Defective Defense

How the Pentagon Buys Weapons That Do Not Work

By

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and

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ISBN # 0-936758-23-6
Printed in the United States of America

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This report is dedicated to all the quiet patriots
who have ethically blown the whistle
on America's defective defense.

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FOREWORD

This report, *Defective Defense*, focuses only on defective weapon systems and their procurement environment. The list of these failures is long enough and spread over enough time to warrant a more cumulative analysis than contemporary journalism has provided. Taken together, these product deficiencies present cumulative concerns that invite more systematic responses. Too often, the patterns of breakdown affecting these systems are exposed, reported and judged in isolation from the subeconomy that produces them in such a substandard and costly manner. By connecting over three dozen of these procurement missions in a catalogue, the authors, Louis Nemeth and Kukula Kapoor Glastris, clarify the fault-lines of this subeconomy which repeat themselves in predictable scenarios of misbehavior.

What emerges is a triangle of institutions, spearheaded by large defense contractors, the Defense Department and the Congress, which, though sometimes squabbling in public, manages to resist the entry of any fundamental forces to change the dynamics which have led to so many weapons debacles. Neither criticism nor perturbation by media, citizen groups, prosecutors or very occasional civil litigants seem to affect the stability of poor quality control. Other potential sources of energetic change -- the organized science and engineering professions, taxpayers upset over this waste of their assets, or competitive alternatives -- have yet to materialize. In short, the power of this triangle, notwithstanding some dissenting currents within its boundaries, is so secure that it need not sanction or remedy its failure to perform accountably. The cloak of sovereign immunity which substantially protects government agencies, their officials and private military contractors limits their liability in law and encourages their sense that the benefits of lack of due care exceed its costs.

The struggle among pressing needs for the federal dollar in a deficit-ridden federal budget dictates that scrutiny for structural corrections is a high priority. Moreover, the mutual mellowing of the arms race between the superpowers provides a more enabling climate for such attentiveness.

This report strives to stimulate a more embracing motivation for reform than has been furthered by piecemeal expressions of dismay or media scoops that are afforded little followthrough. Clearly, another commission of former officials or expatriates from this triangle will not be very bold or very fruitful. What is needed is an exogenous pressure devoid of self-censorship and replete with the energy characteristic of a wider constituency in our country that wants to see results instead of inert recommendations. The likely leaders of this constituency are everywhere -- in business, academia, social service and other citizen groups, labor and religious institutions. We must never forget that there has always been a deep and unresigned public frustration about waste, shoddy workmanship and fraud in government procurement. It is time for those likely leaders to turn that consensus into a driving reality.

Ralph Nader
Washington, D.C.

INTRODUCTION

The Changing Face of Conflict

The World War I soldier went to the front with a rifle, a couple of grenades and a knife. He could expect support from tanks, cannon and, late in the war, aircraft. In the field he would encounter similarly armed opposing forces. Simple methods brought gruesome results: the bloodshed prompted the conflict to be called "the war to end all wars."

World War II furthered the advent of "mechanized slaughter," introducing radar, missiles and atomic weapons to the world.

Post-World War II military development has focused heavily on technology. Advanced jet fighters, nuclear-powered and -armed ships and submarines, heat-seeking and radar-guided missiles, satellite reconnaisance, and computerized weapons have all radically altered the scenarios for potential future conflicts and raised the possibility of a "war to end all worlds."

New warfare technology has changed the face of conflict. Infantry combat at the front is no longer the primary focus of military planning. Future battles will be waged by weapons fired and guided by computers and satellites dozens, hundreds, or even thousands of miles away from their targets.

Accordingly, the role of the soldier has also changed. Proponents of high-tech weaponry proclaim its ability to improve warfare effectiveness for tomorrow's soldiers. But this devotion to high-tech has resulted in weapons that ignore the physicial and psychological limitations of the people who use them. The F-16 fighter can maneuver so fast and make such sharp turns, for example, that pilots can lose consciousness without warning. The F-18 fighter, dubbed "the porcupine" by pilots, has a throttle with nine switches, each handling numerous functions. The jet console has 59 indicator lights, displays 73 messages in 40 different formats with 675 acronyms and sounds six different warning tones -- all of which pilots must learn to interpret instantly.

Mental stress is not the sole danger accompanying such automation; indeed, automation often prevents human beings from stepping in and taking over when failures occur.

High-tech weapons have other problems, as well. The rising costs of such weapons create a vicious circle of contradictory pressures in military planning. Increased costs reduce the number of weapons that can be purchased, so the performance and mission requirements of the systems are constantly expanded to compensate for having fewer units. What results, all too often, is a system that is assigned numerous tasks and does none of them particularly well.

Finally, the lack of a cohesive military strategy has further undermined the effectiveness of many weapon systems. The Weinberger-era philosophy of "buy now, plan later" encouraged the indiscriminate acquisition of "glamour weapons," with little thought given to how such devices would fit into U.S. force structure. Because the systems lacked a specific military purpose, standards of overall quality and performance were often ignored in favor of quantitative measurements.

A Defective Defense

Problems of effectiveness plague high-tech weapons. Ultra-sophisticated warplanes, laser-guided missiles, "smart" munitions and computerized weapons have provided the Department of Defense with enough glimmering gadgetry to entice Congress into dedicating hundreds of billions of dollars to their purchase. But these systems have been beset by design flaws, manufacturing defects and performance shortcomings.

