is less focused, less field-oriented, and longer-term than the proposed ATTDs would be. The DSB panel recommended that, by 1991, each Service devote half its 6.3A budget to ATTDs, sufficient to fund a total of 20 to 30 projects.

Existing Technology Demonstration Programs— At present, the Navy and the Air Force each have a program embodying many of the principles recommended by the DSB for ATTDs. **In essence, both involve establishing an agreement between the developer and the user that if the technology is successfully demonstrated, it will be used; the criteria for success are jointly developed at the outset.** Prior agreement is required both to establish a sense of sponsorship in the user and to ensure that the user reserves sufficient flexibility in its out-year budget requests to make funds available for the program once it has been successfully demonstrated.

DARPA, for its part, has significantly increased its role in prototyping technologies. This increased role has proven controversial.

Navy----The Navy has the smallest 6.3A program of the three Services, totalling $189 million in fiscal year 1989. Part of this 6.3A program represents generic technologies—such as explosives development—that contribute to many weapons systems. The remaining part of the 6.3A budget provides candidates for Advanced Technology Demonstrations (ATDs), which formed the model for the DSB recommendation regarding ATTDs (see table 5).

Navy ATDs are funded through the Navy-wide 6.3A account and are not funded or managed by the commands responsible for the development of particular new systems. ATDs therefore provide an opportunity to demonstrate a high-risk technology to a skeptical customer—a system development com-

[33]Defense Science Board, op. cit., footnote 2, pp. 22-23.

[34]Providing contingency funding in DoD budgeting is discussed later in this chapter under ' 'Reducing program Variability'. ''

Table 5-Navy Advanced Technology Demonstrations

FY 1987	FY 1988	FY 1989
Advanced Fiber Optic Technology	All-Optical Towed Array	Surveillance IRST (infrared search and track)
SEA RAY (fiber optic tether)	Unified Network Technology	MADOM (magneto-acoustic detection of mines)
Undersea Weapons Technology (heavy torpedo propulsion improvement)	Airborne Transient Processor (signal processor)	Quiet Weapon Launch (undersea heavy-weight weapons)
	Fiber Optic ADCAP (heavyweight torpedo)	Adaptive Monopulse Countermeasures
		Ultra-Low-Noise Crossed Field Amplifier[a]

[a]Added to replace the canceled BRIGHT EYE.

SOURCE: Office of the Secretary of Defense.

mand-without making the customer pay up front. They are not appropriate for high-payoff, but low-risk, projects that users are willing to fund without any additional incentive. If an ATD proves to be successful, according to criteria the user has agreed to in advance, the user agrees to pick up future funding. Even with future user support assured, the new technology cannot be incorporated into new systems unless the industrial contractors providing those systems are involved. Typically, about half the effort on an ATD is performed by industry. Moreover, once an improved technological capability has been demonstrated to the Navy's satisfaction, the Navy will provide incentives for contractors to use it. For example, the Navy may establish performance requirements that cannot be achieved with older technologies.

Sources for Navy ATDs come from Navy and other DoD labs, DARPA, and industry, In 1988, 55 proposals were submitted that were ultimately winnowed down to 7 new starts. Projects take a maximum of 3 years and cost about$12 million each over that time. The total ATD budget is projected to grow to about $65 million per year. In fiscal year 1989, the ATD budget was $32 million, which represented about 17 percent of the total Navy 6.3A budget. However, the Navy is moving towards applying ATD management techniques to a much greater fraction of its 6.3A activities; it is estimated that some 50 to 60 percent of the Navy's 6.3A budget could be managed under the ATD model.

Budgets for individual ATDs are protected unless and until they run into problems. Since the projects selected are all high-risk, technical problems are expected; however, to prevent other projects from being dragged down, projects that get into trouble are killed. For example, BRIGHT EYE, an electronic countermeasure program scheduled to start as an ATD in fiscal year 1989, was terminated when it appeared that it would not be able to meet its technical objectives. Budget cuts are not distributed proportionately to all ATDs, but rather are absorbed by canceling the lowest priority projects in their entirety.

OSD, following up on the DSB 1987 summer study that recommended use of ATTDs, is trying to apply this management technique to 50 percent of the 6.3A programs across the Services.

Air Force—The Aeronautical Systems Division (ASD) of the Air Force Systems Command has institutionalized a technology transition process between the Air Force laboratories, which control much of the Air Force's technology base activities, and SPOs within ASD, which are responsible for developing new systems. The objectives of the new process are to bound and focus activities at the laboratories, and to enhance the involvement of

acquisition managers within technology base activities, i.e., to narrow the gap between the originators and users of technology.

When an Air Force laboratory proposes a new 6.3 activity, part of the budget submission process involves preparing a technology transition plan. This plan is presented to a panel composed of representatives from the engineering support directorate (EN) of ASD. This panel--called SENTAR, for Senior EN Technology Assessment Review—evaluates the program's objectives, recommends modifications, compares the program's schedule to its need in the field, helps determine the program's priorities with respect to the lab's other 6.3 work, guides the development of criteria that will denote when the activity is ready to be picked up by a system project office, and determines when the project meets those criteria. A major goal of this process is to identify system project offices-the users—that can benefit from the new development. In doing so, the process generates customers for these innovations who have an interest in seeing them through to completion. Interested program offices commit to a "strong moral obligation" to pick up support for the activity, should it meet the goals identified in its technology transition plan.

This technology transition process also establishes incentives for industry to incorporate new technologies in their bid proposals. The EN of ASD reviews all Requests For Proposals issued by ASD. In these reviews, EN checks to see that the government requester will be receptive to companies bidding technologies that have successfully passed through the SENTAR process. If a company is satisfied that use of a new technology will not be considered too risky by the proposal evaluators, it will be much more likely to incorporate that technology into its bid.

DARPA-The Packard Commission urged that DARPA, which was at the time charged with conducting research and exploratory development in high-risk, high-payoff technologies, also put emphasis on prototyping defense systems. DARPA has since been given an expanded mission in this area. For fiscal year 1989, technology demonstrations were funded at a level of $237 million, or about 42 percent of DARPA's 6.3 budget. Prototype funding was included in the fiscal year 1989 budget within technology demonstrations, and totalled $43 million. For fiscal year 1990, prototyping funds will more than double to $94.7 million and will be separated from demonstrations; the remaining technology demonstrations will be funded at $167 million, $27 million below their fiscal year 1989 level.

Given that the military Services at present largely have control over their own research, development, and acquisition programs, DARPA is perhaps the only agency where a revolutionary new technology that may not fit within the perceived missions of the Services--or that might be seen as threatening those missions-can be explored. However, precisely because DARPA is outside the existing Service acquisition chains, it has in the past faced difficulty in turning technologies over to the military Services for implementation. Giving DARPA a greater role in prototyping will aid the transition of DARPA-sponsored technology from the laboratory to a major field experiment. However, without participation by or interest within the military Services, the problem of turning the technology over to the Services for development into systems might remain.

