United States General Accounting Office

GAO

Report to the Chairman, Committee on Armed Services, House of Representatives

September 1990

DEFENSE ACQUISITION

Fleet Ballistic Missile Program Offers Lessons for Successful Programs

RESTRICTED——Not to be released outside the General Accounting Office unless specifically approved by the Office of Congressional Relations.

GAO/NSIAD-90-160

GAO United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

B-239137

September 6, 1990

The Honorable Les Aspin
Chairman, Committee on Armed Services
House of Representatives

Dear Mr. Chairman:

This report responds to your request concerning the management of the Navy's Fleet Ballistic Missile program. Specifically, it discusses program management features that have been major contributors to the program's success. We also found that successful programs in the other services tend to share similar features.

As requested, we plan no further distribution of this report until 30 days after its issue date, unless you publicly announce its contents earlier. At that time, we will send copies to the Secretary of Defense; the Service Secretaries; appropriate congressional committees; and other interested parties.

This report was prepared under the direction of Martin M Ferber, Director, Navy Issues. Appendix IV lists other major contributors to this report.

Sincerely yours,

Frank C. Conahan

Frank C. Conahan
Assistant Comptroller General

Executive Summary

Purpose

The Fleet Ballistic Missile system is the U.S. sea-based deterrent against the Soviet nuclear threat. Nuclear-powered submarines carrying nuclear-tipped Polaris A-1 ballistic missiles began operational patrols in 1960. In March 1990, fourth-generation submarines began operation with sixth-generation Trident II (D-5) missiles. The Navy's Fleet Ballistic Missile program is one of the few major weapon system acquisitions that, over the years, has consistently met or bettered its cost, schedule, and performance goals.

The Chairman, House Committee on Armed Services, asked GAO to determine (1) what features have contributed to the Fleet Ballistic Missile program's success and (2) whether those features were present in other selected defense acquisition programs. GAO also determined to what extent the six features identified by the Packard Commission as typical of successful commercial programs could be found in the selected defense acquisition programs.

Background

The Department of Defense's acquisition process has been the subject of a number of studies and management initiatives for more than 20 years. These studies suggested ways to address recurring problems in defense acquisition—cost growth, schedule slippage, and performance shortfalls—but these problems continue to exist.

GAO used a comparative case study methodology to determine whether features that were identified as contributing to the Fleet Ballistic Missile program's success were common in other major acquisition programs. The GAO study included one "successful" and one "less than successful" program each from the Navy, Army, and Air Force. GAO considered programs that generally met their cost, schedule, and performance goals as successful. The other successful programs studied were the Army's Multiple Launch Rocket System and the Air Force's F-16. For comparison purposes, GAO studied the Navy's Submarine Advanced Combat System (a portion of which became AN/BSY-1), the Army's Aquila Remotely Piloted Vehicle, and the Air Force's Advanced Medium Range Air-to-Air Missile.

The Packard Commission's 1986 report on defense management included an "Acquisition Model To Emulate," which identified six features that could be used as a model for defense acquisition programs. These features are (1) clear command channels, (2) stability, (3) limited reporting requirements, (4) small, high quality staffs, (5) communications with users, and (6) prototyping and testing.

Results in Brief

GAO identified five interrelated major features that contributed to the Fleet Ballistic Missile program's success. These features are (1) funding and program stability, (2) program responsibility over the system's entire life cycle from development through operations support, (3) continuity of key personnel, (4) program office technical expertise, and (5) good management practices, such as open communications, independent internal evaluation, and on-site management representation at contractor plants.

GAO found no guaranteed "cookbook" approach to a successful weapon system acquisition. Each of the acquisition programs studied developed in a unique environment with its own particular opportunities and problems. In each case, GAO found that the program's success or lack of success was the result of multiple causes. However, more of the Fleet Ballistic Missile program's features were generally present in the successful programs than in the less than successful programs. For example, the successful programs generally had funding and program stability, continuity of key personnel, and program office technical expertise.

Likewise, the successful programs shared more of the Packard Commission model's features than the less than successful programs. For example, the successful programs generally had stability, high quality staff, and good communications with users.

Principal Findings

Program Stability and Life-Cycle Responsibility

Since the mid-1950s, the Fleet Ballistic Missile program office has had a well-defined mission of high national priority. The program also has had strong and continuous congressional and executive branch funding support. Therefore, program managers have been able to concentrate on resolving technical problems rather than funding problems.

The Fleet Ballistic Missile program office has been responsible for the design, development, procurement, and maintenance support of several generations of submarines and missiles. With this life-cycle responsibility for the system, the program's management emphasized the long-term view, knowing that it would be responsible for supporting the system. For example, decisions made during the Trident I missile's acquisition phase are today's logistics and maintenance realities for the same program office.

Most of the Fleet Ballistic Missile program's principal contractors have been with the program from the beginning and share this long-term responsibility. Many of the program's developmental contracts provided for incentive payments based on long-term performance, including reliability and accuracy. For example, the Trident II navigation subsystem's performance on the first 32 operational patrols will determine the final amount of the contractor's incentive payment.

The successful acquisition programs GAO studied had funding and program stability while the less than successful programs did not.

Staff Continuity and Technical Expertise

Military personnel had an acquisition career path in the Fleet Ballistic Missile program office, which provided continuity. The average tenure of the six program managers is 6 years, compared to 27 months for other defense program managers. Also, four of these program managers each served as the program's Technical Director before becoming program manager.

Civilian personnel in the Fleet Ballistic Missile program office also have long tenures and promotion opportunities within the program. For example, about 40 percent of the headquarters civilian personnel have more than 10 years of program experience. These senior personnel use their experience not only to resolve problems but also to avoid them.

Fleet Ballistic Missile program personnel have the necessary technical expertise to direct and evaluate contractor performance. This is in contrast to some program offices that use either contractors as weapon system managers or technical staff from functional organizations outside the program offices.

The successful acquisition programs GAO studied had more continuity in senior staff than did the less than successful programs.

Good Management Practices

Five good management practices have helped to ensure that the Fleet Ballistic Missile system meets performance and design requirements. These practices are (1) open communications, (2) independent internal evaluation, (3) on-site management representation at contractor plants, (4) strict management of proven designs and manufacturing processes, and (5) contracting with multiple incentives for prime contractors and extensive competition at the subcontractor level.

These practices are not unique to the Fleet Ballistic Missile program, but they were generally absent from the less than successful programs studied. For example, the communications practices used are not necessarily different in the type and number of meetings or reviews. However, only the successful programs benefitted from open communications, which resulted in program and contractor personnel recognizing problems as they developed, openly discussing them, and working to resolve them.

Packard Commission Model Comparisons

GAO's review showed that the three successful programs shared more of the Packard Commission model's features than the less than successful programs, particularly stability, high quality staff, and communications with users. This corroborates the Packard Commission's view that inclusion of these features can contribute to program success.

Recommendations

GAO is not making recommendations in this report.

Agency Comments

GAO did not obtain official agency comments. However, GAO discussed the report's findings with Department of Defense officials and officials of the various acquisition program offices reviewed and included their comments where appropriate.

Contents

Figures

Abbreviations

AMRAAM	Advanced Medium Range Air-to-Air Missile
DOD	Department of Defense
FBM	Fleet Ballistic Missile
GAO	General Accounting Office
MLRS	Multiple Launch Rocket System
PM	program manager
SSP	Strategic Systems Programs
SUBACS	Submarine Advanced Combat System

Introduction

The weapon system acquisition process has been the subject of studies and Department of Defense (DOD) management initiatives for more than 20 years. For example, the Blue Ribbon Defense Panel Report in 1970, the Report of the Commission on Government Procurement in 1972, the DOD's Assessment of Its Weapons Acquisition System (the Carlucci Initiatives) in 1981, the President's Private Sector Survey on Cost Control (the Grace Commission report) in 1983, and the President's Blue Ribbon Commission on Defense Management (the Packard Commission) in 1986 were five major studies made by various organizations that examined ways to improve the weapon system acquisition process. As a rule, these studies suggested ways to address recurring problems in defense acquisition—cost growth, schedule slippage, and performance shortfalls—but the existence of continuing studies and initiatives indicates that the problems still exist.

We also have examined and reported on acquisition problems of individual major weapon system programs since the 1960s. In 1988 we reported[1] that the continuing problems associated with defense weapon system acquisition is indicative of the high level of difficulty in developing lasting solutions to the seemingly intractable problems of affordability and stability.

One exception to these acquisition problems has been the Navy's Fleet Ballistic Missile (FBM) program. This program is one of the few major weapon system acquisitions that, over the years, has consistently met or bettered its cost, schedule, and performance goals. Both the Congress and the defense community generally recognize this program as one that has avoided many of the problems associated with defense weapon system acquisition, such as cost growth, schedule slippage, and performance shortfalls.

The FBM weapon system, operational since November 15, 1960, consists of nuclear-powered submarines carrying nuclear-tipped ballistic missiles. (See app. II.) In addition to missiles and submarines, the FBM program includes research and development, production, training, facility construction, and maintenance and operational support. However, FBM submarine reactors are provided by the Naval Nuclear Propulsion Program, and the nuclear warheads are provided by the Department of Energy.

[1] Major Acquisitions: Summary of Recurring Problems and Systemic Issues: 1960-1987 (GAO/NSIAD-88-135BR, Sept. 13, 1988).

The FBM Program Manager (PM) is the Navy's Director of Strategic Systems Programs (SSP), which is the FBM program office. As a direct-reporting PM, the PM reports to the Assistant Secretary of the Navy for Research, Development and Acquisition—the Navy's Service Acquisition Executive—on acquisition matters. The PM also reports to the Chief of Naval Operations for all operational requirements. In addition, the PM acts as the liaison for the FBM program with all other government agencies and leads an organization of about 500 military and civilian headquarters personnel and 2,600 field personnel at government and contractor facilities.

Program History

In the mid-1950s, the defense establishment realized the need to respond to a growing Soviet nuclear threat that largely nullified the elaborate network of facilities that provided early warning of possible air attacks against the United States. The Soviets had already demonstrated a ballistic missile capability, and the country was impressed with a serious urgent need to acquire a defense arsenal of ballistic missiles to counter the Soviet threat. One former PM described the political and psychological atmosphere at the time as a state of national emergency dramatized by the launch of the first earth-circling satellite (Sputnik) in October 1957. As part of the U.S. response, the services began to study and develop intercontinental ballistic missiles.