Some weapons are just poorly built. Sometimes, the problem lies at the heart of the system, its design, rather than its manufacture. Other systems simply are overburdened, having too many mission requirements built into them. Finally, the procurement process itself frequently invites problems.

The Sargeant York division air defense gun (DIVAD), for example, peformed so poorly in even well-orchestrated tests with an excessively forgiving scoring system that former Defense Secretary Caspar Weinberger -- always loathe to say no to a weapon -- was forced to cancel the entire program. The Bradley Fighting Vehicle and HUMMER troop transport also had chronic breakdown problems.

Many weapon systems suffer an inability to perform up to their specifications. Premature fatigue on wings of the A-6E aircraft have caused over half the fleet to be grounded. Cracks in the rotor blades of the AH-64 Apache have similarly grounded portions of that fleet. An Army field commander wrote his superiors that he would recommend taking all the Vietnam-era AH-1s to combat before using even a single AH-64.

These shortcomings are not all innocent mistakes. The Northrop Corporation was recently indicted for falsifying tests on components of several weapon systems, including air-launched cruise missiles and the MX missile. In 1984, Texas Instruments admitted that microchips used in dozens of weapon systems might be faulty, and that the company had not properly tested the chips before selling them. Incidents of substituting sub-standard materials for those outlined in specifications (while charging for the more expensive materials) are numerous. The profit in such schemes is significant and the implications for weapon system performance ominous.

Other systems have dangerous design flaws built into them. The AH-1 and UH-1 Bell helicopters, for example, were manufactured with rotor masts susceptible to what the Army delicately termed mast "separation" resulting in "catastrophic breakup" of the craft.

Some systems are victims of the same high-tech equipment that makes them so attractive to military planners. The M-1 "shoot on the run" tank grinds to a halt more often than it "runs" anywhere. The Aegis ship defense system -- highly dependent on computerized tracking and targeting equipment -- has overwhelmed itself in tests, "tracking and targeting" so many objects that it cannot select among them and shuts down. Problems with the electronic countermeasures (ECM) system on the B-1 bomber, the cornerstone of its ability to penetrate Soviet airspace, have left it virtually incapable of ever performing its mission.

Defective weapon systems pervade the U.S. arsenal. Almost every type of military equipment, from life jackets to nuclear missiles, has experienced problems; every service branch has purchased weapons that are deficient; every major defense contractor has sold the military weapons that do not work. The United States, as a result, truly suffers from a defective defense.

The Public Perception

Defense policy is presented to the American public in a primarily political or ideological framework: the right wants to spend more, the left less. Presidents sell their military budgets to the public with rhetoric, promising "to make America strong," or a "defense second-to-none."

Unfortunately, this rhetoric replaces substantive policy debate and leaves unanswered the most important question: Are we getting the best defense possible for the money we are willing to spend? At a time when what we are willing to spend more than $300 billion annually, the disturbing answer is no. Our country has come to rely for its national security on a generation of weapons that too often do not work as they should.

The problem is not one of ideology or money. It matters little how much this country spends on military procurement if the result is weapons that do not work. Debates on force projection, strategy and military posture are meaningless if the military lacks the equipment to implement them effectively.

Definitions and the Structure of This Report

The term "defective" has three meanings within this report: 1) weapon systems that break down more often than is acceptable; 2) systems with mechanical or design flaws that endanger people using them; and 3) mechanical or design flaws that render a weapon system incapable of fulfilling its mission.

The report is divided into two sections. ***Part One*** examines the problem of defective weapon systems, analyzes how such systems find their way into the U.S. arsenal and makes recommendations to remedy the problem. ***Part Two*** presents a "catalogue" of 41 systems that can be described as defective, and outlines the procurement history and problems of these systems. The catalogue is not meant to be a comprehensive history of every flaw ever discovered in a weapon system. Rather, the catalogue contains outlines of serious problems that have befallen major weapon systems within the last ten years. Our intent is to suggest the systematic nature and extent of the problem of "defective defense."

PART ONE

Defective Defense

AN INVITATION TO ABUSE:

HOW THE WEAPON ACQUISITION PROCESS LEADS TO DEFECTIVE WEAPONS

Problems from the Start

Problems in weapon system acquisition begin the moment the Department of Defense (DoD) lays out design specifications. Too little attention is paid to historical precedent, to studying what previously made weapons effective in combat. A fascination with the latest technology prompts military planners to overlook, or too quickly dismiss, basic off-the-shelf systems that have proven effective in combat.

Moreover, the military often is not quite sure what it wants in a weapon system. "Specs" are frequently changed, with too little consideration of how those changes will affect a system's performance. Design "add-ons" are frequently just that -- hastily conceived extras attached to existing hardware.

The way in which a weapon system progresses from conception to deployment also presents dozens of opportunities for problems to arise. As a result, from the moment the military decides it needs a new weapon system, the odds are stacked against the system performing as envisioned by the services or as promised by the contractor.

An Unstoppable Force

Too often, weapon systems have an invisible "momentum" that frustrates attempts to make sensible improvements or cuts. The momentum a weapon system develops as it progresses through the different milestones of development can overshadow even obvious shortcomings in its design, manufacture, or performance. Strong pressure to sweep problems under the rug -- on the assumption that they can be corrected later -- permeates the procurement process.

