

THOUGHTS ON REFORMING THE MILITARY ACQUISITION PROCESS

Michael D. Rich and Edmund Dews

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The RAND Corporation, 1700 Main Street, P.O. Box 2138, Santa Monica, CA 90406-2138

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For more than 25 years RAND has studied many topics associated with the development and procurement of military systems. These include alternative acquisition strategies, the formulation of weapon system requirements, the estimation of technical risks, the estimation of cost and cost growth, the "design-to-cost" approach to cost control, the methods of test and validation, the use of warranties and contractual incentives, the condition of the defense industrial base, the method of budgeting and programming for acquisition, foreign experience in acquiring weapon systems, the effectiveness of multinational development and production programs, and a variety of reliability and maintainability issues.

Our studies have analyzed various civilian systems and almost every type of military weapon and support system except Navy ships (although we have examined numbers of ship-borne systems). Included among the systems studied are fighter and bomber aircraft, transports, turbine engines, avionics, missiles, precision-guided munitions, spacecraft, armored fighting vehicles, helicopters, nuclear power plants, computers, oil platforms, pioneer process plants, federal demonstration projects, pipelines, and hydroelectric plants. Sponsors for this research have included the three military Services and the Office of the Secretary of Defense; the Atomic Energy Commission; the National Science Foundation; the Departments of Energy, Transportation, and Health and Human Services; and The RAND Corporation itself. About a year ago we published a brief report that draws together the major findings and lessons of this large body of research.¹

This paper outlines an approach to reforming the defense acquisition process and describes briefly a prescription for reform based on our research results. In doing so, it challenges several aspects of conventional wisdom and popular belief and offers a set of recommendations that go beyond those of the Packard Commission.

*This Paper is based on testimony given by Michael Rich to the U.S. Senate Committee on Armed Services, Subcommittee on Defense Industry and Technology, on April 9, 1987. Mr. Rich is a Vice President of The RAND Corporation and Director of the National Defense Research Institute, a federally funded research and development center sponsored by the Office of the Secretary of Defense.

¹Michael Rich and Edmund Dews, with C. L. Batten, Jr., *Improving the Military Acquisition Process: Lessons from RAND Research*, The RAND Corporation, R-3373-AF/RC, February 1986. This report contains references to the numerous publications containing these and other findings. Those references are not repeated here. See also, Michael Rich and Edmund Dews, "Improving Defense Acquisition: A Strategy to Meet the Challenge," *Defense Management Journal*, First Quarter 1987, pp. 24-38.

AN APPROACH TO REFORMING THE ACQUISITION PROCESS

Avoid Misconceptions About the Past

The news media have been full of accounts of conflicts of interest, cost overruns, spare parts overpricing, and contractor fraud, not to mention equipment that fails to meet performance goals or to function reliably. While many of these reports have been exaggerated or poorly informed, they reflect an underlying truth. Achievement has too often fallen short of what the public, the Congress, and the military users of new equipment have a right to expect from defense acquisition management. This situation is by no means new, however, and in designing and implementing measures for strengthening the acquisition process, we need to see the situation in perspective.

The traditional measures of success for major system acquisitions are cost growth, schedule slippage, performance shortfalls, and fielding times. These measures, given our current ability to quantify them, do not tell the whole story about the effectiveness of defense acquisition, but they do give important insights. Our research shows that government and industry management can claim at least modest improvements over time--a conclusion contrary to the usual assertion that defense acquisition has become progressively less effective. Specifically,

- Cost growth for major Department of Defense programs of the 1970s averaged 5.8 percent per year (over and above inflation); the comparable figure for programs of the previous decade was 7.6 percent. Average annual cost growth for comparable programs in the first half of the 1980s has been 4.4 percent (over and above inflation). Defense programs have generally experienced less cost growth than comparable nondefense programs, in some cases much less.
- 1970s programs exhibited somewhat less schedule slippage than those of the 1960s.
- 1970s performance shortfall was close to zero on average, although, as before, some individual programs did experience significant performance problems.
- There has been no lengthening of the heart of the acquisition cycle--from start of full-scale development to a point well into the production phase--over the past three decades. The duration of the planning phase increased a bit during the 1960s and there has been a steady growth in the length of the production phase (owing to the growing complexity of our systems and a rise in unit costs not matched by system procurement funding).