The Navy was responsible for designing the sea-based ballistic missile system. Because of the urgent need, the Navy believed that unusual methods were needed to cut through the normal acquisition review and approval processes if a weapon system was to be developed quickly.

In November 1955, the Secretary of the Navy created the Special Projects Office, now called SSP. This new organization was given full responsibility for the FBM program and was provided the funding and the authority to use any Navy resources needed to develop a military capability in the shortest time possible. The Secretary of the Navy and the Chief of Naval Operations gave the PM complete authority to design, develop, produce, and support the FBM system.

In December 1956, the Navy began development of a submarine-launched ballistic missile that came to be known as the Polaris missile. This weapon system incorporated new technologies and charted unknown technical paths. In particular, three major components—a solid propellant fuel, a small high yield nuclear warhead, and an accurate guidance/fire control/navigation system—needed major technical breakthroughs at the time that the Polaris project was authorized. A nuclear attack submarine also had to be modified to carry and launch the missiles while submerged. SSP's first Plans and Programs Director made the analogy that building and fielding Polaris was similar to building the entire automobile industry. That is, not only did the first automobile have to be developed but also the internal combustion engine, tires, the oil industry, gas stations, and driver training before the automobile's feasibility was known. However, technical problems were solved, and the Polaris program went from concept development to deployment in 3-1/2 years—3 years ahead of the original schedule.

Because of the sense of urgency of the program, funds were made available. Thus, the challenge to SSP during the Polaris development was one of how to use money wisely rather than how to obtain it. Between fiscal years 1956 and 1990, about $74 billion (in then-year dollars) was appropriated for FBM program acquisition.[2] This total does not include the cost of nuclear submarine reactors or nuclear warheads. The total includes about 46 percent of the Trident II missile funding and about 70 percent of Trident II-capable submarine funding; the remaining Trident II acquisition costs have not been appropriated.

The sixth-generation Trident II (D-5) missile began full-scale development in October 1983. At that time, dates were set for the first sea-launched missile flight test and the missile's initial deployment. The land-based missile flight test series was completed in January 1989, and the sea-launched test series began in March 1989, as planned. The missile's initial deployment, however, was delayed 3 months, to March 1990, to allow design corrections to be incorporated after the first and third sea-launched missiles failed and recovery of one contractor's missile motor casting capability, which was destroyed in a fire. Flight tests resumed in December 1989; the six remaining sea-launched development flight tests and demonstration and shakedown operation tests for the USS Tennessee and the USS Pennsylvania—the first two Trident II capable submarines—were successful.

Objectives, Scope, and Methodology

The Chairman, House Committee on Armed Services, asked us to determine (1) what features have contributed to the FBM program's success and (2) whether those features were present in other selected defense

[2]This represents the then-year dollar amounts for the Navy's Shipbuilding and Conversion, Weapons Procurement, Research, Development, Test and Evaluation, Other Procurement, and Military Construction accounts for fiscal years 1956 through 1990. It excludes all operations and maintenance and crew costs.

acquisition programs. We also determined to what extent the six features identified by the Packard Commission as typical of successful commercial programs could be found in the selected defense acquisition programs.

This report responds to the Chairman's request for a management study of SSP, which was the second part of a two-part request. The first part addressed the acquisition status of the Trident II program and resulted in our November 1988 report.[3] As we reported, the Trident II program was proceeding on schedule and was slightly under the initial estimated acquisition cost. However, we cautioned that many key milestones remained, including the entire sea-based test program, before the system's initial deployment.

To address the second part of the Chairman's request, we selected the following approach. We first delineated the features that led to the FBM program's success and compared these features to those in other defense acquisition programs. We then compared the features of these acquisition programs to those described in the Packard Commission's "Acquisition Model to Emulate." This second analysis corroborated our first analysis.

To determine the features that have contributed to the FBM program's success, we developed a list of areas considered important. Because our earlier report had provided information on some successful aspects of the Trident II program, we reviewed reports and documents on the FBM program, such as guidance, and information that had been collected. For example, SSP's Orientation Manual cited nine principles that were established in the FBM program's first year and have been adhered to throughout the program's existence. We also reviewed studies of the defense acquisition process, such as the Packard Commission's 1986 report.[4] We reviewed the Commission's report because it was the most recent study of the defense acquisition system. Also, some of the Commission's recommendations had been implemented by DOD or required by the Congress enacting legislation such as the Goldwater-Nichols Department of Defense Reorganization Act of 1986 (P.L. 99-433). We also interviewed experts in the field of management and defense acquisition. The experts and literature recognized that there is no consensus of definitive criteria that leads to program management success. However, using our

[3] Navy Strategic Forces: Trident II Proceeding Toward Deployment (GAO/NSIAD-89-40, Nov. 21, 1988).

[4] A Quest for Excellence: Final Report to the President (June 1986).

list, we were able to structure a framework of descriptive questions to obtain additional information on the features contributing to the FBM program's success. These questions were used in interviewing (1) officials at SSP's offices in Arlington, Virginia, major FBM contractors, and selected FBM subcontractors, (2) former SSP and contractor officials, and (3) current and former high-level DOD and Navy officials.

We then analyzed our list of features, looking for those that were mentioned most often. Through this process, we identified five major features of the FBM acquisition program that experts considered to have contributed to its success. These features are (1) funding and program stability, (2) life-cycle responsibility, (3) continuity of key personnel, (4) program office technical expertise, and (5) good management practices. This list is not meant to be exhaustive, but rather to represent those features that appeared to be significant contributors to program success (see ch. 2).

To determine if these five features were present in other defense acquisition programs, we used a comparative case study methodology in which the FBM program was compared with other acquisition programs. To select the acquisition programs, we developed case-selection criteria, including (1) representation from the Navy, Army, and Air Force, (2) DOD designated major acquisitions (generally those requiring more than $200 million in research and development or $1 billion in production), and (3) "successful" and "less than successful" acquisition programs, based on a judgmental assessment of how well they met their cost, schedule, and performance goals, using our prior reports as a primary source of information.

Because a program must have been assessed as being successful in all three categories of cost, schedule, and performance or less than successful in all three categories, various candidate programs were eliminated. Also, these assessments were made based on a program's initial deployment goals, and a later assessment may have resulted in different programs being selected. We recognize that most weapon system acquisitions tended to fall somewhere between successful and less than successful as defined, with a mixed performance in the three categories. Therefore, we believe that the acquisition programs selected represent the extremes in defense acquisition at the time they were selected. (See table 1.1 for the acquisition programs reviewed.)

Table 1.1: Acquisition Programs Selected for Our Review

	Lead service			Outcome	
Program	Navy	Army	Air Force	Successful	Less than successful
Fleet Ballistic Missile (FBM)	X			X	
Multiple Launch Rocket System (MLRS)		X		X	
F-16 tactical fighter			X	X	
Submarine Advanced Combat System (SUBACS)[a]	X				X
Aquila Remotely Piloted Vehicle		X			X
Advanced Medium Range Air-to-Air Missile (AMRAAM)			X		X

[a]As noted in app. II, the SUBACS program was restructured and a portion was renamed AN/BSY-1

We designed the case studies to illustrate the types of features, both internal and external to a program, that may influence a program's outcome. We realized that we could not make judgments as to cause-and-effect relationships with respect to a specific feature's effect on the outcome of a program. Thus, we highlighted those features of the other five programs where we found comparisons to those in the FBM program.

We obtained information for the case study comparisons from our prior reports (see app. III) and ongoing efforts and from defense literature. We also interviewed past and present program officials at the service commands where the program offices were located. These included the Naval Sea Systems Command, Arlington, Virginia; the Army Missile Command, Redstone Arsenal, Huntsville, Alabama; the Army Aviation Systems Command, St. Louis, Missouri; and the Air Force System Command's Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio, and Munitions Systems Division, Eglin Air Force Base, Florida. We discussed our observations from the case study programs with Navy, Army, and Air Force officials to verify the accuracy and completeness of the information obtained and incorporated their views where appropriate.

We then compared the features of these case study programs to those in the Packard Commission's model. The Commission report included "An Acquisition Model to Emulate," which contained six features that typified successful commercial acquisition programs and could be used as a model for defense acquisitions (see app. I). Some of these features, such as those dealing with stability and quality staff, overlapped with the features we had identified through the review of the FBM program. The model's features were organized differently and included additional dimensions, such as prototyping and testing, but they provided an additional framework for comparing acquisition programs.

Our methodology for identifying features of success and comparing the features among major defense acquisition programs was limited in the following areas.

- Definitive criteria for determining a successful acquisition program did not exist. Thus, we used experts to identify areas they considered important, from which we developed a framework for asking questions, descriptive in nature, to identify the contributors to success.
- We were not able to define definitive measures; definitions of these features, including those in the Commission's model, were subject to different interpretations. For example, officials of the defense acquisition programs studied could not agree on a definition of "small, high quality staff," especially given that the Commission chose not to put a numerical value on "small."
- The features, such as prototyping and testing or open communication, were implemented to different degrees in the various acquisition programs.
- The acquisition programs were different, if not unique, in many aspects, making it difficult to collect identical information for each. For example, the FBM program began as an urgently needed response to a national emergency, and the F-16 and MLRS programs operate under multinational memorandums of understanding.

This review was conducted in accordance with generally accepted government auditing standards. We did not obtain official agency comments. However, we discussed our findings with DOD officials, and officials of the acquisition programs reviewed and included their comments where appropriate.

Features Contributing to the FBM Program's Success and Comparisons With Other Acquisition Programs

Five interrelated features were consistently mentioned as major reasons for the FBM program's success. These features are (1) funding and program stability, (2) life-cycle responsibility, (3) continuity of key personnel, (4) program office technical expertise, and (5) good management practices. We found no guaranteed "cookbook" approach to a successful defense acquisition. Each of the acquisition programs studied developed in its own unique atmosphere with its own particular opportunities and problems. However, the successful programs studied shared more of the features associated with the FBM program than the less than successful programs.