The momentum is inherent in the way DoD does business: by the time a decision on whether to proceed to production of a weapon system occurs, millions, even billions of dollars have been spent on it. The Sergeant York division air defense gun (DIVAD), for example -- a particularly egregious example of a weapon system's development gone awry -- survived for years in the face of overwhelming evidence that it did not work. It was not until $1.8 billion had been spent on the system that then-Defense Secretary Weinberger abandoned the project in August, 1985.

Also contributing to a weapon system's momentum are legions of Pentagon employees (civilian and military) who have been assigned to manage the weapon's development and procurement cycles, and whose careers are tied to that program's future. Finally, long before a weapon system actually reaches the field, military planners have incorporated it into strategic doctrine, building a false sense of dependency on the system.

Congress shares the blame for the momentum problem. Members find it difficult to vote against ineffective systems when contractors in their states or districts have an interest in those projects. Military contractors and their allies in DoD have perfected the art of sharing the Pentagon pie: companies in 37 states and hundreds of congressional districts had contracts to research or produce some part of the B-1 bomber.

In October 1986, Sen. Alfonse D'Amato, R-N.Y., staged a filibuster to keep alive a Fairchild Industries contract for the T-46 trainer, although the Air Force had decided it did not want the craft and planned to modify its older T-37 trainers. Fairchild built the T-46 trainers at its Long Island, N.Y. plant, and Sen. D'Amato defended his actions as protecting jobs in his state. Apparently, then-Majority leader Sen. Robert Dole, R-Kan., was motivated by the same concern: part of the reason for his opposition to the T-46 was that the T-37 was built in Wichita, Kansas. The self-interest that propels ill-conceived weapon systems through the procurement process is widespread.

Contractors, too, have a stake in weapon system momentum, and are willing to spend money to build it. Grumman Aircraft employs nearly 25,000 people on Long Island and maintains a 30-person Washington, D.C. office to protect its interests. Grumman gave more than $225,000 in campaign contributions to members of Congress in 1986, $40,000 of which went to candidates from New York.

The self-interest of Pentagon employees, contractors and members of Congress in promoting specific weapon systems makes stopping defective weapons difficult.

The Price is Right: Competing for Contracts

Imagine buying a car from the same dealership that sold you your last car, which turned out to be a lemon. Further, imagine not haggling with the salesperson on the cost of the car, but agreeing to pay an inflated sticker price. Finally, imagine agreeing to pay an extra charge for the new car based on the repair costs you incurred on the last car. The analogy is simplistic, but it serves to illustrate some of the reasons defective weapons are bought -- at exhorbitant cost.

The single biggest problem with the Pentagon's complicated method of weapon acquisition is that it runs counter to market discipline. Rather than soliciting bids for weapon systems, the Pentagon frequently indulges in a process known as "negotiated procurement." Under this buying system, DoD selects a single contractor and negotiates a contract. (DoD can sidestep congressionally-mandated requirements for competitive bidding in numerous ways, such as asserting that only the selected contractor has the facilities or ability to build the system in question.) No other contractors are invited to submit bids at lower cost or for better performance. Since there is no competition, there is no pressure to hold down prices. More important, negotiated procurement eliminates a principal quality-control incentive: the existence of another manufacturer that can build the product better. With negotiated, or "sole-source" procurement DoD must negotiate for repairs or modifications, which usually increases costs. The only option is to cancel the project and seek out a new contractor -- which may produce long delays and additional costs, still without any guarantee of quality.

In 1980, just before the Viper anti-tank weapon was to go into production, the Army and the contractor, General Dynamics, estimated the Viper's unit price to be $245. By 1982, the price had risen to $787. This weapon self-destructed when test fired.

Once the government has signed on with a contractor, even in a competitively-let contract, it is boxed into a corner. If cost overruns, shoddy quality or other manufacturing problems arise, the choice is between assuming the additional costs or cancelling a project in which millions or billions of dollars have already been invested. Unfortunately by the time the Viper was ready for production, Soviet advances in tank armor had rendered the weapon virtually useless against the latest Russian tanks. Production of the weapon nonetheless went forward.

Contracts are also rewarded as a result of political pressure. In the early 1970s Chrysler and General Motors (GM) built prototypes of a new tank, the M-1, to replace the Army's aging M-60. GM's reliable diesel-powered version beat Chrysler's "advanced" but troubled turbine-powered tank in head-to-head competition. But the financially ailing Chrysler Corporation lobbied the Ford administration hard, and eventually won the $20 billion M-1 contract. Sure enough, when production began in 1979, problems with the turbine engine surfaced. The tank's air intake system was completely redesigned, and some problems, such as excessive exhaust heat -- which makes the tank an easy target for infrared-equipped weapons -- have never been solved.

Risky Business: The Development Contract Racket

The contracting process is bifurcated. There are development and production contracts. Manufacturers win development contracts after they have been given specifications for a weapon and have, in turn, presented the Pentagon with a proposal for a design. If the proposal is approved, the company wins the contract to design and produce a prototype of the weapon system. Theoretically, contractors win production contracts to build the systems in large numbers only after a prototype has passed developmental tests.