An additional concern raised over giving DARPA a greater role in prototyping is the degree to which it will retain its original mission of exploring high-risk, basic technology. If the expensive prototype demonstrations siphon funds from these activities, DARPA's original mission could be endangered.

Preplanned Product Improvement and System Upgrades

In addition to the increased use of prototypes and demonstrations, another solution to the problem of attempting too large a technological leap is the concept of preplanned product improvements. If a system is designed from the start with the intention of periodically upgrading its capability, its operators can be assured that they will be able to add state-of-the-art technological capability in the future without demanding it all at once.

Product improvements, or system upgrades, offer a lower-cost and faster alternative to new systems development for getting new technology out into the field. However, since they do provide an alternative, upgrades may be resisted by the Services as posing

a threat to new system development. For example, in the past the Navy has been reluctant to propose upgrades to its existing fleet of Los Angeles-class submarines because those upgrades might be seen as reducing the rationale for the Seawolf, a major new submarine that the Navy sees as essential to counter the increased Soviet threat. Moreover, more realistic lifetime estimates for deployed systems are necessary if upgrades to those systems are to receive realistic consideration.

Summary

Technology demonstrations have the potential for solving two seemingly contradictory problems: overemphasis on what later turns out to have been unproven technology, and unwillingness to accept what later turns out to have been viable technology. By convincing the skeptics that a technology can work, and at the same time disabusing the optimists of the notion that it can do everything, objectively evaluated technology demonstrations enhance the technology insertion process.

Prototype development is thought by some to be an important aspect of realistic program planning and cost evaluation. However, others caution that excessive prototyping can impede the very process that it is supposed to enhance.

THE DEFENSE ACQUISITION SYSTEM

Introduction

For years, defense analysts have been frustrated with the length of the acquisition process. Delays in acquisition lead to lost time in fielding new systems, and threaten our technological lead over the Soviets. These delays also result in higher costs due to the expense of maintaining extended development efforts. Even more serious than the increased time and cost, according to a DSB panel[35] that studied the acquisition cycle over a decade ago, are the "second order effects" of delays: technological obsolescence by the time new systems are fielded, increased risk as designers stretch the state of the art to avoid this obsolescence, and added complexity as delays aggravate the tendency to want "everything."

Moreover, delays beget additional delays. Cost escalation due to delays, together with budgetary ceilings, leads to program stretchouts that compound the original delay. Extending the expected time for deployment also causes planners to magnify the anticipated threat, upping the systems' requirements and lengthening the development time still further.

No single aspect of the acquisition process is responsible for schedule delays. To prevent delays, and to shorten the acquisition cycle, the overall acquisition process must be made more efficient and more effective, Therefore, the following discussion of acquisition, along with Appendix A upon which this discussion is based, takes a broad view. It examines several systemic difficulties with acquisition, each of which can lengthen the acquisition cycle or drive up its cost (which, as stated above, can amount to the same thing).

These problems are not new. The foreword to a recent compilation of six major studies of defense acquisition over the past four decades states that ''the bulk of the cures proposed as far back as 1948 were still being proposed in 1983 because they had never been implemented. "[36] The possibility certainly exists, of course, that none of these studies identified the real problems, which therefore remain to be addressed. Alternatively, perhaps sheer intransigence and bureaucratic inertia within the Department of Defense keep it from substantially improving its operation.

More likely, however, is that many difficulties in defense acquisition stem from factors that are beyond the Department's direct control and that no amount of unilateral DoD activity can address. **To the** extent that **such external factors dominate, improving defense acquisition will require making large-scale structural and institutional changes that would not be restricted to DoD.**

Some of these changes are impossible within our present system of government. Others would interfere with various objectives that the nation has so

[35]Defense Science Board, op. cit., footnote 31, pp. 38-39.

[36]David Lockwood, Andrew Mayer, and Cheryl Crow, Library of Congress, Congressional Research Service, "Defense Acquisition: Major U.S. Commission Reports (1949-1988), Vol I," prepared for the Defense Policy Panel and Acquisition Policy Panel of the Committee on Armed Services, House of Representatives, Committee Print No. 26, Nov. 1, 1988, p. V.

far-explicitly or otherwise-decided are at least as important as efficient defense acquisition. And still others involve resolving longstanding political disagreements and identifying common ground in the face of seemingly incompatible positions.

Since the constraints within which defense acquisition must operate are so important, the discussion that follows begins with a description of some of these constraints and their effects. Next, the analyses of particular acquisition problems, and specific options that have been proposed for ameliorating some of them, are presented. The chapter then concludes with a more general discussion of four different overall approaches that can be taken towards defense acquisition reform. Depending on which overall approach one selects, different specific options make sense.

Comparison With the Private Sector

One of the most important features of defense acquisition is that it is conducted by the government. Since the premise is widely accepted that the private sector can accomplish tasks more efficiently and cheaply than the bureaucracy-encumbered Federal Government, previous studies have looked to the private sector to provide a model. A 1977 study by the DSB found that, while the portion of the defense acquisition cycle preceding full-scale development had lengthened over the previous two decades, the corresponding interval for commercial aviation programs had not (see Appendix B of Volume 2).[37] More recently, the Packard Commission concluded that "major savings are possible in the development of weapon systems if DoD broadly emulates the acquisition procedures used in outstanding commercial programs. "[38]

There are certainly lessons that the private sector can offer the Federal Government, lessons that the Packard Commission sought to uncover. However, fundamental and inherent differences between the government and the private sector must be understood before any of these lessons can be applied.

These differences-described more fully in Appendix A of Volume 2-concern factors such as the inability to measure government effectiveness in the same way that profit, or return on investment, provide figures of merit for the commercial world. They involve the standards of accountability demanded by the taxpayer-and imposed by Congress—on the expenditure of government funds, as well as the pursuit of national goals such as fairness, environmental protection, and equal opportunity that may interfere with the ability to acquire defense systems efficiently.

Other important differences between the government and the private sector include the role of Congress and the political process, which has no parallel in the commercial world. DoD's sheer size (its budget is several times larger than that of the largest U.S. corporation) imposes inefficiencies of scale not shared by smaller private-sector operations. Market forces that reward efficient companies and punish inefficient ones have no counterpart within the DoD, which cannot simply sell off or disband a military Service or agency that does not perform as well as hoped. As James Schlesinger, former Secretary of Defense, has stated;

> This is a society that based its system of government on the Constitution, which calls for a dispersion of powers. That means that everybody has to agree, and under normal circumstances, most people don't agree, As a consequence, we are never going to have the kind of model efficiency in the Department of Defense, or in government generally, that some kind of theorist would want. [39]

Efficiency v. Effectiveness

Defense analyst Edward Luttwak has stated that ''The great irony is that the defense establishment is under constant pressure to maximize efficiency, and that its leaders believe in that goal when they ought to be striving for military effectiveness—a condition usually associated with the deliberate acceptance of inefficiency. "4° The nature of defense acquisition imposes specific requirements that go beyond even

[37] Defense Science Board, op. cit., footnote 31.