I would be remiss if I did not point out that our research has also led us to identify and explore numerous caveats about these generally positive conclusions.

- We are largely unable to separate the causes of lower cost growth, so we do not know the extent to which recent declines are attributable to more realistic early cost estimates, improvements in cost controls and contract arrangements, greater use of contingency margins during the recent periods of budget growth, or other possible explanations.
- Acquisition research has focused mainly on cost growth during development and early production, but the problems of production instability and stretchout, the longer retention of systems in the operational inventory, and the need to upgrade systems to permit them to meet the increasing threat now require serious attention to cost growth during the production phase.
- System performance measures used by managers and reviewers of acquisition programs have tended to emphasize functional performance, such as vehicle speed and range, thereby failing to capture many parameters that contribute to overall mission effectiveness (such as those related to the reliability and maintainability of our systems).

Despite some real instances of very troubled programs, the acquisition process has generally been much more successful than most of its critics have claimed. We must resist proposed changes that rest on false premises (such as proposals to compress development time and overlap development and production because of the mistaken notion that we have been taking longer and longer to reach the full-rate production phase).

Recognize the Key Challenges of the Future

Despite the Defense Department's past record of achievement, our research has led us to conclude that the acquisition process does indeed require major changes. The reason lies primarily in four important trends:

- **Escalating enemy threats.** The combat capabilities of the Soviet Union and its allies have grown in geographic breadth, numerical size, and qualitative capabilities. For the first time, the Soviets can threaten many critical elements of U.S. support infrastructure. This greatly complicates the technical and operational challenges faced by U.S. weapon developers. Future weapon systems must not only keep pace with the functional performance improvements in enemy weapons, but *in addition* they must be designed to provide for substantial improvements in the mobility and supportability of U.S. forces, their productivity in combat, and their resiliency to attacks on support infrastructure.

- **Resource constraints and uncertainties.** Defense budgets will almost certainly level off or even begin to decline in real terms, thereby increasing the resource pressure on defense acquisition. And trends within the defense budget (such as the funding competition between readiness and modernization programs) may add to that pressure. To overcome the decline in the number of men and women of prime military age, pay scales may need to rise considerably, leading to a shift of budgetary resources from materiel to personnel.
- **Longer retention of weapon systems in the operational inventory and fewer new programs.** With major weapon systems becoming increasingly capable, complex, and costly, progressively fewer new major acquisition programs are being started and, within each program, fewer units are bought each year. One result is that weapon systems are now retained in active service for longer and longer periods of time. All three Services will thus have to deal with aging systems and the associated problems of obsolescence.
- **Increasing difficulties of producing at an affordable cost.** Many programs incur cost growth even after they are years past the beginning of full-scale development. One explanation can be found in the frequent production stretchouts and year-to-year production rate changes that they experience. Because most weapon production employs out-of-date, inflexible manufacturing technology, this production-phase turbulence makes low-cost production and effective cost control exceedingly difficult.

The implications of these trends are clear and they ought to be the guideposts for concentrating efforts at acquisition reform. Specifically, those responsible for weapon acquisition must:

- Strengthen the process by which combat *subsystems* are developed and used to upgrade fielded weapon systems. Increased reliability and maintainability should be a major goal of this process.
- Increase the number of new system "platform" options that will become available for evaluation (if not always for procurement) through the remainder of the century.
- Enable our defense industrial base to produce efficiently at usually low but frequently changing rates of production (the likely environment of the future).

Only by focusing tightly on these critical objectives will acquisition reform efforts achieve the improvements necessary to meet future challenges. Moreover, proposals that do not directly improve our ability to achieve these objectives are of secondary importance.

A STRATEGY FOR ACQUISITION REFORM

To meet the acquisition challenges of the present and future, we recommend an integrated strategy of mutually supporting components. None of the components is novel, although each is currently an exception to general practice, at least in emphasis. Although the strategy has wide applicability across the full range of military weapon systems, it should not be rigidly applied, nor is it a panacea.