Funding and Program Stability

The Defense Systems Management College defines program instability as "the condition imposed on a program due to problems in requirements, technology, and funding." Our 1988 report on recurring problems and systemic major weapon system acquisition issues concluded that instability within the acquisition process has been a continuing problem since the 1960s. As a rule, weapon system acquisition studies for the last 20 years have stressed that a major weapon program encounters problems of cost growth, schedule slippage, and performance shortfalls when the program becomes unstable. Conversely, we have reported that stable programs generally proceed through the acquisition process on schedule and within cost targets and meet performance requirements. For example, our 1985 report[1] on the production problems of six weapon systems stated that weapon systems that avoided major problems in production had a development phase in which design, planned procurement quantities, and funding were relatively stable. However, systems that had problems in early production went through development phases that were characterized by design, funding, and quantity instability.

FBM Program

One of the most important features in this program's success has been funding and program stability. For this program, we defined program stability in two dimensions. First, SSP has had a single, well-defined mission, allowing it to focus attention on one job over almost 35 years. Second, technological advances in the program have been evolutionary rather than revolutionary.

[1] Why Some Weapon Systems Encounter Production Problems While Others Do Not: Six Case Studies (GAO/NSIAD-85-34, May 24, 1985).

Since its inception, the program has had strong and continuous congressional and executive branch funding support. The Congress has regularly appropriated the funds requested for the FBM program. This commitment enabled those responsible for managing the program to concentrate on resolving technical problems instead of funding problems.

From its inception, SSP has had a single mission and unchanging requirements. Although each variant of the missile, from the Polaris A-1 to the Trident II D-5, has been an improvement, the system and the job it performs have essentially stayed the same. The FBM mission involves a ballistic missile launched from a submerged submarine to travel great distances to deliver one or more nuclear warheads on targets. This is in contrast to, for example, the Navy's attack submarine acquisition programs, where the changing threat environment requires corresponding mission and requirement changes with which the PM must contend.

Each improvement to the FBM system has been evolutionary as opposed to revolutionary. A stable design provides confidence that development problems have been overcome and that a system will meet technical and operational performance requirements. Once the technology and design were proven in the first Polaris missile, each new generation of the FBM system was based upon a proven prior version: an evolution of the prior version, not a radical, technological jump. SSP's third PM said that program office personnel disciplined themselves to make only the required technological jump to meet the need and did not undertake a development until they understood the technology. This approach enabled SSP to build upon past successes, analyze past failures, and apply the lessons learned to each succeeding variant. In addition, SSP made maximum use of existing facilities and relied heavily on prior variants' materials, processes, and databases in its evolutionary approach.

Other Programs

In the other acquisition programs, we found that the two successful programs were stable, and the less than successful programs generally were not.

MLRS

The successful MLRS program has had a stable and well-defined mission since early development, and the system's requirements and the defined threat have not changed during the program. In addition, the program's technical risk was low because the design did not require major technology advances. According to program officials, the program also has had strong congressional support and adequate funding. Funding and program stability was enhanced by multiyear contracting and gave the contractors and the program office clear and unchanging goals to meet.

F-16

The successful F-16 fighter program's production began in 1977. According to program officials, early and adequate funding was a significant feature in the program's success. They noted that early program funding provided stability and that the program's multinational production and multiyear contracts reinforced the stability. Also, the predecessor Lightweight Fighter Prototype Program reduced the technical risk during the F-16's full-scale development phase.

SUBACS

The less than successful SUBACS program experienced schedule delays, increased costs, and a reduction in performance capabilities. According to program officials, the SUBACS Basic program (the first phase of the SUBACS program) underwent drastic mission and requirements changes. As a result, the program design was changed three times through 1985. However, since SUBACS Basic was renamed the AN/BSY-1 and a new program office was formed in October 1985, the program has stabilized.

Aquila

The less than successful Aquila remotely piloted vehicle program was canceled in late 1987 after 13 years of development. Army officials stated that a major problem with the program was that funding levels were never stable from year to year, which led to program restructuring when funding changes occurred. The Army's decision to delete fiscal year 1982 funding and thus begin program termination, followed by a congressional decision to restore full funding, is an example of the program's funding instability.

AMRAAM

The less than successful AMRAAM program has had an unstable design throughout its development, and although the missile is now in limited production, it still does not have a stable design. This instability was a contributing factor to congressional funding cuts and a delayed full-production decision.

Life-Cycle Responsibility

A major acquisition program normally proceeds through five basic phases during a system's life cycle. These phases are (1) concept exploration/definition, (2) concept demonstration/validation, (3) full-scale development and low-rate initial production, (4) full-rate production and initial deployment, and (5) operations support. In addition to being responsible for developing and producing the system, the PM is normally responsible for maintenance and logistics planning, which is performed by assigned program office personnel. For most Navy weapon systems (the main exceptions being those for the FBM and Naval Nuclear Propulsion programs), the performance of maintenance and logistics is transferred from the program office to a service or logistics command after production. For Army systems, logistics planning occurs within the program office, but operations support comes from other support organizations within the program office's host command. The Air Force divides responsibilities between the Air Force Systems Command for system development and production and the Air Force Logistics Command for support.

FBM Program

Unlike most Navy weapon system program offices, SSP, its subsystem contractors, and selected subcontractors have life-cycle responsibility for the FBM program. This means that SSP has management control over all program phases (initial research, design, development, test, evaluation, production, maintenance, training, and fleet support) and all program aspects, including technical data, quality control, and reliability. Having total life-cycle responsibility bonds research and development decisions with implementation of those decisions later in the program and helps to focus attention on the long-term effects of each decision before implementation. It also provides a continuation of program policies, concepts, techniques, and control.

At SSP, the people responsible for the design of each piece of equipment are ultimately responsible for the consequences of that design, whether in terms of producibility, maintainability, or reliability. For example, SSP's decisions on the Trident I program in the early acquisition phases are today's logistics and maintenance realities. Thus, SSP has, in effect, a "cradle-to-grave" responsibility for program maintenance and material reliability because its maintenance and logistics responsibilities are not transferred to a service or logistics command after production, as is the case with most Navy weapon systems or with Air Force systems.

Contractors also are included in SSP's life-cycle responsibility. Their responsibility begins when they receive the requirements; continues through development, into production, and onto operational support; and ends when the system is retired or is replaced by an advanced system. Also, incentives expressing long-term life-cycle values are included in many of the developmental contracts as a means of reinforcing long-term performance considerations during the system design phases. For example, the Trident II missile subsystem contracts include reliability, accuracy, and other performance incentives. Incentive payments are based on results of test missiles flown over a 3-year period, including both development test missiles and production missiles flown by Navy crews during demonstration and shakedown operations and in evaluation tests after the missile's deployment. Similarly, the Trident II navigation subsystem's performance on the first 32 operational patrols, extending up to 4 years past the missile's deployment, will determine the final amount of the contractor's incentive payment.

Other Programs

None of the other acquisition programs studied had total life-cycle responsibility.

Continuity of Key Personnel

In 1986, we reported[2] that frequent personnel changes at the PM/deputy PM level indirectly hindered program stability and that defense PMs' tenures averaged about 27 months while deputies averaged 30 months. These periods of experience are relatively short, considering that the typical weapon system acquisition cycle spans 10 to 15 years. However, responding to PM turnover, the Congress provided, in Public Law 98-525, dated October 19, 1984, that a military PM's tour of duty "shall be (1) not less than four years, or (2) until completion of a major program milestone..."

FBM Program

In contrast to our 1986 report findings, we found that many officials said that the continuity of the FBM program's key personnel helped SSP keep the philosophy of the program and the infrastructure of the government/contractor relationship intact. This program's continuity has two major components. The first of these deals with SSP's PMs. In almost 35 years, the program has had six PMs with an average tenure of almost 6 years. (Only the Naval Nuclear Propulsion Program exceeds this average, with only three PMs over about 38 years.) The second is the key civilian personnel that have been with the program for many years.

From the outset, tours of duty at SSP were extended; SSP personnel have had long tenures and promotion opportunities within the program. Thus, newcomers to SSP are able to learn about the program and its operation from veteran personnel. Lessons learned from previous system variants by these personnel help to decrease the chances of repeating the same mistakes in current projects and enhance problem resolution when problems occur.

[2] Acquisition: DOD's Defense Acquisition Improvement Program: A Status Report (GAO/NSIAD-86-148, July 23, 1986).

Military Personnel Continuity

SSP has developed a military acquisition career path within its own headquarters and field organization. Four of SSP's six PMs "grew up" through a military career path in SSP, each serving as the Technical Director before being promoted to the PM with the rank of rear admiral. In addition, 30 percent of all military officers assigned to SSP have more than 10 years of FBM experience. This experience means that SSP management can explain the technical aspects of the program to all levels: the Congress, DOD, Navy, and contractors.

Civilian Personnel Continuity

A large number of key civilian personnel at SSP have been with and promoted within the program office for many years. For example, about 40 percent of SSP's headquarters civilian personnel have more than 10 years of experience in the FBM program. The average tenure of Senior Executive Service civilians at SSP headquarters is about 21 years. At SSP field organizations, many personnel have 20 or more years of FBM experience. By having worked on the earlier FBM variants, SSP's personnel are able to use this experience to resolve problems in the newer variants.

This same kind of experience occurs with FBM contractor personnel. For the most part, the same team of contractors that started with the program in the 1950s is still with the program. During one of our visits, contractor officials noted that they were the "new kids" in the FBM program, having only been in the program for about 21 years. Other contractors have many personnel that have worked with the FBM program 20 to 30 years. The effect of having experienced Navy and contractor personnel interacting with each other on a system that each has helped to develop facilitates the exchange of information and the resolution of problems.

Other Programs

Frequent turnover of personnel, especially at the PM level, may have affected two of the less than successful programs. The high PM turnover resulted in a loss of program expertise and corporate memory for both the Aquila and AMRAAM programs. However, the MLRS program's continuity of civilian personnel helped alleviate the negative effects of PM turnover. Also, the F-16 program benefitted from having PMs with longer tenure and prior experience in the program and from having civilian personnel continuity.