[38] President's Blue Ribbon Commission on Defense Management, op. cit., footnote 30, April 1986, p. 12.

[39] ''The Second Annual Report of the Secretaries Of Defense, " edited transcript of a conference held by the Southern Center for International Studies, at Gaillard Municipal Auditorium in Charleston, SC, Sept. 30, 1988, p. 24,

[40] Edward Luttwak, ''The Price of Efficiency, " *Military Logistics Forum*, July/August 1984, p. 22.

the disincentives to efficiency facing government activities in general. Much of the technology used in defense systems is at a level of sophistication ahead of that used in the commercial sector—if indeed any commercial analogs exist at all. Although the defense lead is not as pronounced as it has been—and several areas of defense technology now lag behind their commercial counterparts-military technology must nevertheless often be developed from scratch for a relatively limited production run.

Since DoD is the only customer for sophisticated military systems, producers do not have the option of selling elsewhere should they not be able to sell to DoD.[41] If the Defense Department wants to maintain a diversity of suppliers, it must buy enough from each of them to keep them in business-even if their products may not be DoD's first choice. The most efficient producer of a military system cannot be permitted to drive the others out of business. Aggravating the problem of maintaining a viable production base are annual purchase sizes—typically determined by externally imposed budgetary limits—that mandate suboptimal production rates.[42]

Entrepreneurs in the commercial sector willingly accept the risk of failure—in the form of a loss of investment or reduced earnings-as the price for the chance to strike it rich. Substantial failure on the part of DoD, however, would have consequences that could be far more severe. Therefore, DoD practices a far greater degree of redundancy and risk aversion than a commercial enterprise does. Such risk aversion also extends to proposals for reform, which face a stricter 'burden of proof" than might be expected for corporate reform.

In light of the factors that characterize government activities in general and defense acquisition in particular, it may well be true, as defense analyst Leonard Sullivan has concluded, that ''many efforts to make acquisition more efficient are simply second-order expedients to paper over largely insoluble first-order problems. "[43]

Analysis of the Acquisition Process

The President's Blue Ribbon Commission on Defense Management was not the first attempt to apply lessons from the private sector to defense management. Seventeen years before chairing the Commission, David Packard, then Deputy Secretary of Defense, established the present DoD acquisition process to emulate industrial practices of project management and sequential review and approval. The basic process is one of distinct phases separated by decision points or milestones. OSD develops policy for major system acquisition programs and conducts reviews to ensure that those programs respond to specific needs and are managed soundly. The military Services and defense agencies individually, for the most part, identify those needs and define, develop, and produce systems to meet them.

DoD acquisition programs are run according to the principle of Program Management, in which one individual, the program manager, is responsible for integrating in a single office the diverse administrative, professional, and technical capabilities required to manage the development and production of a major system. However, many people and organizations inside DoD, but outside the program office, have considerable influence over the program's outcome as well. **The separation of responsibility and authority—whereby people with no direct accountability for a program's outcome nevertheless exert control—has been identified by study after study as a major problem of the defense acquisition structure.** Analysts differ as to the degree to which power and accountability can be brought back together in the defense acquisition environment.

The review and oversight that acquisition projects receive at all levels, from commands within individual military Services through OSD to Con-

[41] Companies can produce for export, but such exports must be approved by the U.S. Government and are not usually approved for technologies at or above the state of the art available to U.S. forces. Moreover, as the abortive F-20 fighter program demonstrated, foreign governments may not want U.S. systems that the U.S. DoD is unwilling to buy.

[42] In-depth examination of defense industrial base concerns is beyond the scope of 111)\ study. For treatment of this subject, see ''Bolstering Defense Industrial Competitiveness, " Report to the Secretary of Defense by the Under Secretary of Defense for Acquisition, July 1988; and the report of the Defense Science Board 1988 Summer Study on *the* Industrial Base, 1989. Weapon system production rates arc discussed further in *Effects of Weapons Procurement Stretchouts on Costs and Schedules* (Washington, DC: U.S. Congressional Budget Office, 1987).

[43] Leonard Sullivan, Jr., op. cit., footnote 6.

gress, has also attracted considerable attention from analysts of the acquisition system. Many critics decry what they see as excessive bureaucratic layering and micromanagement. However, others point out—as did the GAO-that such critics ''fail to realize that program managers are responsible for expenditures involving billions of dollars in public funds and that a system of checks and balances is essential." [44] The level of scrutiny needed to ensure an appropriate level of checks and balances remains controversial.

Problems in defense acquisition can be separated into a number of categories, including: program variability (sometimes called program instability); the requirements generation process, including the process by which resources are allocated and weapons systems are selected; bureaucratic paralysis; inappropriate organization of the defense procurement system; and the quality of and incentive structure facing acquisition personnel.

Program Variability

Sources of Program Variability-Perhaps the most significant difference between defense acquisition programs and commercial activities is the degree and the unpredictability of year-to-year change in defense programs. Constant variation makes sound management impossible. As a result, studies of the defense acquisition system always highlight variability as a major problem.

Many pressures for changes in defense acquisition programs are peculiar to government procedure, originating from every level of congressional and executive branch operation. Other stimuli for change, shared by both government and private activities, are changing threats (or market demands, in the commercial world) and the inherent uncertainty of the technology development process. Even if the changes **due to governmental procedure could somehow be eliminated, these latter sources--which no amount of planning or acquisition reform can remove-would remain.**

A key source of self-imposed change is politics, not in the pejorative sense that the word has acquired connoting back-room deals, influence peddling, and pork barreling, but in its original definition as a struggle between competing interests. Decisions to build multi-billion dollar weapon systems do not merely follow from technical or strategic analyses. They also represent choices concerning the relative importance of certain military needs over others, and of those military needs over other public needs (e.g., housing, health care, economic security, tax relief, and deficit reduction). Finally, these decisions also ultimately represent commitments to specific manufacturers employing people and purchasing goods in specific congressional districts. These are inherently political decisions, and in the United States, no political decision is final.

The political process involves constant competition and interaction among many different actors: the military Services against one another and against OSD, DoD against the rest of the executive branch, the executive branch against the Congress, and various committees, subcommittees, and Members of Congress against one another. When the interests of many of these parties align, differences between them can be resolved. However, in the face of fundamental disagreement, the competition for influence and control can make it very difficult to maintain continuity.