This strategy is described in detail elsewhere; let me first list its eight major elements and then briefly describe them:

- **Improve the Requirements Formulation Process**
- **Make the Early Phases of Development More Austere**
- **Develop and Mature Critical Subsystems Separately from Platforms**
- **Encourage Austere Prototyping**
- **Use Phased Acquisition to Improve the Transition from Full-Scale Development to Full-Rate Production**
- **Focus Greater Attention on Upgrades**
- **Encourage Plant Modernization by Means of Computer-Integrated, Flexible Automation**
- **Continuously Evaluate the Effects of Acquisition Policy Changes**

Improve the Requirements Formulation Process

There has never been a greater need to structure requirements for new operational capabilities wisely. This requires:

- A more coherent planning framework that first considers the general capabilities needed to underwrite U.S. strategies and commitments and then examines preferred concepts of operations and the specific military capabilities implied by these concepts.
- A strong, central, and coordinated focus to exploit and integrate the unique capabilities of each Service, eliminate unnecessary and undesirable duplication, and assure common analytic approaches for dealing with a common threat.
- A stronger role for the major operational commanders.
- More planning that addresses entire "categories" of equipment (fighter aircraft, helicopters, or attack submarines, for example) rather than individual weapon systems. This would

facilitate the structuring of hearings along mission lines, as suggested in the Committee's 1985 Staff Report on Defense Organization.

- Throughout the acquisition process, more systematic consideration of possible tradeoffs among the various characteristics of the weapon system platform and its associated munitions, support systems, and basing modes.

Make the Early Phases of Development More Austere

Greater austerity during the initial stages of new programs is essential to increasing new program starts, increasing the number of new concepts evaluated in each program, and weeding out unpromising concepts before they attain too much bureaucratic momentum. Detailed, technically oriented guidelines at the beginning of concept validation should be replaced with more general statements of mission and system performance goals, plus details of the expected operational environment and important resource constraints and targets. This change will promote design creativity and reduce both government and contractor management costs.

Develop and Mature Critical Subsystems Separately from Platforms

For the foreseeable future, U.S. forces will modernize principally by upgrading current weapon systems with new subsystems featuring higher levels of functional performance and superior reliability and maintainability. To assure the availability of an adequate menu of mature subsystem options for such upgrades, the Defense Department must fundamentally change the way it develops certain types of equipment, especially combat-related electronics.

Currently, the full-scale development of electronic subsystems is begun well after the full-scale development of the platforms in which they will be incorporated. This is so for both aircraft avionics and the increasingly sophisticated electronic equipment embodied in surface systems. In general, the developer of an electronics subsystem has less than two years to mature his equipment before it must be installed in a pre-production platform. The pace and phasing of subsystem development present difficulties not only for the equipment developer but also for the decisionmaker, because the unavailability or immaturity of critical subsystems and their associated support elements (support equipment, technical orders, etc.) during early testing detracts from the quality of the test information used in evaluating a system's readiness for production.

For sophisticated electronics functions that are critical to the combat performance of our platforms--fire control radars, navigation and ranging, surveillance and target acquisition, electronic countermeasures, and the like--we must provide sufficient development iterations to ensure that the equipment meets the required level of reliability and maintainability. This approach is known as

"maturational development." In the strategy we favor, the development of the platform would be decoupled from that of critical electronic subsystems, so as to allow the necessary "head start" in their development.

The required functional performance capabilities of the subsystems can usually be demonstrated within a single development cycle. That level of performance would then be "frozen." In the extra time made available by this approach, the subsystem would be subjected to as many cycles of design, test, and evaluation as might be needed to attain the required level of reliability and to demonstrate the required capability for fault isolation.

Maturational development is a proven concept, having been applied successfully to space and ballistic missile subsystems and to many commercial electronic subsystems. The Carousel inertial navigation system, used in both civil and military aircraft, is an outstanding example. Also, maturational development is essentially the strategy the Air Force has successfully adopted for turbine engines. As they mature, building blocks become available for use in more than one weapon system--new ones as well as those being upgraded. The benefits include not only improved subsystem reliability but also avoidance of duplicative development efforts.

Encourage Austere Prototyping

Use of full-scale demonstration models before beginning formal full-scale development--sometimes known as fly-before-you-buy--has gone in and out of fashion over the past 40 years, although it has been consistently supported by the results of RAND research.