In awarding development contracts the government generally assures contractors a profit regardless of whether the weapon system works or goes into full-scale production. The process is the antithesis of the free market process, where manufacturers risk their own capital to develop a new product, hoping to recoup the initial investment plus profit if the product sells. This is one reason why the average U.S. company earned an 11 percent return on investment in 1984, while the average defense contractor reaped a 27 percent return. Defense contractors argue that cost-plus development contracts are necessary to provide incentive to re-tool factories. Without profit-assured development contracts, they assert, new weapon systems would never be developed, because there is only one potential customer, the U.S. government. Critics of the development contract process contend that there is enough money to be made in production contracts that companies would be willing, if grudgingly, to assume some monetary risk in the early stages of weapon system design. Indeed, the Pentagon has insisted on sharing the development costs of the Advanced Technical attack and fighter aircraft (ATA and ATF). More importantly, by routinely and automatically funding weapon system development, DoD makes taxpayers assume costs and risks that, if borne by contractors, would markedly and immediately improve weapon system performance.

This logic, however, escapes the Pentagon. Deputy Secretary of Defense Donald J. Atwood, a former executive of General Motors, announced on June 19, 1989 that the Department of

Defense will pay all development costs on new weapon systems. Atwood claims that forcing contractors to share development costs "encourages [them] to skimp" on costs, often at the expense of quality. "We suffer the penalty," he said, by purchasing weapon systems that do not work properly and that require extensive maintenance.

"The intial development phase is where you design producibility, quality, performance and simplicity," Atwood noted. "We shouldn't be skimping and trying to save money."

Atwood did not address the issue of why DoD even allows a weapon system to go into production if quality has been sacrificed in the development stage. Development contracts, after all, do not include any guarantee of production contracts to follow. Atwood's contention that "we suffer the penalty" when contractors fail to deliver a high-quality weapon system inverts the entire procurement process by suggesting that DoD is a powerless consumer of military hardware designed and built by contractors over whom it has no control or influence. Moreover, the assertion that contractors will be more likely to develop weapon systems with high levels of quality and dependability if they do not have to share any financial burden for those systems flies in the face of common sense. Rather, Pentagon funding of full development costs will continue to encourage waste and inefficiency, with little or no benefit to weapon system quality. Such quality assurances will come only through critical and arduous testing in the development phase, with a demonstrated willingness to reject systems that fall short.

Let It Be: How Design Changes Ruin Weapons

The tendency to make weapons more complicated, and consequently less reliable, as they move through the procurement process wastes tax dollars and puts military personnel at risk. Technology is added, performance and missions requirements are changed and cost estimates increase. Contractors rarely object to "requirement creep," because high-tech weapons are more profitable than simpler ones.

When contractors design effective, low-cost weapons, they are often ruined by Pentagon-demanded changes. In the late 1950s, the Armalite Corporation designed the AR-15 automatic rifle, which challenged the Army-designed standard, the M-14. Tests, as well as actual combat use during the early Vietnam War years, convinced the Marines and the Air Force that the AR-15 was by far the superior weapon. But Army bureaucrats who favored the M-14 took control of the new weapon and forced it to meet unnecessary performance requirements, such as higher bullet velocity. The once reliable AR-15 became the notoriously unreliable M-16.

The Pentagon has also subverted its own well-designed weapons. In the late 1960s and early 1970s a few Air Force designers built a prototype "lightweight fighter" called the F-16. The jet was meant to be faster and lighter, and thus more maneuverable, than the electronics-laden F-15. It would also be cheaper, so more F-16s could be built. But during development, and even after production was underway, the Air Force kept loading the F-16 with complicated high-tech avionics and weaponry. The rationale was to expand the plane's capabilities. The result was an inversion of the original goal of producing a lightweight, low-cost fighter. The F-16 is now less maneuverable and, at $17 million each, more than six times more expensive than originally planned.

The Pentagon is addicted to high-tech weaponry, and will eagerly add complex accoutrements to weapon systems. Both contractors and procurement officers at DoD understand the political importance of high-tech weapons. Technical wizardry dazzles Congress into loosening the purse-strings. Citizens come to believe that U.S. soldiers are fighting with nothing but the best. Technologically-advanced weaponry, however, is often difficult to use, prone to failure, expensive to maintain, and inappropriate in many combat situations.

Indeed, evidence suggests that high tech equipment is often disastrous in the battlefield. Highly technical equipment requires highly technical maintenance from specially-trained personnel. These people may not be readily available to assist when problems arise thousands of miles from an American base.

High-tech weapons cause strategic problems that military planners often try to address with high-tech "solutions." The Warsaw Pact's three-to-one advantage over NATO in tanks is one example. The Pentagon has addressed this imbalance with a strategy called "follow-on forces attack" (FOFA), which relies on guided missiles, heat-seeking "smart" munitions and complicated radar targeting systems to destroy Soviet tank forces before they get to the battlefield.

There are no cost estimates for this strategy, although its entire premise is that it is less expensive than building enough tanks to match the Soviets. More troubling is the implementation of the strategy. Various FOFA components have failed tests, and skeptics have dubbed it the "13-miracle weapon," because it depends on 13 disparate systems working together flawlessly. This in-tandem dependency is logistically impossible to duplicate in tests; thus, there is no way to determine beforehand if the strategy will work in a combat situation.

Production Planning: A Missing Link in the Procurement Process

The Maverick missile is made at the Hughes Aircraft plant in Tucson, Arizona. According to industrial engineers, it took Hughes about 3,088 hours to produce, assemble and test each missile. Both Hughes and the Air Force had previously determined that it should take only 178 hours for each missile.