MLRS

The MLRS program benefitted from having several key officials that remained with the program for a decade or more. In particular, the civilian deputy PM stayed with the program for 11 years, from system development through deployment, and provided strong continuity in leadership.

F-16

The first five PMs served an average of over 3 years in that position. Also, five of the six PMs had background dealing with the program either internally as Deputy PM or externally, having served on the Air Staff or the Air Force Inspector General's staff.

Civilian personnel continuity also benefitted the F-16 program. The assistant PM, who has served in that position for 9 years, and two senior program control and financial management officials have each worked on the F-16 program for 13 or more years.

Aquila

From August 1978 through its termination in 1987, the Aquila program had six PMs with an average tenure of 19 months. This PM turnover may not have been conducive to the most effective Aquila development and acquisition effort. Army officials said that, except for PMs, continuity of key personnel was fairly good within the Aviation Systems Command in St. Louis, Missouri, and the Missile Command in Huntsville, Alabama. However, the transfer of program management to Missile Command almost completely disrupted staffing continuity, as only two individuals moved to Huntsville and a new PM was assigned.

A similar lack of personnel continuity occurred in the prime contractor's staff, where project manager turnover was also high. According to an Army program official, the contractor had four project managers over 7 years, three in the program's first 4 years. In addition, when the contractor moved its Aquila operations to Austin, Texas, many personnel, including some key officials, did not move with the program. Thus, the contractor lost much of its expertise and corporate memory on the program.

AMRAAM

Our 1987 AMRAAM report[3] stated that frequent turnover at the PM level may have adversely affected the AMRAAM program. From 1980 to 1984, five PMs were in charge of the program for various lengths of time. This resulted in the loss of corporate knowledge and historical perspective. It may also have caused cost and schedule problems to go unresolved longer than necessary.

[3] Missile Procurement: AMRAAM Cost Growth and Schedule Delays (GAO/NSIAD-87-78, Mar. 10, 1987).

Program Office Technical Expertise

In programs located within the services' major system commands, many of the technical staff are assigned from functional organizations outside the program office. For example, one fighter aircraft program office may have a staff of only 15 to 20 people, while another 90 or more people supporting the program office are part of the functional organizations within the Naval Air Systems Command. Unlike those in self-contained program offices, such as SSP, these support people may work on different programs concurrently.

One recent study of defense acquisition management[4] noted the following:

> "Most defense officials and contractors agree that the most appropriate type of management for a development or production program depends on several program characteristics. The greater the technical complexity, budget, concurrency, and importance of a program, the greater the need for a self-contained [program management office] with its more direct control of functional activities."

We believe the FBM program is one that fits this assessment.

FBM Program

To assist SSP in setting up its organization, the Navy allowed SSP's top management to hand pick those people with the appropriate technical expertise that would best help SSP achieve its goals. Thus, SSP is generally not dependent upon other Navy organizations for technical support because its personnel have the necessary in-house technical expertise to direct and evaluate contractor performance. For example, its Technical Division has primary responsibility for the development, test, production, installation, repair, maintenance, and fleet support of the FBMs; that is, the division is responsible for the entire weapon system's coordination, integration, and management. This is in contrast to many other program offices that use contractors as weapon system managers or technical staff from functional organizations outside the offices. This technical capability within the program office sets the FBM program apart from most other weapon system programs, with the major exception being the Naval Nuclear Propulsion Program.

SSP places a strong emphasis on evaluating the technical program management of its contractors. For example, SSP conducts contractor technical program management evaluations, which began early in the FBM program, to help it assess the effectiveness with which management

[4]Fox, J. Ronald, and James L. Field. The Defense Management Challenge: Weapons Acquisition. Boston, Massachusetts: Harvard Business School Press, 1988, pp. 158-159.

actions and technical disciplines are being implemented. Carrying out these evaluations effectively requires a high level of technical expertise within SSP.

Other Programs

The MLRS program was the only one studied in which in-house expertise played a significant role in its outcome. For most of its existence, this program had strong in-house technical expertise because the deputy PM hand selected a project office staff based on technical expertise in missile system acquisitions. However, beginning in 1988, Missile Command directed a transition to a new arrangement in which most of the staff working for this program belong to the Command's functional directorate rather than the project office.

Good Management Practices

Since the Polaris program, SSP has used various management practices. While not inclusive of all the practices used, five that have significantly contributed to the FBM program's success are

- open communication,
- independent internal evaluation,
- on-site management representation at contractor plants,
- strict configuration management for approved designs and manufacturing processes, and
- incentive contracting at the prime level and extensive competition at the subcontract level.

FBM Program

The openness for communication in the FBM program has led to recognizing problems as they develop, openly discussing them, and working to resolve them. This practice, as well as others, has enabled SSP to ensure that the weapon system meets performance and design requirements and has contributed to the program's success. According to the third PM, much of the credit of the FBM program's success belongs to the first PM, who established various management practices that were critical to the program's success. He added that these practices encouraged an openness for communication between SSP and the contractors, which he believes is one of the program's hallmarks.

Open Communication

SSP officials characterized their communications as "open" with all FBM program participants. They define this open communication in the following way: If there is a problem, bring it forward and start to solve it, because hiding problems only makes them get worse—in other words, "don't kill the messenger."

In addition to emphasizing solutions versus punishment, SSP encourages early problem recognition by having a team approach that fosters openness between contractor and government personnel and that, according to SSP and contractor officials, promotes an open discussion of problems in seeking resolution. Problems and possible solutions may be discussed during weekly staff meetings,[5] quarterly Steering Task Group meetings,[6] and Technical Director's reviews. Also, FBM submarine crews provide feedback on problems encountered during patrols, either by reports or post-patrol reviews.

Since the program's inception, SSP's philosophy has been to inform the Congress and DOD of the program's progress. This type of communication has built a sense of credibility outside the program office that has benefitted SSP.

Independent Internal Evaluation

SSP's internal evaluation branch, known as SP-12, monitors program progress on a continuous basis at all levels of management by reviewing contractor progress reports, internal SSP progress reports, and evaluations of contractor efforts independent of SSP's Technical Division. SP-12's forum for communicating to the PM is the weekly staff meeting.

On-Site Representation

SSP has an extensive network of on-site management representatives in field offices at its contractors that report monthly to the PM. Some field offices have over 100 SSP personnel on site at contractor and government facilities that act as SSP's technical representatives and administrative contracting officers. In addition, SP-12 personnel visit field offices and contractor plants to collect information for their independent evaluations.

Strict Configuration Management

SSP has a strict configuration management policy regarding changes to successfully tested and approved designs and manufacturing processes. This so-called "no-change policy" recognizes that the various components that constitute the weapon system have many subtle interactions. Experience has shown SSP that seemingly trivial changes in a design or

[5]SSP branch management and selected contractors report to SSP's top management on significant changes, short- and long-range milestones, contract milestones, and funding. SSP field offices also report in a similar manner each month.

[6]This group is comprised of senior representatives from subsystem prime contractors, officials from government agencies directly involved in the program (including the Department of Energy's nuclear weapons laboratories), military customers who use the system, and SSP Technical Division staff.

in the manner in which it is produced can cause unpredictable and, sometimes, serious consequences to the program. Therefore, once a design and a method of production have been evaluated and proven through testing (in the case of the missile, flight testing), the design and the manufacturing processes and procedures are fully documented, and SSP enforces a strict control system thereafter. This system ensures that components are manufactured using the same design and manufacturing processes and procedures, thereby assuring that production units will be as acceptable as those proven successful through testing.

Contracting Philosophy

SSP has used most of the same contractors for more than 30 years without significant competition at the prime level for most subsystems, but extensive competition is pursued at the subcontract level. SSP believes that the absence of competition at the prime level has helped it to foster a good working relationship with its contractors.

The guidance subsystem—the only subsystem with ongoing competition at the prime level—has been cited as a model for competition, due to its being the best example of a cost and technical competition working together to support the program's goals. Prime contractors compete for each year's production of the Trident II guidance subsystem's components. The fiscal year 1988—the 15th—Trident submarine contract was competed and won by the builder of the previous 14 Trident submarines. However, the other five subsystem prime contracts were not competed.

With respect to subcontractor competition, as of January 1990, the Trident II (D-5) program had met or exceeded goals set for five of six subsystems. In most cases, the subsystem goals were set equal to or higher than the Trident I (C-4) program's achievements.

Starting with the Poseidon program, SSP has used incrementally funded, multiple year contracts covering full-scale development and initial production. SSP has refined this technique in the Trident missile programs. Because most fixed-price incentive contracts can only put an incentive on price, SSP uses cost-plus-incentive fee contracts through which it can include reliability, accuracy, and other performance incentives. SSP found that the considerable time and effort spent in negotiating the incentive structure for these contracts have served the program well. The negotiating process forces SSP to sort out and quantify program objectives and priorities. Consequently, contractors can make the needed trade-offs during their development and design work to achieve performance or production incentives during later stages of work.

Former senior Navy acquisition officials said that performance incentives had been successful in some Navy aircraft contracts but not in some torpedo and antiair missile contracts. One official noted that these incentives (1) do not cost a lot of money, (2) involve a lot of pride on the part of a contractor to make the product work, and (3) require a program office that understands the product.

Other Programs

In the other programs studied, various methods of communication, such as regular meetings and reviews, were used that appeared to be similar to those used in the FBM program. However, only the successful program offices focused on early problem recognition and resolution. For example, the MLRS PM said that weekly and daily meetings between lower level engineers in the program office and the prime contractor were used to bring issues to management's attention. Formal quarterly reviews between upper level management also were oriented to resolving problems. Similarly, F-16 program officials said that communication within the program office and outside with other Air Force officials, the contractors, and the participating foreign governments was a key to the program's success.

None of the other programs studied had an independent internal evaluation group. In addition, on-site defense contract administrative services personnel or their program office personnel were usually used in the other successful programs to collect information on contractor progress. On-site representatives were used in a manner similar to that used by SSP in the successful MLRS program and the less than successful AMRAAM and SUBACS programs. However, the number of program representatives ranged from one to eight, significantly less than the number used by SSP.