If prototyping is done austere, as we recommend, its cost need be no more than a very small percentage of total program costs, perhaps 1 to 5 percent. Much evidence suggests that prototyping helps to control cost growth; thus the up-front investment in a prototype may subsequently lead to savings. Even more important than control of cost growth, however, is the boost prototyping gives to system quality through earlier, more detailed, and more reliable identification of serious engineering problems. Finally, prototyping enhances the accuracy of early cost estimates, the understanding of subsystem interface difficulties and requirements, and the overall effectiveness of program management. In short, this approach to early development, especially when coupled with maturational development of critical subsystems, can greatly improve the chances of success in the subsequent full-scale development phase.

Use Phased Acquisition to Improve the Transition from Full-Scale Development to Full-Rate Production

Recent emphasis on independent and realistic operational testing is a major step forward. Testing, however, is not enough. The test results must be exploited before high-rate production begins, but test and production schedules do not usually allow enough time to do so. The result has been that:

- High-rate production decisions occur long before the end of testing, usually before the end of development testing and sometimes even before the beginning of operational testing.
- The operational user takes delivery of substantial numbers of units before the completion of testing.
- These patterns are found whether or not early prototyping has been part of the development strategy.

By the time testing is concluded, test data fully analyzed, and desirable design changes identified, many units having the original system configuration are typically already in the field. Incorporating changes in these units is expensive. Work in progress at RAND indicates that for a fighter's radar alone, design improvements could cost several hundred million dollars. Faced with such costs, the Services have often decided to accept degraded capabilities.

Failure to exploit test information, if it persists, will negate the benefits expected from more thorough testing and reduce the advantages derived from austere prototyping. The decision to begin high-rate production must not take place so early that it prevents exploitation of lessons learned from operational testing. Nor should the emphasis on operational testing necessarily imply a delay in the start of production activities. What is needed is a longer period of low-rate production, during which corrective design actions can be economically made. This strategy for exploiting test information is called phased acquisition.

Focus Greater Attention on Upgrades

The increasing importance of upgrading fielded systems as the cost-effective way of modernizing U.S. forces requires additional changes in the acquisition process. In particular, the Services need to collect engineering data in realistic operational settings throughout a system's operating life. Because its purpose is to identify opportunities for upgrading as well as equipment deficiencies, this type of testing and analysis calls for much more active and direct participation by contractor design engineers than has previously been common in the operational phase.

In fact, the acquisition process should explicitly encourage upgrades in parallel and in competition with new system programs. In many circumstances, this kind of competition promises greater benefits than the usually much more costly method of supporting two prime contractors through full-scale development of a new system. It also increases flexibility in adapting to many of the uncertainties that surround acquisition of defense systems.

Encourage Plant Modernization by Means of Computer-Integrated, Flexible Automation

The U.S. defense industry has established world leadership in the design of weapon systems, but is unable to fully exploit this advantage because support in the form of modern production facilities is often lacking. In general, defense procurement relies on some of the oldest manufacturing plants in the U.S., and the rate of investment in new equipment for defense production appears to be quite low. This handicap is difficult to overcome, however competent contractor and service managers may be, especially when changes in design and production rate are frequent. Failure to modernize production facilities goes a long way to explain the high production costs, long flow times, and limited surge capabilities that characterize much of defense procurement.

The nation needs substantial investment in new computer-based manufacturing equipment that can quickly shift from item to item and produce very small quantities of varying designs with nearly the same efficiency as traditional production lines can produce large quantities of a single item. Rather than economies of scale, use of such equipment results in economies of scope through high utilization rates and distribution of fixed costs among different products.

Modernization of defense manufacturing facilities should therefore be a major element now in any long-term acquisition strategy that aims at reducing fielding times and cutting unit production costs. DoD already has useful initiatives under way--IMIP, TECHMOD, MANTECH, and the like--but they represent only modest efforts with limited goals. Officials must develop new and more effective ways to stimulate investment in the kind of flexible plant that will be increasingly necessary in the future, when it may be even more difficult to assure stable production rates and when we will have to rely more and more on rapid system upgrades to maintain qualitative superiority. Among other steps, the Services should emphasize flexible production capabilities in modernization of depot facilities and in prime and subcontractor source selection at every stage of the acquisition cycle.