Part of the reason it was taking 17 times longer than projected to complete a missile is because assembly line workers spent much of their time repairing and re-working the missiles or waiting hours on end for spare parts from subcontractors.

When all this came to light, the Air Force refused to accept any Mavericks because of shoddy workmanship. In 1984, Hughes closed the Tucson plant. By January of 1985, it was back in business.

The Maverick suffered from an ailment common to the procurement process: poor production planning. DoD policies require preparations for production (processes, materials, etc.) to begin early in the development phase of a weapon system's acquisition cycle (see Figure 1). These preparations should begin before full-scale development, and should increase throughout the cycle. The preparations should continue into the production phase, "until it is demonstrated that the facilities, equipment and people can produce the weapon system in the quantities and of the quality needed."

Insufficient planning frequently leaves both contractors and the military ill-prepared to enter production upon completion of the development process. As a result, weapon systems often develop manufacturing flaws that require extensive and expensive repairs.

Production planning and preparation can be thwarted by unforeseen technological difficulties. Several such problems occurred in the Copperhead program, for example. Planning for production of the Martin Marietta Copperhead projectile did not occur until almost two years after full-scale development had begun. This left the manufacturer little time to react to problems with the system. Indeed, shortly after production planning began in 1977, Martin Marietta was expected to begin delivering prototypes. When the company won the first production contract in 1979, manufacturing labor hours soared 50 percent over initial estimates, the result of problems in making the steel casing that holds the weapon's control section. Martin Marietta had tried to machine a softer steel than required by the design specifications, and to later strengthen it through a heat treatment process. But the heat treatment left the housings distorted and still of insufficient tolerance. Each lot had to be examined after the heat treatment, and each housing had to be re-machined.

Another common factor in production-oriented defects is design change. The design of a weapon system may be altered as a result of technical difficulties encountered in its initial production (most often prototype production), as in the case of the Copperhead, or because of "requirement creep" after the system is well into its development.

Requirement creep frequently catches the contractor short: planning, tooling and scheduling are suddenly rendered irrelevant. The Pentagon rarely compensates for redesign by adjusting the timeline for delivery of the system. The High-Speed Anti-Radiation Missile (HARM) was plagued by design changes throughout its development. Three years after Texas Instruments won an advanced development contract in 1974, the Defense Systems Acquisition Review Council demanded increased maneuverability from the missile and more extensive frequency coverage (increasing the number of radar systems the weapon could detect and target). These changes forced a complete redesign of the missile's "seeker," including the already state-of-the-art microwave circuit boards that control the system.

DoD does have guidelines for production planning (occuring before production begins). Former Secretary of Defense Caspar Weinberger issued two directives in January 1984 to address specifically some of the problems in production planning. Directives 4245.6 and 4245.7, "Defense Production Management," and "Transition from Development to Production," call for production strategies to be developed as early as the demonstration and validation phase of weapon acquisition, and require a "comprehensive" engineering and production planning program before full-scale development can begin.

DoD also uses regularly scheduled "production readiness reviews" to determine whether a weapon system is being adequately prepared to enter production. But the reviews are not carried out at regular intervals.

The F-16 program had only four production readiness reviews before General Dynamics began delivery of developmental prototypes in 1977. All four occurred in 1976, although full-scale development began at the start of 1975 and continued through 1977.

The Copperhead program received similar treatment. As with the F-16, production readiness reviews were not conducted throughout the full-scale development phase of the Copperhead program. The Copperhead had a single production readiness review, conducted in March 1979, six months before a production decision was to be made. A single review can hardly be considered sufficient to meet the "regular intervals" requirement of DoD regulations. The head of the team conducting the review complained that the single review was both too early and too late. Although the development prototype had been built, the tooling and other manufacturing processes were not yet in place, so there was little upon which to base a production readiness decision on. And a review coming just six months before the final production decision left both the manufacturer and the Pentagon little time to correct any problems that might have been discovered by the review.

Finally, the Pentagon body administering the reviews became part of the problem. DSARCs (Defense Systems Acquisition Review Councils) were instituted in the early seventies by then-defense undersecretary David Packard to streamline and discipline the acquisition process. But over the years, Pentagon "supplycrats" -- military and civilian bureaucrats whose careers depended on the weapons under review -- gained enough control of the DSARCs to render the review process meaningless. DSARCs, made up of high-ranking political appointees, voted on whether to continue a weapon program based on the weapon meeting program "milestones." But it was supplycrats who wrote the milestones. Milestones were thus seldom based on critical benchmarks, such as whether a weapon passed a certain test, but on administrative goals, such as whether the test had been performed. This virtually assured approval of initial purchases for production. There was no consideration of alternatives that might be better or more cost-effective.

Haste Makes Waste: The Problem of Concurrent Development

Unlike the normal weapon system acquisition cycle, with its strictly defined phases and milestones, "concurrent development" overlaps the development and production phases, with production beginning before development is complete. The aim of concurrency is to speed up the eight-to-twelve year lead time a weapon system commonly experiences between conception and deployment.

The long lead time is a principal force in allowing requirement creep, increasing the demands on a system and goldplating, stocking systems with the latest high-tech gadgetry. Throughout the development of a weapon system, the threat it is intended to address is reevaluated. Requirement creep increases the likelihood that a weapon system will have performance problems when it enters production. Unfortunately, concurrent development almost guarantees such problems.