Only the F-16 program office emphasized configuration management to the extent that it was similar to SSP's no-change policy. Cost control considerations and the need to maintain commonality between the various aircraft configurations were the basis for the F-16 program's policy restricting the amount of changes by setting a $100,000 per unit limit on configuration changes. The other program offices generally made design changes and modified production articles that were built to earlier designs. For example, the AMRAAM design still has not stabilized, although the missile is in limited production.

Applicability to Other Defense Acquisitions

In the acquisition programs studied, we found that each program's success or lack of success was the result of multiple causes. The successful programs shared more of the FBM program's significant features than the less than successful programs. However, the features contributing to the FBM program's success are not necessarily the only features that are required for a program to be successful. The other successful programs had features that were either not present or not significant in the FBM program. Also, in contrast, the less than successful programs had some of the FBM program's features. In other words, similar features in different acquisition programs can have different outcomes. For example, although PM turnover had little or no effect on the successful MLRS program, it proved to be a significant problem in the less than successful Aquila program.

We found no guaranteed cookbook approach to a successful defense acquisition. Each of the acquisition programs studied developed in a unique environment with its own particular opportunities and problems. Many conditions and situations contributing to the FBM program's success are unique to that program and may not be repeated for other defense acquisitions. For example, the United States was operating under a great sense of urgency to develop the FBM system as soon as possible. Thus, since its beginning, the program has held the highest defense acquisition priority, and the Congress has regularly appropriated the funds requested for the program. However, while stable and sufficient early funding lend stability to a program, officials told us that availability of funds is not necessarily sufficient for success.

The FBM program is the only program studied that had life-cycle responsibility. As such, SSP is involved not only in the development and production of a new missile but also in the effects of earlier year decisions on logistics and maintenance for the earlier missiles in operation. SSP also emphasizes the long-term view in its decision-making and in contracting by structuring contracts to include long-term performance incentives and cost incentives, which is unlike most programs. Also, most program offices developing systems incorporate logistics support, but they do not have to live with the effects of their decisions because the support responsibility is transferred to another organization.

As noted in earlier reports, high PM turnover is common in weapon system acquisitions and is not conducive to effective program management and program stability. The FBM program shows the benefits of PM continuity, and the MLRS program shows that continuity at the civilian deputy PM level can alleviate the negative effects of PM turnover.

Civilian personnel continuity and program office technical expertise give SSP experience and program knowledge for negotiations with contractors and for effective oversight of contractors. However, most program offices do not have continuity and expertise similar to those in SSP. The others have not built and fielded six generations of their weapon system like SSP. Only the MLRS program shared the benefit of having the project office staff hand selected based on their prior expertise.

The good management practices used in the FBM program are not necessarily unique to that program. For example, SSP's communication practices are not necessarily different in the type and number of meetings or reviews, but SSP uses a team approach and encourages openness in order to surface, address, and resolve problems. This approach, which is made possible by the continuity and technical expertise of SSP's staff and its contractors' managers and staff, has contributed to the program's success.

tended not to share as many of the model's features. This corroborates the Commission's view that these features are more likely to contribute to a program's being successful than if they are not in place. (Table 3.1 shows which acquisition programs studied had features similar to those in the model.)

Table 3.1: Comparison of the Features of the Acquisition Programs Studied With the Commission's Acquisition Model Features

	Acquisition program					
	Successful			Less than successful		
Management feature	FBM	MLRS	F-16	SUBACS[a]	Aquila	AMRAAM
Clear command channels	X	X	X	X	X	X
Stability	X	X	X			
Limited reporting requirements	X					
High quality staff	X	X	b	b	b	b
Communications with users	X	X	X		X	
Prototyping and testing	X	X	X	X	X	X

[a]As noted in app. II, the SUBACS program was restructured and a portion was renamed AN/BSY-1

[b]Signifies "insufficient information to compare."

Although many of the programs contained elements of the model's features, program office definitions of specific features did not match the model's definitions. For example, command channels were uniformly described as being "clear" within the service's traditional service structure. However, each service implemented the Commission's recommendations concerning clear command channels differently, which, except for the direct-reporting SSP PM, negated having limited reporting requirements.[2]

While all of these management features may not be incorporated in a particular defense acquisition program, these features may improve an acquisition program's chances for success. However, the presence of these features does not guarantee success. For example, two of the programs we studied, the F-16 and the MLRS, did not possess all of the model's management features but were still considered successes. Also, as all six programs had prototyping and testing, the type and extent of prototyping and testing—the quality, quantity, adequacy, and use of test results, not just their existence—apparently made a difference in the programs' successes; for example, the F-16 program benefitted from the successful Lightweight Fighter Prototype Program.

[2]Acquisition Reform: DOD's Efforts to Streamline Its Acquisition System and Reduce Personnel (GAO/NSIAD-90-21, Nov. 1, 1989).

Definitions of the Packard Commission Model's Features

The following are the six underlying features that typified the most successful commercial programs, as defined in the Packard Commission's "Acquisition Model to Emulate."[1]

"1. Clear Command Channels. A commercial program manager has clear responsibility for his program, and a short, unambiguous chain of command to his CEO [chief executive officer], group general manager, or some comparable decision-maker. Corporate interest groups, wishing to influence program actions, must persuade the responsible program manager, who may accept or reject their proposals. Major unresolved issues are referred to the CEO, who has the clear authority to resolve any conflicts.

"2. Stability. At the outset of a commercial program, a program manager enters into a fundamental agreement or 'contract' with his CEO on specifics of performance, schedule, and cost. So long as a program manager lives by this contract, his CEO provides strong management support throughout the life of the program. This gives a program manager maximum incentive to make realistic estimates, and maximum support in achieving them. In turn, a CEO does not authorize full-scale development for a program until his board of directors is solidly behind it, prepared to fund the program fully and let the CEO run it within the agreed-to funding.

"3. Limited Reporting Requirements. A commercial program manager reports only to his CEO. Typically, he does so on a 'management-by-exception' basis, focusing on deviations from plan.

"4. Small, High-Quality Staffs. Generally, commercial program management staffs are much smaller than in typical defense programs, but personnel are hand-selected by the program manager and are of very high quality. Program staff spend their time managing the program, not selling it or defending it.

"5. Communications with Users. A commercial program manager establishes a dialogue with the customer, or user, at the conception of the program when the initial trade-offs are made, and maintains that communication throughout the program. Generally, when developmental problems arise, performance trade-offs are made—with the user's concurrence—in order to protect cost and schedule. As a result, a program manager is motivated to seek out and address problems, rather than hide them.

"6. Prototyping and Testing. In commercial programs, a system (or critical subsystem) involving unproven technology is realized in prototype hardware and tested under simulated operational conditions before final design approval or authorization for production. In many cases, a program manager establishes a 'red team,' or devil's advocate, within the program office to seek out pitfalls—particularly those that might arise from operational problems, or from an unexpected response by a

[1] A Quest for Excellence: Final Report to the President by the President's Blue Ribbon Commission on Defense Management, June 1986, pp. 49-51.

competitor. Prototyping, early operational testing, and red teaming are used in concert for the timely identification and correction of problems unforeseen at a program's start."

The Six Defense Acquisition Programs Studied

Fleet Ballistic Missile Program

The FBM weapon system, operational since November 15, 1960, consists of nuclear-powered submarines carrying nuclear-tipped ballistic missiles. (Figure II.1 shows the relative size of each generation of FBM submarine, and table II.1 provides information on FBM submarines.)

Figure II.1: FBM Submarine Class Comparison

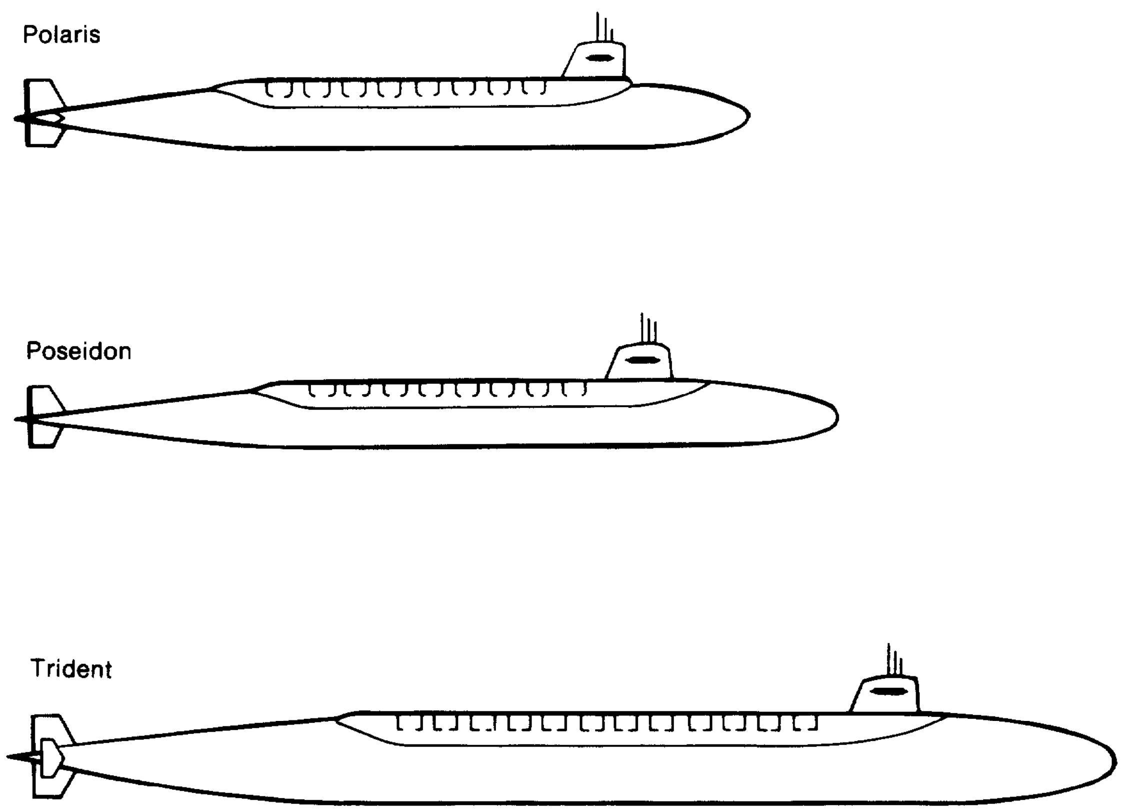


Table II.1: FBM Submarine Comparison

	Polaris 598 class	Polaris 608 class	Poseidon 616/627/640 class	Trident 726 class
Length (feet)	382	410	425	560
Beam (feet)	33	33	33	42
Submerged displacement (tons)	6,700	7,900	8,250	18,700
Number in class	5	5	31	21[a]
Missiles				
Number	16	16	16	24
Type	Polaris	Polaris	Poseidon or Trident I	Trident I or Trident II

[a]The Selected Acquisition Report contains a total of 13 Trident submarines, additionally, the eight Trident I submarines will be modified to Trident II capability

The latest missile—the Trident II (D-5)—began full-scale development in October 1983 and was initially deployed in March 1990. This missile will be deployed on the ninth and subsequent Trident submarines. The first eight Trident submarines are currently deployed with the Trident I (C-4) missile, but the Navy plans to modify these submarines for Trident II missile capability. (Figure II.2 shows the relative size of each generation of FBM, and table II.2 provides information on FBM characteristics.)