The struggle between Congress and the executive branch leads to what is generally referred to as ''legislative oversight responsibilities" within Congress and as ''micromanagement" within the executive branch. It results in hundreds of budget line item changes and other legislative restrictions and requirements each year. Although congressional modifications to the DoD budget request certainly complicate program management, changes generated within the many layers of DoD management add significantly to the problem. Many, if not most, of the budget cuts imposed upon or generated within DoD are due to DoD's inability to forecast program costs accurately, to defer new starts until sufficient funding to cover the actual (rather than the originally estimated) costs is available, or to eliminate programs—rather than stretch them out—in the event of funding shortfalls. GAO has found that, although the impact of underfunding programs is ''well-recognized and documented, a workable and effective method for

[44] U.S. General Accounting Office, "A Critique of the Performance of the Defense Systems Acquisition Review Council: Billions in Public Funds Involved," PSAD-78-14, Jan. 30, 1978, p. i.

matching DoD's needs with budgetary constraints has not been developed. "[45]

Reducing Program Variability-Although measures can be taken by both Congress and DoD to reduce the number and effects of program changes, changes cannot be eliminated. Analysts disagree as to which of two management failures is the more serious in the light of unexpected change: failure to plan and budget flexibly, or failure to hold to a fixed schedule. Efforts to reduce program variability include reforming congressional budget review procedures, multiyear budgeting, program "baselining, " increasing DoD management flexibility, and reducing personnel turnover.

Reforming the Congressional Budget Review Procedure-The current congressional budget process, involving three levels of review between the budget committees, the authorizing committees, and the appropriations committees, takes too long to complete. Final decisions on the defense budget are made by congressional conference committees as (or in many recent cases, after) the new fiscal year starts, late in the executive branch's preparation of the following fiscal year's budget. Last-minute changes in the appropriated funding levels require last-minute changes to the next year's request--changes that can be difficult to accommodate in a rational manner.

Changing the congressional budget process would require a major revision in congressional procedures that would involve either cutting down the number of committees having a significant role or sharply delineating committee responsibilities. However, Congress is a highly pluralistic institution, and there is no single individual or organization that can mandate these changes. Enacting them would therefore require either widespread agreement within Congress or the unilateral abdication of authority on the part of committees that are now involved.

Even if the number of actors reviewing the budget is reduced, the structure of that budget may not be optimally suited for evaluating defense roles and missions. Congressional review of the defense budget now deals more with accounting inputs (dollars, personnel slots, buildings, etc.) than with defense outputs (mission capabilities or strategic goals). The inputs are easier to count and to control, and unlike defense mission capabilities they permit comparisons to other programs across the entire Federal Government. However, they also focus congressional attention on funding for individual program elements, whereas many argue that a more appropriate role for Congress would be a high-level strategic review,

Multiyear Budgeting-Lengthening the budget cycle would provide a longer planning horizon and require less frequent congressional review. Congressional oversight would be directed more towards strategic guidance and away from individual line items, offering the hope that programs could enjoy greater stability. Although there are constitutional restrictions on appropriations longer than 2 years for certain military purposes, legislative and executive procedures could be changed to permit budgeting in 2-year intervals, and program authorizations could be even longer-term. However, this approach has limits, because absolute program stability is fundamentally incompatible with holding elected officials accountable at periodic intervals for their actions. Every time an elected official is replaced, there is—and must be—the opportunity for the new official to change the way things have been done.

Although biennial budgeting was attempted for DoD for fiscal years 1988 and 1989, no funds were appropriated for 1989 during the 1988 budget cycle. One effect that the experiment did have, however, was to give Congress more visibility into out-year plans of DoD than it had previously had. In particular, for the 1990-1991 budget submission, Congress will for the first time be given access to DoD's Five Year Defense Plan. Although some might fear that this visibility would simply give Congress that much more opportunity to meddle, it is also plausible that improving the communication between Congress and DoD in this manner can help give Congress the confidence in DoD planning that is needed before Congress can relax its level of oversight and micromanagement. It extends the planning horizon, enabling both Congress and DoD to take a longer view.

45 U.S. General Accounting Office, "Major Aequisitions: Summary of Recurring Problems and Systemic Issues 1960- 1987," GAO/NSIAD-88-135BR, September 1988, p. 10. (See also the previous section of this chapter on "Affordability.")

Baselining--A "baseline" is an internal contract between a military program manager and the senior management of his or her Service concerning the cost, schedule, and performance milestones for a new weapon system program, Since changes to the baseline require equally high level review, formalizing a baseline represents an attempt to reduce the amount of change that programs undergo within DoD. In practice, however, baselining requires that the program manager have the authority to reject changes to his or her program that are imposed from sources outside the program. Granting this degree of authority is extremely difficult within the present DoD environment. For example, although specified in a program's baseline, one of the most important program parameters, its budget, is in the final analysis established externally. Moreover, it is often changed annually by the Congress. Fully realizing the benefits of program baselining requires extending it, or some equivalent, to Congress. It also requires providing program managers or their superiors sufficient authority to resist or accommodate changes imposed by other DoD organizations, such as testing and evaluation offices. Changes of this scope would go against recent congressional initiatives that strengthen independent auditing and evaluation functions within DoD.

Increasing Management Flexibility-Another way to reduce the variability of DoD programs is to increase the Defense Department's ability to adjust to changing circumstances without requesting congressional approval, DoD's ability to accommodate changes—whether imposed by Congress or resulting from changing threats or unanticipated technological difficulties-is also limited by the absence of reserve funds. Unless a means is available for addressing unforeseen problems quickly, it is often impossible to meet expected costs and maintain schedules.

Although no individual program's requirement for such reserves can be predicted, the amount likely to be needed by a group of programs can be statistically estimated in aggregate. However, the intense competition for funds within DoD and the degree of scrutiny applied to defense budgets by Congress both mitigate against providing reserves. Indeed, in an environment where there are already far more claims on defense dollars than there are available funds, there is every incentive to underestimate the costs of programs when Service budgets are prepared. So even if contingency reserves are initially provided for, they are one of the first items to be trimmed. And were management reserves somehow to survive DoD's internal budget preparation process, they would probably not fare well on Capitol Hill, where they—referred to as "slush funds''—are usually eliminated to protect the taxpayer from waste, fraud, and abuse.

Members of Congress, on the other hand, can point to instances where they believe DoD has used internal fund transfers to evade congressional restriction or to protect programs that Congress has sought to delay or cancel. Providing DoD with management reserves and raising the thresholds for internal funding transfers will therefore require establishing a relationship of greater credibility and trust between DoD and Congress.

Personnel Turnover—Another contributor to program variability is turnover in acquisition personnel. Although typical defense programs have lifetimes measured in decades, the average tenure of defense program managers surveyed by GAO in 1986 was less than 21/z years. Such short tenures make it difficult to increase the authority of program managers, because they hinder any attempt to assign accountability. Moreover, short tenures can generate pressures to sacrifice long-term quality for short-term results. (See the section on ''Acquisition Personnel" below.)