For major weapon systems, DoD places special emphasis on "minimizing the time to develop, produce and deploy." As a result, many of the most advanced -- and important -- systems enter the U.S. arsenal without even the pretense of having been perfected, and perform accordingly. The Sergeant York (which can be used to illustrate almost any flaw existing in the weapon system acquisition process), the F/A-18, HARM and the Air Force's cruise missile were all developed concurrently, and they all entered production before completing testing.

For each of these systems, DoD was essentially operating in the dark. Production was approved and begun with limited information on the ability of the system to meet its operation requirements. All of these systems, not surprisingly, failed to perform as expected, either in continued tests or after deployment in training exercises and maneuvers. Weapons procured under concurrent development belie the common assumption that all the flaws weapon systems encounter are ironed out before they reach the battlefield, and that American soldiers are armed with the best weapons money can buy.

There are ways of reducing lead time that are not so counterproductive, such as giving contractors less complicated weapons specifications. Concurrency is the procurement equivalent of the "rush job." As in all rush jobs, seemingly minor details are sometimes overlooked in the race to complete the project.

More attention to performing, completing and analyzing weapon system tests would do much to address the problems of concurrency. But that alone is not enough, for weapon system testing is plagued by over-generous evaluations of tests conducted in unrealistic environments by officials who frequently ignore or brush over unfavorable results.

Of Promises and Proof: The Need for Honest Testing

Former Deputy Defense Secretary Paul Thayer once told a group of military contractors he was addressing that their costs -- and, subsequently, the Pentagon's and the taxpayers' -- would drop "10 to 30 percent" if they "made equipment right the first time." With the procurement budget now exceeding $150 billion annually, Thayer's estimate means that up to $50 billion each year may be wasted on defective weapon systems.

The principal mechanism for ensuring weapon system effectiveness is testing. Two types of testing are normally performed on a new weapon system before it is approved for production. "Developmental tests" are conducted by a team of Pentagon specialists, and are used to gather engineering and design information and to ensure that the system meets its technical specifications. Developmental tests are usually conducted after a system enters full-scale development.

"Operational Test and Evaluation" (OT&E) is a much more important process. OT&E is designed to assess the performance of a weapon system in a "realistic combat environment" where it is operated by the military personnel who would ultimately use it.

The Defense Department's policy on weapon system procurement requires "successful accomplishment of test and evaluation objectives" before a system can move to the next phase in its acquisition. Furthermore, a decision to begin production of a weapon system "must be supported by sufficient OT&E to estimate operational effectiveness and suitability. ..."

There are, of course, exceptions to the policy. Shipbuilding programs, for example, are routinely excluded from OT&E before production approval.

The real problems come when testing is neglected not because of logistical concerns, as in shipbuilding, but because of the Pentagon's rush to get systems into production and into the field. When this happens, promises replace proof, and proof itself becomes subject to the schedules and imaginations of program managers who have a vested interest in exaggerating weapon system performance.

The GAO has uncovered incidents where the services falsified the evaluation forms that are meant to verify test results. As with the Bradley Fighting Vehicle, tests are often conducted by those who are familiar with the patterns of the test rather than those who will actually use the system in battle. This ensures a successful test, but in no way ensures that the weapon will perform well under combat conditions.

The core problem has long been the same. Responsibility for conducting and evaluating operational tests rests with people whose primary job is to bring weapons to fruition: program managers in the Secretary of Defense's office and in the individual services. Rigorous testing routinely forces these people to accept delays and expenses that run counter to the fulfillment of their primary duties.

In the early 1970s, a "blue-ribbon" defense panel and a presidential commission studying procurement reached the same conclusion: a separate office of operational testing and evaluation, independent of the services and development bureaucracies, was needed. In 1977, then-Defense Secretary Harold Brown created such an office. But within two years, development officers allied with defense contractors convinced top Pentagon officials to eliminate the independent OT&E office.

In 1983, the Congressional Military Reform Caucus was successful in passing an amendment to the defense authorization bill in response to accounts of misleading and inaccurate test results reported to Congress. The amendment required DoD to reestablish an independent OT&E within the Pentagon. OT&E was set up to oversee the testing of all major weapon systems and report the results to Congress. The director of OT&E was to be a civilian, appointed by the President and approved by the Senate. The Director was to have a staff and the right to design and monitor weapons. The Director's reports were to go directly to the Secretary of Defense, and from the Secretary unamended to Congress.

More than 18 months after Congress ordered the establishment of the OT&E, Defense Secretary Weinberger had not named a permanent director for the office, which was running on only token staff. At the time, the OT&E staff was relying on reports from the services to prepare its reports on weapon system testing. Congress, of course, had ordered creation of the

OT&E because service testing programs had been considered unrealistic, and their reports inaccurate.

Finally, the Pentagon, required by law to pick a civilian to head OT&E, chose John Krings who, after a stint in the Air Force, had spent 30 years as a test pilot and lobbyist for McDonnell Douglas.

In his time at OT&E, Krings has tried to play both sides of the fence. In public statements he has vowed to ensure the independence of his office and to conduct tests that would truly determine the effectivness of weapons; but when confronted, Krings has bowed to pressure from the military and industry.