Figure II.2: Six Generations of FBMs

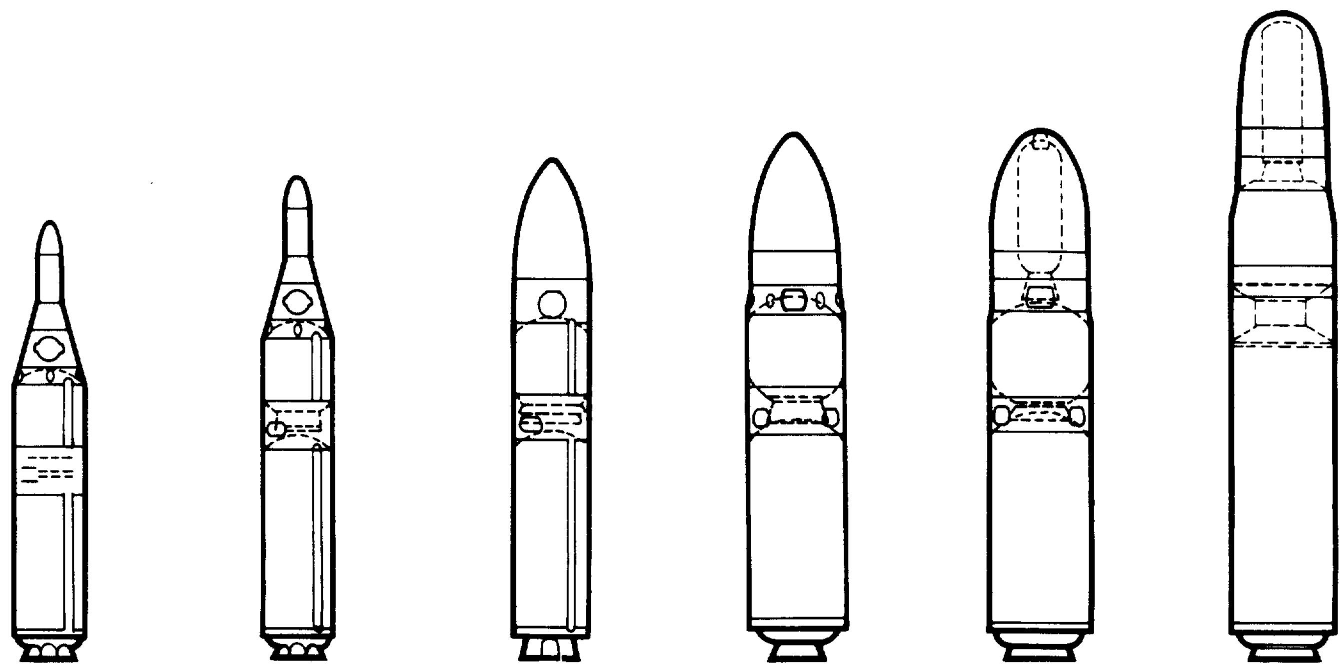


Table II.2: FBM Comparison

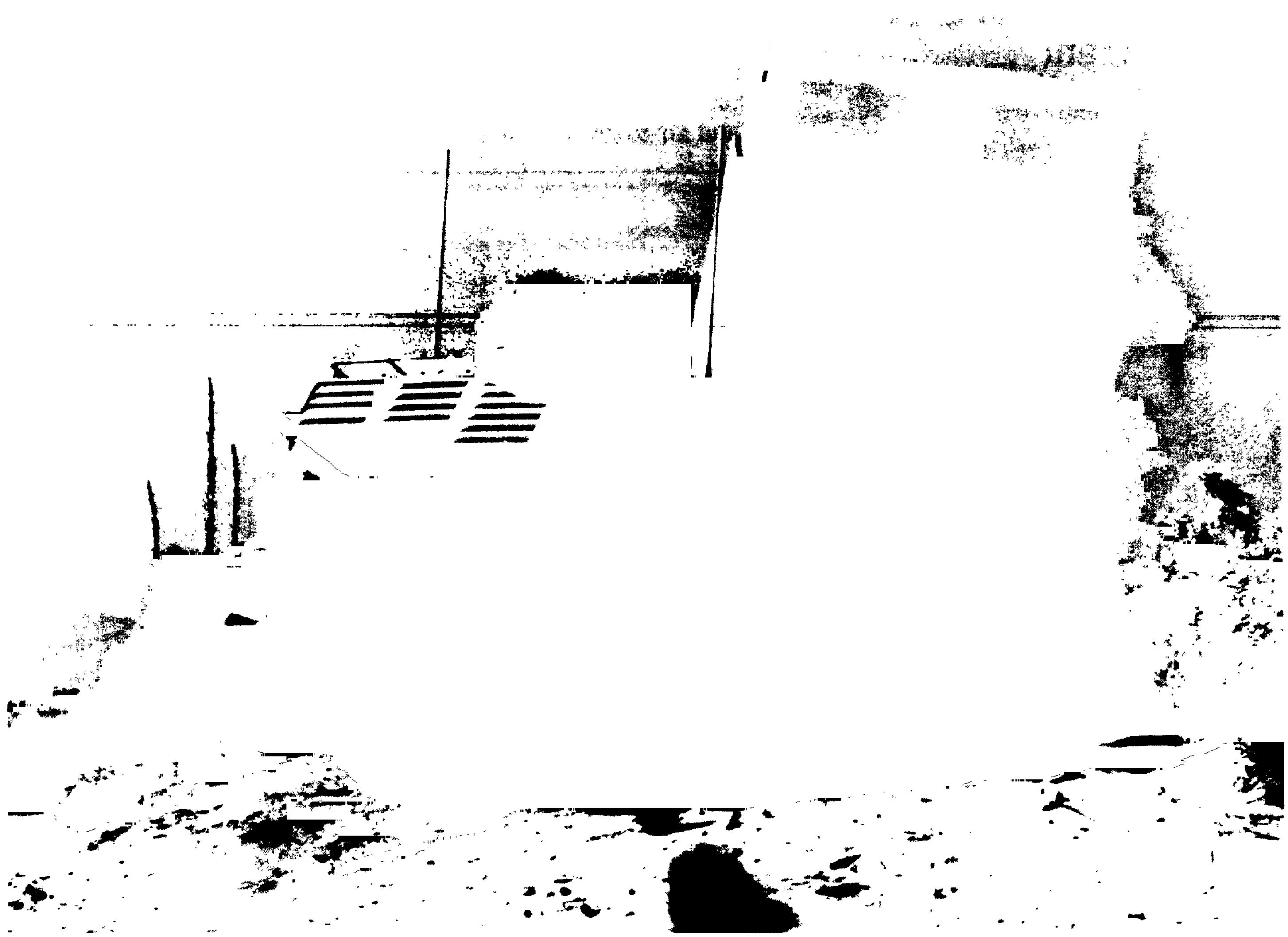
	Polaris A-1	Polaris A-2	Polaris A-3	Poseidon C-3	Trident I C-4	Trident II[a] D-5
Length (feet)	28.5	31	32	34	34	44
Diameter (inches)	54	54	54	74	74	83
Weight (pounds)	28,800	32,500	35,700	64,000	73,000	130,000
Range (nautical miles)	1,200	1,500	2,500	2,500	4,000	4,000
Year deployed	1960	1962	1964	1971	1979	1990
Year retired	1965	1974	1982			
Number of missiles (includes test missiles)	205	374	699	640	595	899

[a]Specifications are approximate; quantities are based on Selected Acquisition Report estimates.

Multiple Launch Rocket System Program

The Army's MLRS is an unguided, surface-to-surface artillery rocket system (see fig. II.3) that can provide a high volume of fire in a short period of time. It began development in 1976 and achieved initial operational capability in 1983, and the Army entered its second multiyear production contract in fiscal year 1989.

Figure II.3: The MLRS



Source: DOD

The MLRS program is considered a success in terms of meeting its cost, schedule, and performance goals. Because of a successful accelerated development program, the system was fielded in less than 7 years. Some program features that stand out as important contributors to the program's success include (1) low-risk technology, (2) stable requirements, (3) adequate funding and strong support from the Army, the Office of the Secretary of Defense, and the Congress, (4) strong leadership and good continuity in key personnel, and (5) an innovative acquisition strategy.

F-16 Program

The F-16 is a single engine, lightweight, highly maneuverable fighter (see fig. II.4) that is currently coproduced by the Air Force and four North Atlantic Treaty Organization nations. The F-16 performs in both air-to-air and air-to-ground missions.

Figure II.4: The F-16

Source: DOD

The F-16 began full-scale development in 1975 and reached initial operational capability in October 1980. As of April 1990, 1,637 F-16 aircraft had been delivered to the Air Force. F-16C/D aircraft, currently being built, are operational at 13 U.S. Air Force bases, and F-16 aircraft are deployed by 12 nations. The F-16 program office continues to manage sales of several F-16 configurations to foreign countries.