Requirements Generation and Resource Allocation

Weapons systems are procured by "buying commands" within the military Services that are not directly tied to the Commanders in Chief (CINCs) of the operational forces, who (or, more often, whose successors) would have to use those systems in combat.[46] As a result, many studies have found that the operational users are not sufficiently involved in the acquisition process, including the establishment

[46]For operational purposes, the Armed Forces are organized into military commands that report through the Chairman of the Joint Chiefs of Staff and the Secretary of Defense to the President. The military Services themselves, each headed by a civilian Secretary, are responsible for training and equipping military forces, but not for commanding them operationally.

of the military requirements that initiate new acquisition programs. Furthermore, requirements, when established, tend to be observed rigidly rather than being reexamined in light of new circumstances such as schedule and cost overruns. While changing the requirements too frequently does exacerbate program variability, as described above, unwillingness to make changes in light of changing circumstances can force cost, schedule, and complexity upwards.

Requirements tend to be overstated due to insufficient interaction between those who know what is needed and those who know how to provide it. Further pressure for exaggerating military requirements stems from the process by which DoD decides to develop new systems. This process is conducted essentially in two stages. Once a military requirement has been established, funds to meet that requirement must be found in a highly competitive and political environment involving the military Service, OSD, the Office of Management and Budget, and Congress. After funds are reserved, a second stage of competition selects the actual supplier.

The funding competition imposes great pressure to over promise capability while underestimating cost; there are few incentives to enforce realism. Specific designs cannot be offered at this stage because they would interfere with the ensuing source selection competition. Program managers, who should be in the best position to weigh the military requirements for a system against the technological prospects for satisfying those requirements, are generally brought into the acquisition process too late to have a significant impact on requirements generation. It also appears that they are too seldom able to modify requirements in response to subsequent events.

A recent study aimed at monitoring the reorganization of DoD, which drew upon the Packard Commission's recommendations and the Goldwater-Nichols Defense Reorganization Act, noted progress in enabling trade-offs to be made between requirements, cost, and schedule and in taking affordability more seriously. "The organizations and procedures that could make possible such a change [in acquisition procedures] have been set up," the study concluded, but "their effective operation will require continued high-level attention."[47]

Bureaucratic Paralysis

Causes and Effects—A constant complaint of those involved throughout the defense acquisition process concerns the increasing bureaucratic burden they must struggle through in order to do their jobs. This bureaucracy manifests itself in multiple levels of approval, the diffusion of responsibility and authority, the lack of individual accountability, and the profusion of auditors, inspectors, specifications, and regulations. It is blamed for causing excessive delay, stifling innovation, suppressing initiative, and increasing costs.

Although these perceptions are widespread, they are difficult to validate objectively. Analysis attempting to quantify trends in regulatory activity found some indicators that showed increases and others that did not. The effects of governmental bureaucracy and regulation are even harder to measure than the trends in regulatory activity, given the absence of a standard for comparison. Although private sector activities are often held out as models for defense acquisition, it is not clear how relevant they are to government operations (see sections on "Comparison With the Private Sector" and "Efficiency v. Effectiveness" above). Therefore, the usefulness of studies measuring how much lengthier or more expensive government programs are than ''equivalent" private sector ones is limited. Given all the uncertainties and difficulties of estimating the cost penalty imposed on defense acquisition by existing defense acquisition regulations, it is not surprising that such estimates are widely divergent. They range from a few percent to more than 50 percent.

A simple model of the cost of excessive regulation is shown in figure 9. With minimal regulation or oversight, the government is dependent upon the goodwill of contractors and public officials. Honest officials and corporations could operate very efficiently in this regime, but dishonest ones would take advantage of the lack of oversight to defraud the government. At the other end of the

[47] Harold Brown and James Schlesinger, co-chairmen, '' Making Defense Reform Work: The Project on Monitoring Defense Reorganization." a joint project of the Johns Hopkins Foreign Policy Institute and the Center for Strategic and International Studies, Washington DC, November 1988, p. 49.

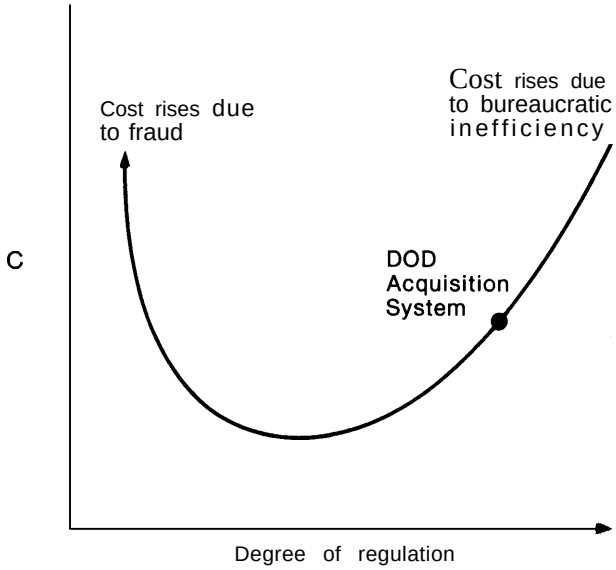
spectrum, tight regulatory controls deter or detect those defrauding the government, but they also drive up the cost of doing business for everyone else.

Much of the political debate concerning "waste, fraud, and abuse" concerns where on this curve the defense procurement system lies. Analyses of defense procurement consistently indicate that the system lies somewhere on the side of excessive regulation, at least in terms of strictly economic considerations. However, the public—to which Congress responds very effectively—may well believe that the system is not yet regulated enough, especially in the wake of recent reports of procurement scandals and defense contractor fraud. It may be that the costs of imposing stricter controls are not well understood by the public, and that if these costs were more widely recognized, calls for additional regulation would be moderated. However, it is also conceivable that the American taxpayer prefers to pay the high costs of overregulation rather than permit even lesser amounts of public money to go unearned into someone's pocket. If public demands for overregulation can be thought of as a source of avoidable waste, then perhaps some waste must be considered the price of curbing fraud and abuse.

Some argue that the present approach of legislating strict oversight and accountability requirements has the effect of penalizing everyone in defense acquisition instead of just those individuals who are truly guilty of violations of ethics or law. One alternative system, according to this line of reasoning, would be one in which people are trusted to be capable of doing their jobs without intrusive oversight and indeed are allowed to do so. However, those found guilty of violating this trust would be punished severely. While the relaxed oversight might reduce the probability of detecting illegal or unethical activities, those actions could nevertheless be deterred by the increased severity of the punishment if caught. This approach would replace the current adversarial relationship between government and industry with a more collaborative one.