In March 1986, for example, the AMRAAM missile was up for congressionally-mandated certification. Krings wrote Weinberger a memorandum outlining several problems with the AMRAAM. The GAO had just issued a scathing report on the missile, stating that half of the 20 missiles that had by that time been delivered were returned due to malfunctions. The missile, however, was certified, with Krings' support. Responding to the ensuing furor on Capitol Hill, Krings insisted that certification did not necessarily mean the weapon would go into full production; it meant only that he could authorize further testing.

Krings' approach to operational testing rouses the ire of his critics. "Operational testing is more and more becoming a matter of forecasting," he has written. "Truly candid projections of operational utility can be made with very high confidence through sophisticated simulation and combined operational and developmental testing." Krings' opponents contend that he and OT&E cannot afford to use conjecture in evaluating weapon systems because lives depend on their peformance. The whole point to operational testing, after all, is to determine if a weapon will perform well under combat conditions. Extrapolating how it *might* function from developmental tests is imprudent. Moreover, the nature of computer-based simulation as an alternative to actual operational tests can be misleading. In computer simulations, weapons are assigned kill probabilities -- the likelihood of destroying a target -- much higher than past combat performance justifies, leading to an overly optimistic assessment of weapon system effectiveness.

Computers cannot accurately replicate battlefield conditions such as visibility, communication difficulties and motion, which means combat requirements cannot be adequately determined. The element of surprise is entirely lacking, though it can have a decisive effect in actual combat.

A GAO report in 1986 found that for all concurrently developed systems it reviewed, no OT&E results were made available to DoD until after production began. The GAO also reported that OT&E did not accurately reveal the shortcomings and potential problems with weapons that it reviewed.

Test results submitted by the Pentagon to Congress on the Air Launched Cruise Missile (ALCM), for example, described the test launches as partial successes when in fact the missiles crashed during the tests. Because critical tests were not undertaken on F/A-18 production models before they went into production, extensive and costly retrofittings were required.

The concurrent development and production of weapons blurs some of the old distinctions between developmental and operational testing, Krings claims, because the phases overlap. If a weapon spends enough time in the developmental phase, Krings asserts, it acquires a maturity, and is allowed to proceed, regardless of how effective it really is.

Two years ago, Congress enacted a prohibition on contractor participation in OT&E functions after reports of improper tests in which contractors took part became public. Krings has since argued for weakening the law, under which contractors are barred from providing test equipment, software, or logistics support.

Another problem is tests on sub-systems of a weapon, conducted by the contractor prior to delivery of the weapon itself. Northrop has been indicted on fraud charges for falsifying test results on components of various weapon systems, and for falsely indicating that other tests had been conducted, when in fact they had not. Other contractors have substituted qualitatively inferior materials for those specified in contracts. These schemes are all the more disconcerting because the flaws may not show up in developmental or operational tests. Northrop, for example, is accused in the indictment of falsely certifying that fluids in the guidance system of the air-launched cruise missile could withstand freezing at temperatures as low as 65 degrees below zero, as required by the contract. The company knew, the indictment alleges, that the fluid could freeze at 40 degrees below zero. Only tests conducted at those extreme temperatures would disclose the system's shortcomings, and computer simulations would never discover it.

Kamikaze Dolphins and World War III: The Black Budget

The fastest growing area of federal spending is the part of the defense budget dedicated to "black," or secret, programs. Ten cents of every defense dollar is allocated to this group of weapons so secret that their existence is not even acknowledged by the Pentagon. Approximately 50 members of Congress know bits and pieces about weapons in the black budget, but they do not have nearly enough information to exercise even minimal oversight.

Former Defense Secretary Caspar Weinberger insisted that the extensive secrecy is critical to national security. But while secrecy may be necessary for a limited time, there is reason to question Weinberger's blanket claim. Too much secrecy, in fact, is doing irreparable harm to national security. The lack of oversight in the "black" budget compounds all the existing procurement problems.

The black budget has become a haven for programs so bizarre that military planners rightly fear they could not withstand public scrutiny. One program tried to train dolphins for kamikaze missions. Another is aimed at building robots which walk upright and gallop like horses.

More common, however, are programs that are behind schedule, over budget, or riddled with flaws, or rife with corruption. A congressional aide familiar with black programs contends that some projects have "gone black" to conceal the fact that the Pentagon awarded contracts to companies that lost competitions. "In a black project, people don't worry about money," says a systems engineer with Lockheed Missile and Space Company, a prime black contractor. "If you need money, you got it. If you screw up and you need more, you got it. You're just pouring money into the thing until you get it right. The incentive isn't there to do it right the first time. Who's going to question it?"

An all-too-typical example of the effect of excessive secrecy is the Stealth fighter program. Unlike its sister bomber program, which was recently unveiled to the public (although it has yet to fly), the Stealth fighter was for years an open secret. Models of it were available in many toy stores, and Lockheed, a Stealth contractor, admits that it lost over 1,000 documents relating to the plane. Yet military officials refuse to acknowledge that the Air Force is building a Stealth fighter. This is a handy way of ducking charges by knowledgeable critics that the weapon cannot do what it was designed to. Because of its secret status, the Stealth fighter will not undergo operational testing before going into production, assuring that current flaws will be built into the jet.