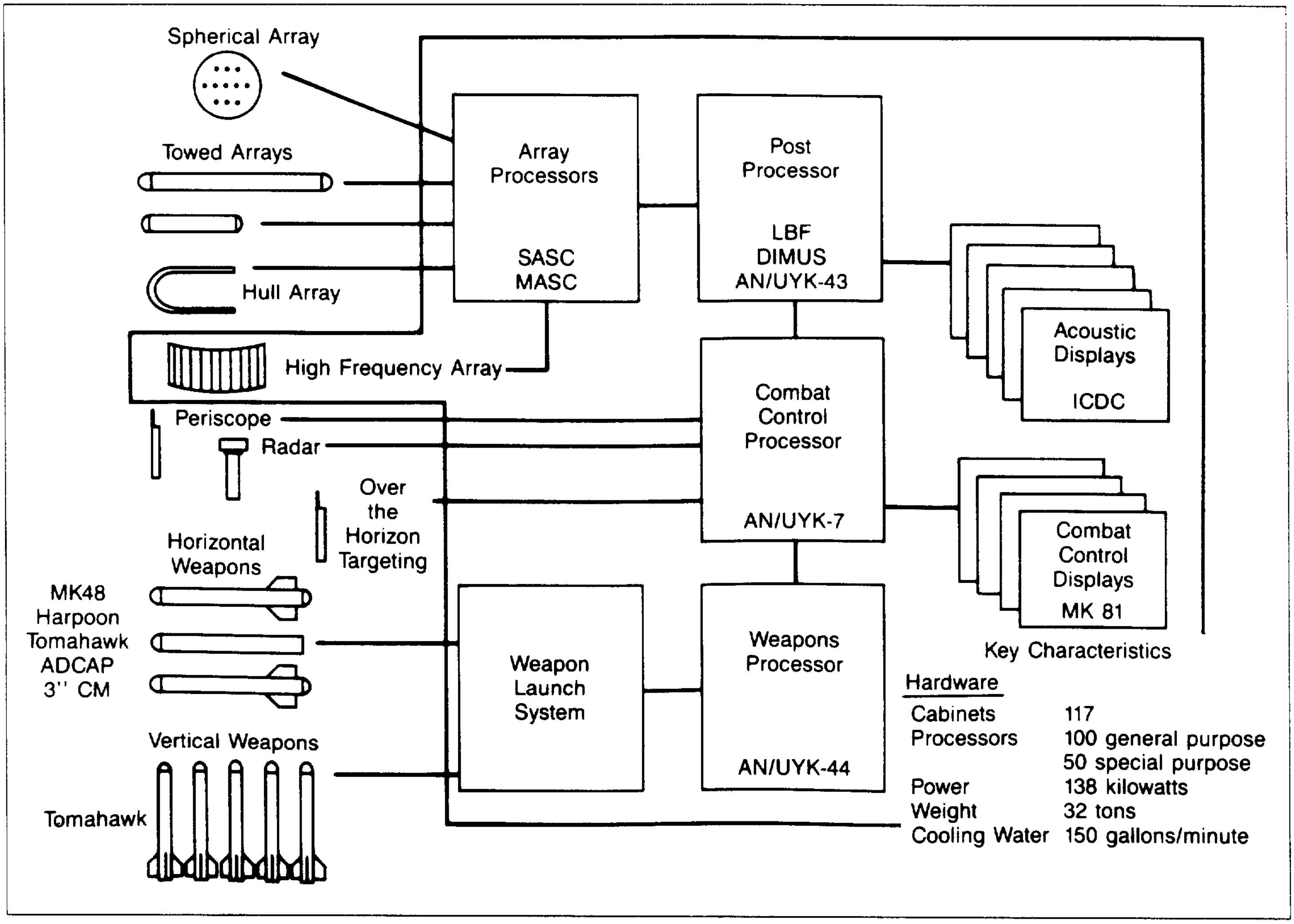
F-16 officials cited program stability as a key to the success of the program. Several characteristics combined to create program stability. These characteristics are (1) adequate funding throughout the program, (2) reduced technical risk resulting from the Lightweight Fighter Prototype Program, (3) lack of initial performance requirements, (4) emphasis on cost containment since the program's inception, and (5) multinational coproduction, which provided strong incentives to minimize design changes and cost increases.

Submarine Advanced Combat System Program

In 1980, the Navy began to develop an advanced combat system for improved SSN-688 class submarines authorized in fiscal years 1989 and beyond. The SUBACS began as a single-phased program to meet the Soviet antisubmarine warfare threat through the 1990s. However, in October 1983, the Secretary of Defense approved a Navy plan to accelerate, by 6 years, SUBACS development and to introduce it in three phases—SUBACS Basic, SUBACS A, and SUBACS B—for improved SSN-688s authorized in fiscal years 1983 and beyond. The three-phased approach was undertaken so that additional capabilities could be introduced earlier than planned and to spread program risks and costs over time.

The SUBACS program, considered less than successful, encountered technical, schedule, and cost problems during full-scale development, which led to several program restructures. The last restructure redesigned the SUBACS Basic effort and resulted in renaming the program the AN/BSY-1. The AN/BSY-1 will provide improved capabilities in acoustics and weapon launch areas but will not provide the SUBACS Basic's planned growth potential and reliability improvements. Deliveries of the 24 required AN/BSY-1 systems began in 1987. The AN/BSY-1 Combat Control and Acoustics System is shown in figure II.5. In addition, the Navy combined the SUBACS A and SUBACS B performance requirements and renamed the effort AN/BSY-2, which is to be installed on SSN-21 attack submarines.

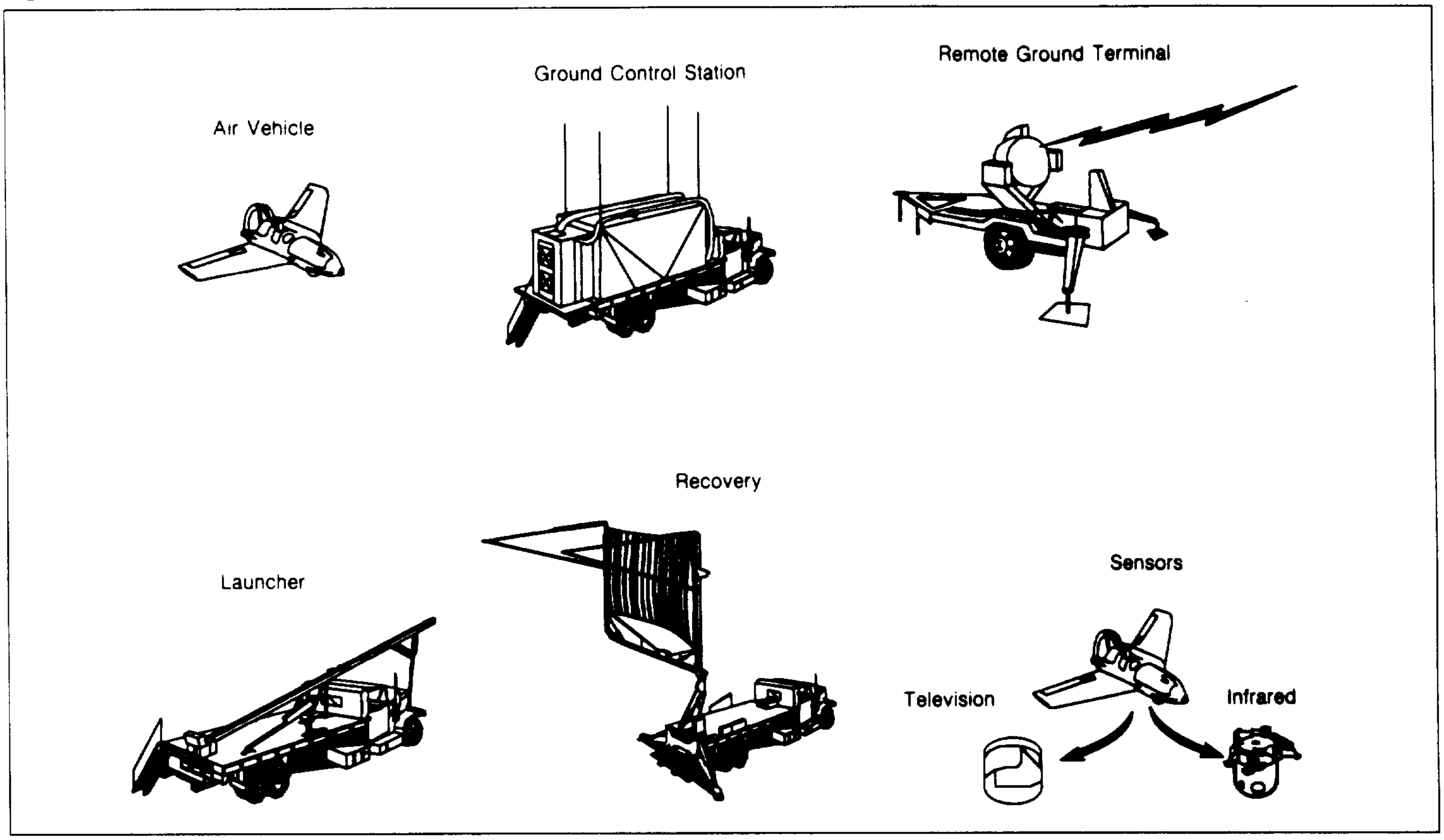
Figure II.5: AN/BSY-1 Combat Control and Acoustics System



Aquila Program

The Army's Aquila remotely piloted vehicle was a small, unmanned aircraft that was designed to conduct battlefield surveillance and target acquisition over enemy territory. The Army began developing the Aquila in 1974 and canceled the program in December 1987. The Aquila system's major components are shown in figure II.6.