Reducing Paperwork and Bureaucracy— Measures to cut red tape or streamline the bureaucracy will fail unless they take into account the reasons why the bureaucracy was initially established. Regulations and guidelines are a means of preserving institutional memory in an environment where presidential appointees have a median length of service of just over 2 years[48] and where military personnel are regularly rotated. They incorporate the political oversight and review procedures that come with the expenditure of public funds. They codify management procedures for large and unwieldy organizations. **Finally, regulations and guidelines further important policy objectives that may be in the nation's or DoD's collective best interest even though they might interfere with the most efficient execution of individual programs. As** has been stated before, the government has many goals—environmental protection, occupational health and safety, fair labor practices, equal opportunity, etc.—that may conflict with any individual program manager's ability to run a program efficiently. Just because a program manager does not believe his or her program should be the vehicle to implement national policy does not mean that that policy should be ignored. Although regulations have

Figure 9-Cost v. Regulatory Intensity



SOURCE: Office of Technology Assessment, 1989.

[48]National Academy of Public Administration, "Leadership in Jeopardy," November 1985, p. 4. (This figure applies to the entire Federal Government.)

been criticized as attempts to solve yesterday's problems by impeding today's progress, those problems are certain to reappear in the absence of some means of institutionalizing the lessons learned. **In other words, much of the bureaucracy and regulation surrounding defense acquisition has resulted from the political environment—reflected in public opinion and in legislation—within which defense acquisition is done.**

Studies such as that of the Packard Commission have recommended changes in the DoD bureaucracy that would have the effect of delegating authority to lower levels. Program managers and their immediate superiors would be freer to do their jobs, and the advocates for interests such as competition, small business, equal opportunity, testing and evaluation, etc., would be relegated to advisory roles. In particular, the Packard Commission recommended setting up a streamlined acquisition chain of command in which program managers would report through no more than two levels of command to the senior procurement executive in DoD (the Under Secretary for Acquisition). Much of this structure has now been established. **However, the new structure supplements-and does not replace—the existing chains of authority and command.** According to the study monitoring implementation of the Packard Commission recommendations:

> . . . the purposes of the legislation [implementing some of the recommendations] have not been met. Our sense is that the new positions were simply superimposed on top of the existing structure.[49]

The new acquisition chain is at present a communications link, and does not control funds. Truly implementing the Packard Commission's recommendations would require substantial changes in the operation of DoD.

The Packard Commission and other studies held out certain programs within DoD-in particular, highly classified "special access" or "black" programs[50] and high-priority strategic programs—as models that have successfully conquered the DoD bureaucracy. Special access programs, due to extreme security requirements, bypass much of the review, approval, and bureaucracy that ordinary programs must contend with. However, those same security constraints make these programs difficult to analyze in general.

Some officials with extensive experience in both special access and ordinary program management say that the approaches used in the special access world enable equipment to be fielded much more quickly, and at lower cost, than do standard acquisition programs. Other officials say that the high priority, high-level review, and high-quality staffs of special access programs, more than their management techniques, are responsible for their success. Moreover, they point out that bypassing checks and reviews—although sometimes necessary in the name of security-adds considerable risk. While some say that extension of special access contracting procedures would improve acquisition, others say it could not provide a general solution.

A number of different approaches can be taken to reduce bureaucracy and regulation within DoD. Implementing any of them, however, presumes an atmosphere of trust among DoD, the rest of the executive branch, and Congress; many reforms require the same degree of trust to hold between DoD and the defense industry,

Major Legislative and Administrative Reform- One approach would be to replace the existing statutory and administrative framework, in which fraud and abuse are deterred by extensive reporting and auditing requirements, with one in which greater responsibility is placed on voluntary compliance coupled with vigorous enforcement and severe punishment for those who get caught breaking a law. Enacting such a system would involve a major overhaul of the existing defense acquisition system and the environment in which it operates. Moreover, it would require (and also follow from) reducing what many in government and industry see as the existing adversarial relationship between the two.

Bottom-Up Review The opposite approach is to start with the present system but examine each regulation, directive, and specification to ensure that

@" 'Making Defense Reform Work: The Project on Monitoring Defense Reorganization, " op. cit., footnote 47, p. 50.

50Technically, DOD does not usc the term L'b]ack.progm$A ''specia] access program" is onc in which additionat restrictions beyond those available through the normal Confidential-Secret-Top Secret classification system are deemed required. The budgets and existence of such programs mayor may not bc classified. "Black" programs generally refer to those whose existence is kcpt secret.

it is still relevant and appropriate. Such a task would be a mammoth undertaking. Moreover, those with the time to review the regulations would most likely not be the ones adversely affected by them, and it is unlikely that this approach would effect significant change.

Evolutionary Review-Another approach, which is being implemented in a number of DoD activities, is to establish a mechanism by which those adversely affected by a regulation can petition for its waiver, with all such petitions examined to see which regulations should be waived or modified across the board.

Those affected by a regulation can already seek its waiver from the issuing authority without any special program. However, DoD programs such as the Pilot Contracting Activities Program and the Model Installations Program have been established to provide waivers in a more systematic way. Requests for waivers are tabulated to identify those regulations that seem to provide the greatest barriers. If approved, waivers are evaluated on an experimental basis to see if they should be made permanent or even extended DoD-wide. These programs at present cannot waive regulations imposed externally on DoD (by legislation, for example). However, they can identify those external regulations and laws that participants find to be particularly onerous, and the DoD can then propose legislation or regulatory reform at higher levels to ameliorate the problem.

One drawback to this approach, from the point of view of those seeking major reform, is that it is an evolutionary process. Another problem is that in at least some cases, individuals having to put up with obsolete, ineffective, or inapplicable regulations have found it far easier to ignore them than to petition for their waiver.

Shifting the ' 'Burden of Proof '—In this approach, the "burden of proof" is shifted from those seeking to waive regulations to those seeking to enforce them against the objections of the program manager. Essentially, it consists of pre-delegating waiver authority all the way down to the program manager, who could decide which regulations are appropriate. The "special interests" and "advocates" would still exist and would still be free to make recommendations to the program manager. However, the program manager would be free to disregard their advice, unless they were able to persuade the program manager's superiors. To the extent that regulations are simply being ignored today, as described in the preceding paragraph, this approach is in essence being taken now—without official sanction.

Such a system could only work if program managers and their superiors were evaluated not only on how well individual programs fared but also on how well the programs, on balance, supported the intent of the regulations—which, after all, serve to incorporate DoD and national policies that senior policymakers have decided are important. Program managers would have to realize that their goal is not simply development and deployment of a weapon system but furthering national policy as well.

True implementation of this approach would also require congressional action to relax statutory constraints, since those could not be waived by program managers. Moreover, the problem of identifying the essential core of laws and regulations that would remain mandatory-ineligible for waiver at the program manager's discretion—re-creates the original problem. If it were easy to identify the irreducible core of regulations and laws in the first place, this approach would not be necessary.