Continuously Evaluate the Effects of Acquisition Policy Changes

Finally, if it is to meet the challenges of the future, acquisition strategy cannot be static. While we recommend adoption of the integrated strategy outlined here, we realize that it requires systematic monitoring, assessment, and readjustment. Appropriate metrics and data systems will be necessary. Furthermore, officials must assign responsibility for both day-to-day monitoring and in-depth analysis in order to ensure that senior managers and policy-makers have adequate information to assess the long-term effects of policy changes and to help in formulating new policies.

WHAT IS DISTINCTIVE ABOUT THIS APPROACH

RAND has recommended the strategy outlined above for many years, and several elements of this strategy (along with some of our more detailed recommendations) appear in the Packard Commission report and various congressional acquisition reform proposals. However, our preferred approach and specific recommendations are distinctive in several important respects. To sketch those differences most starkly, we list here the five principal weaknesses or limitations of the popular prescriptions for acquisition reform.

- **Insufficient appreciation of the importance of upgrades.** The principal means of modernizing U.S. (and allied) forces to counter future improvements in the enemy threat and deal with the growing problems of obsolescence will not be new system platforms, as in the past. And yet acquisition reformers pay almost no attention to the problems associated with generating promising subsystem improvements and replacement options and the process by which fielded systems can be upgraded in timely fashion at low cost.
- **Inadequate attention to the underlying acquisition process.** The Packard Commission emphasized organizational and personnel questions, paying relatively little attention to how the necessary steps in the acquisition process are conducted and sequenced. By contrast, RAND's research has found that improvements in the acquisition process, itself, promise much more leverage in meeting future challenges than adjustments in office charters and reporting relationships.
- **Too much faith in the applicability of commercial practices to the defense marketplace.** The dominant theme of many of the recent reform proposals is an attempt to replicate the commercial world. Unfortunately, RAND research has repeatedly revealed that sound commercial practices do not automatically make sense in the defense context. Two prominent examples are warranties, which have a mixed record even in commercial applications, and production competition. Design competition has long been intense, needs no further stimulation, and clearly pays off well. But in the defense setting, prime contractor price competition in the production phase appears to be characterized by as many failures as successes, with much uncertainty about how to choose when to compete. An "across the board" implementation of the Competition in Contracting Act in acquiring new weapon systems will surely fail to achieve the benefits Congress hopes for. The DoD should be allowed and, indeed, encouraged to apply the Act quite selectively.
- **Insufficient attention to the goals of manufacturing efficiency and flexibility.** Although the Packard Commission has urged the use of technology to reduce costs, this recommendation focused narrowly on the role of prototypes in the development phase.

The Commission seemed to accept for the indefinite future an obsolescent manufacturing technology that is inefficient except for programs funded at stable production rates close to original program plans.

- **Too much effort toward "eliminating" uncertainty (instead of "adapting" to it).** The current popularity of "contractual" solutions reflects an underlying but usually unstated supposition that defense acquisition activities can be made to be both stable and predictable. That assumption, of course, is far from reality. Consequently we have fashioned a prescription for acquisition reform that would increase subsystem and system options, improve the Defense Department's ability to identify and hedge against technical and programmatic risks, and strengthen the resiliency of the defense industrial base in coping with the uncertainty inherent in the defense environment.

Although the uncertainties faced by defense acquisition are to a large extent unavoidable, much can be done to reduce these uncertainties and successfully adapt to them *if the existence of risk and uncertainty is more fully accepted and reflected in acquisition decisions*. In this, the Congress can take the lead in important ways. Using its oversight powers to stimulate adoption of the acquisition strategy elements described above is the foremost example. Working for greater predictability in the funding of acquisition programs, and accepting the need to provide R&D contingency funds, are also important steps. What may not be so obvious is the need to slow the pace of *legislated* changes in acquisition management. In the last two or three years thoroughgoing organizational, policy, and regulatory changes have been initiated. Time is needed for these changes to be understood, assimilated, and carried into effect, and for the results to be assessed. Once a more rational strategy becomes the norm, the acquisition process will surely benefit if its managers are allowed a respite in which to get on with the job.