Figure II.6: Major Components of the Aquila System



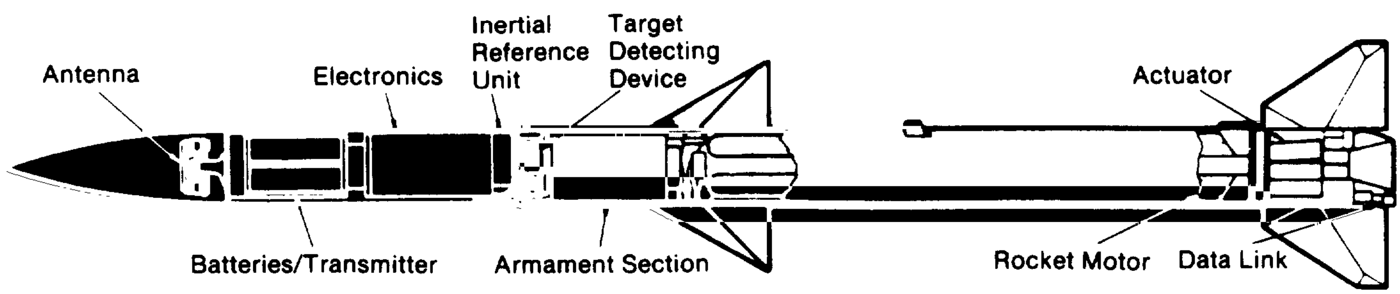
The Aquila program is considered less than successful because it did not meet its cost, schedule, and performance goals. After more than 13 years of development and costs of about $800 million, the system never entered production.

Several factors stand out as significant features of the Aquila's development history, which in combination may have contributed to the program's demise. These factors are (1) unstable funding, (2) unstable program management, (3) changing requirements, (4) limited support from the Army, and (5) the system's poor performance during field operational testing.

Advanced Medium Range Air-To-Air Missile Program

The primary objective of the AMRAAM program is to produce an all-weather, medium-range missile that will enable a pilot to simultaneously engage multiple aircraft in combat. The missile (see fig. II.7) is to destroy targets both within and beyond the pilot's visual range and is to be compatible with the Air Force and Navy's latest fighter aircraft. Since 1976, the Air Force and the Navy have been jointly developing AMRAAM to meet their future air-to-air missile requirements.

Figure II.7: The AMRAAM



Since its inception, the AMRAAM program has experienced significant cost growth and schedule delays, and the missile's present operational capability is uncertain. A number of factors may have contributed to these problems, including (1) unrealistic cost and schedule estimates during the program's early phases, (2) an unstable design throughout development, and (3) a high degree of turnover at the PM level.

GAO Reports Used in Our Review

Defense Acquisition

Defense Acquisition: Perspectives on Key Elements for Effective Management (GAO/NSIAD-90-90, May 14, 1990)

Defense Acquisition Programs: Status of Selected Systems (GAO/NSIAD-90-30, Dec. 14, 1989)

Acquisition Reform: DOD's Efforts to Streamline Its Acquisition System and Reduce Personnel (GAO/NSIAD-90-21, Nov. 1, 1989)

Defense Management: Status of Recommendations by Blue Ribbon Commission on Defense Management (GAO/NSIAD-89-19FS, Nov. 4, 1988)

Major Acquisitions: Summary of Recurring Problems and Systemic Issues: 1960-1987 (GAO/NSIAD-88-135BR, Sept. 13, 1988)

Procurement: Assessment of DOD's Multiyear Contract Candidates (GAO/NSIAD-88-233BR, Sept. 1, 1988)

DOD Acquisition Programs: Status of Selected Systems (GAO/NSIAD-88-160, June 30, 1988)

DOD Acquisition Programs: Status of Selected Systems (GAO/NSIAD-87-128, Apr. 2, 1987)

Acquisition: DOD's Defense Acquisition Improvement Program: A Status Report (GAO/NSIAD-86-148, July 23, 1986)

DOD Acquisition: Strengthening Capabilities of Key Personnel in Systems Acquisition (GAO/NSIAD-86-45, May 12, 1986)

Why Some Weapon Systems Encounter Production Problems While Others Do Not: Six Case Studies (GAO/NSIAD-85-34, May 24, 1985)

Impediments To Reducing The Costs Of Weapon Systems (PSAD-80-6, Nov. 8, 1979)

Fleet Ballistic Missile

Navy Strategic Forces: Trident II Proceeding Toward Deployment (GAO/NSIAD-89-40, Nov. 21, 1988)

Observations on the Defense Enterprise Program (GAO/T-NSIAD-87-26, Apr. 2, 1987)

Trident II System: Status and Reporting (GAO/NSIAD-84-86, May 15, 1984)

Information Regarding Trident II (D-5) Missile Configured Trident Submarine Costs and Schedule (GAO/MASAD-82-47, Sept. 3, 1982)

MLRS

Defense Budget: Potential Reductions to the Army and the Navy Missile Budgets (GAO/NSIAD-90-29, Nov. 13, 1989)

Defense Budget: Potential Reductions to Missile Procurement Budgets (GAO/NSIAD-89-17, Nov. 18, 1988)

Defense Budget: Potential Reductions to Missile Procurement Budgets (GAO/NSIAD-87-206BR, Sept. 10, 1987)

Defense Budget: Potential Reductions to Army and Marine Corps Missile Budgets (GAO/NSIAD-86-158BR, Aug. 6, 1986)

An Assessment Of The Army's Multiple Launch Rocket System Multiyear Contract (GAO/NSIAD-86-5, Oct. 28, 1985)

GAO Analysis of Projects Proposed by the Department of Defense for Multiyear Contracting in its Fiscal Year 1983 Budget Request (PLRD-82-72, Apr. 29, 1982)

The Army's Multiple Launch Rocket System Is Progressing Well And Merits Continued Support (MASAD-82-13, Feb. 5, 1982)

Budgetary Pressures Created By The Army's Plans To Procure New Major Weapon Systems Are Just Beginning (MASAD-82-5, Oct. 20, 1981)

F-16

Procurement: An Assessment of the Air Force's F-16 Aircraft Multiyear Contract (GAO/NSIAD-86-38, Feb. 20, 1986)

F-16 Integrated Logistics Support: Still Time To Consider Economical Alternatives (LCD-80-89, Aug. 20, 1980)

Status Of The Air Force's F-16 Aircraft Program (PSAD-78-36, Apr. 24, 1978)

Contract for the Development and Production of F-16 Aircraft (PSAD-78-3, Oct. 21, 1977)

Operating And Support Costs Of New Weapon Systems Compared With Their Predecessors (LCD-77-429, Oct. 17, 1977)

Sharing The Defense Burden: The Multinational F-16 Aircraft Program (PSAD-77-40, Aug. 15, 1977)

Status Of The F-16 Aircraft Program (PSAD-77-41, Apr. 1, 1977)

SUBACS and AN/BSY-1

Navy Acquisition: Cost, Schedule, and Performance of New Submarine Combat Systems (GAO/NSIAD-90-72, Jan. 31, 1990)

Navy Contracting: Fiscal Year 1986 Contract Award for Construction of SSN 688 Submarines (GAO/NSIAD-87-120, May 4, 1987)

Navy Acquisition: SUBACS Problems May Adversely Affect Navy Attack Submarine Programs (GAO/NSIAD-86-12, Nov. 4, 1985)

Aquila

Aquila Remotely Piloted Vehicle: Its Potential Battlefield Contribution Still in Doubt (GAO/NSIAD-88-19, Oct. 26, 1987)

Aquila Remotely Piloted Vehicle: Recent Developments and Alternatives (GAO/NSIAD-86-41BR, Jan. 4, 1986)

Results Of Forthcoming Critical Tests Are Needed To Confirm Army Remotely Piloted Vehicle's Readiness for Production (GAO/NSIAD-84-72, Apr. 4, 1984)

DOD's Use Of Remotely Piloted Vehicle Technology Offers Opportunities For Saving Lives and Dollars (MASAD-81-20, Apr. 3, 1981)

Status Of The Remotely Piloted Aircraft Programs (PSAD-77-30, Feb. 18, 1977)

AMRAAM

Missile Procurement: Further Production of AMRAAM Should Not Be Approved Until Questions Are Resolved (GAO/NSIAD-90-146, May 4, 1990)

Weapon Acquisition: Improving DOD's Weapon Systems Acquisition Reporting (GAO/NSIAD-90-20, Nov. 14, 1989)

Missile Procurement: AMRAAM Not Ready for Full-Rate Production (GAO/NSIAD-89-201, Sept. 7, 1989)

DOD Acquisition Programs: Status of Joint Major Programs (GAO/NSIAD-89-158, July 17, 1989)

Missile Development: AMRAAM's Combat Effectiveness at Production Not Fully Tested (GAO/NSIAD-88-186, July 7, 1988)

Missile Development: Development Status of the Advanced Medium Range Air-To-Air Missile (GAO/NSIAD-87-168, Aug. 14, 1987)

Missile Procurement: Advanced Medium Range Air-to-Air Missile Preproduction Test Results (GAO/NSIAD-87-165FS, June 2, 1987)

Missile Procurement: AMRAAM Cost Growth and Schedule Delays (GAO/NSIAD-87-78, Mar. 10, 1987)

Missile Development: Advanced Medium Range Air-To-Air Missile (AMRAAM) Certification Issues (GAO/NSIAD-86-124BR, July 9, 1986)

Missile Development: Advanced Medium Range Air-To-Air Missile Legal Views and Program Status (GAO/NSIAD-86-88BR, Mar. 28, 1986)

Missile Development: Status of Advanced Medium Range Air-To-Air Missile (AMRAAM) Certification (GAO/NSIAD-86-66BR, Feb. 18, 1986)

The Advanced Medium Range Air-To-Air Missile: Resolve Uncertainties Before Production (GAO/NSIAD-84-18, May 7, 1984)

Major Contributors to This Report

National Security and International Affairs Division, Washington, D.C.

Brad Hathaway, Associate Director
Bernard Easton, Assistant Director
Fred Fenstermaker, Project Manager
Timothy Morrison, Deputy Project Manager
Sarah Brady, Evaluator
Toni Townes, Evaluator
Ann Baker, Evaluator
Karen Creller, Evaluator
Beth Hoffman, Evaluator

Ordering Information

The first five copies of each GAO report are free. Additional copies are $2 each. Orders should be sent to the following address, accompanied by a check or money order made out to the Superintendent of Documents, when necessary. Orders for 100 or more copies to be mailed to a single address are discounted 25 percent.

U.S. General Accounting Office
P.O. Box 6015
Gaithersburg, MD 20877

Orders may also be placed by calling (202) 275-6241.