Organization of the Defense Acquisition System

So far this chapter has discussed acquisition procedures within the existing organization, in which OSD establishes policy and participates in milestone reviews for major programs, but acquisition is executed (and for programs other than the major ones, reviewed) by the Services. However, there are other organizational models, ranging from giving the USD(A) the acquisition authority that presently rests within the Services all the way to creating a civilian acquisition agency outside DoD.

Most studies of defense acquisition argue that the military Services must have primary responsibility for acquisition to ensure that the needs of the operational user are met. However, some civilian analysts argue that much of what goes on in managing acquisition programs does not require, and may not even be greatly aided by, military control. They argue that the professional, stable, and highly trained acquisition work force needed to implement procurement reform can be created only

in the context of a civilian acquisition agency. Even so, few proponents of a civilian agency call for it to be outside DoD; most believe that the Secretary of Defense must be responsible for national resources devoted to defense.

Although a study of European nations that use centralized procurement systems might illuminate the successes or failures of such a plan, there are significant factors that make such an analysis difficult. One important difference is that European defense programs are small compared to that of the United States. There are other differences, too: European military services do not dominate acquisition, European defense plans are done on a multiyear basis, the legislatures make minimal changes to annual defense procurement budgets, the government imposes minimal "how-to" requirements on the defense industry, and industrial policy is a major consideration in defense contracting.

One compromise position, adopted by the study group that examined the implementation of the Packard Commission recommendations, would be to encourage each of the Services to create a specialized "acquisition corps, " but to consider creating an independent acquisition organization under the USD(A) in the event that the Services balk.[51] Although the study stated a preference for leaving acquisition authority with the Services, it went on to conclude that ''radical steps, such as the establishment of a single procurement organization within the Department, should not permanently be ruled out. "5[2]

Acquisition Personnel

Improving defense acquisition depends on a high-quality, stable, and well-trained acquisition workforce. In a letter to President Reagan one year after the publication of the Packard Commission report, David Packard stated that:

> Personnel policy is the keystone of virtually all of these reforms. With able people operating them, even second-rate organizational structures and procedures can be made to work; and without able people, even first-rate ones will fail.[53]

Improvements recommended by the Packard Commission included reducing the barriers to recruiting senior-level executive branch personnel,[54] attracting qualified new personnel and improving the training and motivation of existing personnel at the middle management levels, and continuing the recent improvements in defining military career paths in acquisition, Members of the Commission thought that civilian acquisition personnel needed much more attention than military personnel, and their report cited many of the deficiencies of the federal Civil Service system that are described in the context of national laboratory personnel in chapter 5.

As was noted in the previous section, the 'Project on Monitoring Defense Reorganization" recommended establishing within each of the military Services a professional ''acquisition corps. " Within these corps, military officers who wished to specialize in acquisition would be able to pursue a career path that did not constantly rotate them out of acquisition billets. They would also receive the training necessary to do their jobs and compensation comparable to their private sector peers. Officers with operational experience would still be assigned to acquisition jobs, but in fewer numbers than now. Although the Services have long resisted establishing such corps, the study concluded that the increased professionalism that this approach would bring is essential for effective and efficient acquisition.[55]

All proposals for reforming acquisition personnel policy run into conflicts among competing objectives. Creating a military acquisition corps could improve acquisition but it would also create a military career path unlike any that the Services now believe to be appropriate. Making fundamental reforms to Civil Service procedures—or even exempting significant groups from them—would pose

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51 ''Making Defense Reform Work: The Project on Monitoring Defense Reorganization," op. cit., footnote 47, p. 59.

52 1 bid., p. 51.

53 David Packard, letter to the president of the United States, July lo, 1987; cited by J. Ronald Fox and James L. Field, *The Defense Management Challenge: Weapons Acquisition* (Boston, MA: Harvard Business School Press, 1988), p. 315.

54 Among the changes specified Were simplifying financial disclosure forms and allowing appointees to defer capital gains tax liability incurred in divesting assets so as to satisfy conflict-of-interest provisions.

55 ''Making Defense Reform Work: The project on Monitoring Defense Reorganization, " op. cit., footnote 47, p. 59.

substantial political difficulties. Federal employees already feel as if they have 240 million supervisors, and it sometimes appears, at least while reading "Letters to the Editor" columns whenever civilian pay raises are debated in Congress, that there is nothing so despised as a civil servant. Proposals that would increase compensation or other benefits of Federal employment in an effort to attract more senior and more highly qualified employees would be seen by many as adding slots to the Federal trough.

Conflict-of-interest regulations provide a case in point. Many individuals with experience in defense acquisition argue that ''revolving door" legislation that erects barriers to the interchange of individuals between government and industry prevents skilled individuals with hands-on technical or managerial experience in the industrial world from contributing their skills to DoD. On the other hand, a significant segment of public opinion—shared by a significant segment of Congress—sees the interchange of individuals between government and industry as providing inherent conflicts of interest. The political reconciliation of these two points of view will be difficult.

Policy Options

Trade-offs, inefficiencies and problems in the defense acquisition system stem from a wide variety of interrelated causes. Some of them are due to structural limitations of the United States Constitution and our resulting political system. Others result from the relationship between the Congress and DoD, and would be amenable to congressional action or clarification. Many problems arise from conscious choices that have been made to emphasize some national goals over others, choices that could be reversed if the political mood of the nation were to shift. And still others are unintended consequences of aggregating many individual actions, each of which may be widely accepted.

Solutions almost always involve trade-offs. Should the government relax its controls over industrial performance, or should they be strengthened? One point of view is that of the Packard Commission, which believed that although major improvements were essential, "self-governance is the most promising mechanism to foster improved contract compliance. "[56] Quite a different viewpoint is provided by the Project on Military Procurement, which argued that "as expensive as it is to hire legions of auditors, it is even more expensive to allow contractors to continue to steal and goof off. "[57] Although this picture of contractor behavior is not supported by analyses of defense procurement—which generally find that fraud, while certainly present to some extent, does not consume a significant fraction of the defense budget—it does represent the attitude of a substantial fraction of taxpayers and therefore of Congress.[58] Regardless of its merit, reformers of the defense acquisition system ignore this public sentiment at their peril.

Has the overhead that comes with government procurement (viz., accountability trails and socio-economic goals) impeded defense procurement so badly that we should be willing to trade off these goals to obtain a more efficient system? Is the risk of a visible and, in hindsight, preventable failure worse than the risk of quashing individual initiative by imposing regulations? Are we willing to assign individual accountability and responsibility, knowing that the price of allowing star performers to excel is the risk that incompetent and even criminal actions may take place as well? What are the costs of delaying a military capability v. the benefits of delaying an expenditure? These are difficult but crucial questions.

Incentives

The best, and possibly the only, solutions to acquisition problems involve changing the incentive structure facing people and organizations, rather than imposing additional regulations. The present

[56] President's Blue Ribbon Commission on Defense Management, op. cit., footnote 15, P. 84.

[57] Dina Rasor, et al. *Defense procurement Papers: Campaign '88* (Washington, DC: Project on Military procurement, September 1988), P. 45.

[58] A public opinion survey of 1,500 Americans taken for the Packard Commission found that the public believes $45 of each $100 in the defense budget goes to wrote (poor management) and fraud (illegal activities), with that $45 about evenly split between the two. Money lost through waste and fraud is thought to end up primarily in defense contractors and individuals' pockets. See Appendix L, "U.S. National Survey: Public Attitudes on Defense Management," prepared by Market Opinion Research; in *A Quest for Excellence: Appendix,* Final Report by the President's Blue Ribbon Commission on Defense Management, Executive Office of the White House, Washington, DC, June 1986, pp. 217, 219.

acquisition system offers incentives, according to J. Ronald Fox and James Fields, but these often act the wrong way. They argue that no lasting improvement is likely unless an appropriate system of incentives and disincentives is formulated and enforced:

> Unless changes are made in the contractor source selection process, which makes optimistically low cost estimates a significant advantage in competing for a contract, it is useless to discuss realistic contractor proposals. The source selection process must give far more weight to realistic cost estimates and the contractor's record of past performance.
>
> Unless changes are made in the current profit system that demands higher costs as a prerequisite for higher profits, it is futile to expect lower costs. Because profits are largely based on cost, there is little economic motivation for contractors to reduce direct or indirect costs. The profit system needs a major overhaul to relate profits more to contract performance than to the level of costs.
>
> Unless changes are made in the current military personnel system that makes short-term assignments necessary for military officers to acquire the number and variety of assignments required for promotion, any significant reduction in personnel turnover in defense program offices is unlikely.
>
> Unless changes are made in the current OSD and congressional practice of routinely accepting program stretch-outs as a tactic for funding new programs, it is unrealistic to advocate economical production rates.
>
> Unless changes are made in the current DoD practice of waiving training requirements and offering only short training courses, which limit coverage to introductory rather than in-depth treatment of important subjects, it is unrealistic to expect improved training for acquisition managers.
>
> Unless changes are made in military careers that **currently** provide few opportunities beyond age 45 or 50, it is unrealistic to expect military officers not to seek a second career in the defense industry. In addressing this problem, DoD needs to listen to lieutenant colonels and colonels and Navy commanders and captains to learn their views on the advantages and disadvantages of the acquisition career field.
>
> Without genuine promotion opportunities for those who make the difficult decisions associated with successful negotiating and wise buying, it is unrealistic to expect to retain in government service experienced program managers able to do much more than promote their programs, prepare progress reports, and conduct briefings.[59]

Approaches

Although there are innumerable specific changes that could be made to the way defense acquisition is done, the discussion in this chapter suggests that many policy choices concerning defense acquisition fundamentally rest on where the balance is established between efficient defense acquisition, on the one hand, and furthering national goals such as fairness and accountability, on the other. Four alternate approaches, each establishing this balance in a different way, are presented below. In Approach 1, the balance is tilted sharply towards efficient acquisition. Approach 2 has the same objectives as Approach 1 but pursues them in a more gradual manner. Approach 3, ratifies the present choice of that balance, and Approach 4 takes the position that non-defense-related national objectives should be emphasized even more than they are today.

Approach 1: Enact major structural and legislative reforms of the environment within which defense acquisition takes place, emphasizing efficient procurement over other national goals.

Selecting this approach would represent a conclusion that the existing procurement system places too much emphasis on non-procurement-related objectives. Many laws and regulations mandating, for example, procedures for competitive bid solicitation and award, barriers to conflict of interest, and the promotion of minority-owned and small business, would have to be reviewed and revised to give individual contracting officers and program managers greater authority to do as they see fit for the good of their programs. They would be less involved with justifying every action, establishing audit trails, complying with accounting standards, and fostering full and open competition. Instead, the system would rely more on individual responsibility, which would have to be measured both by the success of the programs and by the necessarily subjective evaluation of their manager's superiors as to how well

[59] J. Ronald Fox and James L. Field, op. cit., footnote 53, pp. 318-319.

they protected the public trust.[60] Careful study would be needed to arrive at a new balance between acquisition and these other goals. Successful accomplishment of this approach would also require some degree of societal consensus, and the continuing cooperation of Congress, so that the balance between procurement and these other goals would not be reexamined every budget cycle.

Approach 2: Preserve the basic structure of the defense acquisition system, but pursue evolutionary changes that **would emphasize efficient acquisition over other goals.**

This approach is similar in underlying intent to the preceding one, but would not try to do everything at once. To the extent that individual regulations, laws, policies, or procedures could be shown to impede acquisition efficiency, the regulation, law, etc., could be individually evaluated to see what would be lost if it were changed. By proceeding at a much more measured pace than the previous approach, some would argue that it has a much better chance of being implemented and would pose less risk On the other hand, those totally dissatisfied with the present acquisition system would probably find anything less than a total overhaul insufficient.

Approach 3: Decide that the current balance between efficient acquisition and other national goals is more or less appropriate, and in so doing recognize that acquisition will not be as efficient or as effective as it would be if it were conducted in isolation from those other goals.

This approach, too, would seek evolutionary improvement to the acquisition system when specific impediments could be identified. However, it would not presume that, given a conflict between acquisition and other values, acquisition should necessarily win. Selecting this approach essentially codifies the *status* quo--it would be assumed that the environment surrounding the acquisition process is shaped by a compromise between competing interests and has led to the creation of a system that perhaps pleases no one, but is preferable to any significant alternative.

Approach 4: Extend regulation and oversight of the defense acquisition system under the premise that it is not yet sufficiently responsive to national needs.

Those who see recent press accounts of procurement improprieties and contractor fraud as indicating a lack of supervision and oversight would recommend an approach diametrically opposed to those discussed above. instead of favoring acquisition efficiency over other objectives, they would seek changes—such as more stringent accounting requirements and conflict-of-interest standards—that would have the effect of increasing the bureaucratic overhead of the acquisition process. Proponents of this approach argue that more stringent regulation would save taxpayers funds on net—i.e., that although the extra controls might cost money to establish, they would prevent an even greater amount of fraud and abuse, or that the price of the further standards is worth paying to ensure public confidence in the acquisition process.

[60] This latter criterion is not easy to measure. Is it good enough for a contracting officer to consistently award contracts to companies who do good work? What if he or she then retires to take a high-paying job with one of the companies that he or she had favored? What if another company, which had reason to believe that it could have done a job better or cheaper or both, was not allowed to bid? In both these cases, the appearance that the most efficient use of taxpayer funds may not have been made must be considered, even if the reality is that the product obtained was as good as any.