The explosive growth of the black budget is less the result of concern for national security than it is symptomatic of the Pentagon's desire for less accountability. Using secrecy in the name of national security is often just a cover for poorly orchestrated and ill-conceived ideas.

Freedom from Harm: Defense Contractor's Limited Liability

The preponderance of risk-isolation for defense contractors in the military procurement process undermines efforts to ensure quality in weapon system production. Development contracts that guarantee profit regardless of system performance, dependence generated by sole-source production contracts and cost-plus contracts that actually reward, through profits, repairs and modifications, all serve to protect defense contractors from the consequences of building defective products.

In addition, defense contractors enjoy another privilege not afforded private industry: freedom from liability. Under federal law, military personnel cannot sue for damages for injuries incurred in the course of military service. Both the government and the contractor are protected from federal suits under the Federal Tort Claims Act. In June 1988, the U.S. Supreme Court extended this protection from liability to state law. In *Boyle v. United Technologies*, the Court held that the Federal Tort Claims Act supersedes and invalidates liability under state law when a military contractor satisfies three criteria: (1) the United States government approved "reasonably precise specifications" for the equipment in question; (2) the equipment "conformed to those specifications"; and (3) the contractor "warned the United States about the dangers in the use of the equipment."

Thus, military contractors are effectively immunized from liability, even when they know a weapon system is dangerous to those who use it. This injustice removes another incentive for assuring quality in the design and production of military weapon systems.

In and Out the Revolving Door

The phenomenon of the "revolving door," in which DoD employees take jobs with major contractors, and vice versa, is a prime reason why weapon procurement is replete with inefficiency and corruption. There are countless examples of military officers, from generals on down, who have left the Pentagon and sought employment with contractors. The attention paid to former Senator John Tower's defense contractor employment after leaving office shows that Congress is also susceptible to revolving door problems. Officials often support programs that are clearly inefficient, even dangerous, to better their chances of getting work with producers of the self-same weapons when their military days are over.

Some examples of the revolving door in action:

* George Sawyer has been through the revolving door in both directions. Until 1981, Sawyer was president of a marine architecture firm, which he left to become Assistant Secretary of the Navy for shipbuilding and logistics. Upon leaving the Navy in 1983, Sawyer became an executive vice president at General Dynamics. In his official capacity with the Navy, Sawyer provided both his former employer, John J. McMullen Associates, and his future employer, General Dynamics, with millions of dollars in contracts. On May 5, 1983, Sawyer ended a long-standing cost overrun dispute on the Trident submarine program by signing an order that saved General Dynamics billions of dollars. Two weeks later he announced his intention of joining the company.

  Sawyer was cleared of conflict of interest charges in the incident, which stemmed not from the fact that he had wooed (and been wooed) by General Dynamics, but from the fact that he had failed to disclose this courtship.

* In the past 20 years nearly 250 U.S. military personnel have been killed in accidents involving Bell Helicopter's AH-1 Cobra and UH-1 Huey helicopters. Ten years ago the Army Safety Center recommended that the Army no longer purchase the craft from Bell. General William Maddox, Jr., who was Director of Army Aviation, dismissed the recommendation. Maddox was later hired by Bell Helicopter to run its Asian operations.

* Marvin Boodnick went to work for Hughes Aircraft in March 1981, only two days after quitting his job as price-cost analyst for DoD at Hughes.

* Col. James P. Foster led a Pentagon team analyzing future Air Force space systems until retiring in September, 1983. He went to work for TRW's Space and Technology Group,

where one of his prime responsibilities was analysis and long-range planning for future space systems.

Reformers in Congress have tried without success to shut the revolving door. Unfortunately too many people stand to benefit from it. The promise of a lucrative job with a defense contractor is seductive. The salaries are much larger than those offered by the government.

Every Good Bureaucrat Does Fine: Personnel Policies at DoD

"DoD has all the symptoms of being corrupt, incompetent, and incestuous, and is so to an alarming degree. This is not because of some sinister plot .... Many of the players are aware that things are going badly .... They are not, in the main, dishonest or incompetent, just caught in a very bad situation. The bureaucrat soon learns that he who does nothing has a simple life, and he who tries to do something gets in trouble. All pressures are to maintain the status quo ....

The basic reason for the problem is incredibly simple, and will be incomprehensible to anyone who has not spent time in the system: there is no profit and loss sheet. The goal of every good bureaucrat is to get an exclusive franchise on whatever it is he is doing .... The only requirements are to stay busy, generate paper, and make no mistakes."

Thomas Amlie, former Director of the Navy Weapons Center at China Lake, speaking to Dina Rasor, Director of the Project on Military Procurement.

In the two world wars, the United States had to expand its officer pool quickly to meet the demands of war. The United States then made the choice to keep a huge number of those officers on active duty for a relatively small peacetime force. The dearth of qualified officers after World War II has been exchanged for a Pentagon bureaucracy top-heavy with high-ranking military men who have relatively few meaningful jobs for which to compete. The Marine Corps, for example, has 1,636 lieutenant colonels, but only 356 command positions for lieutenant colonels. The result is that all these very qualified officers take a single job and turn it into several jobs.

In the face of this surplus, the Pentagon rotates the officers from post to post within DoD. Each gets a short tenure of command, while other officers eagerly await their turn to take a command position.

Officers are forced to go through this process or retire because of the Pentagon's so-called "up or out" policy. This sets up a perverse incentive to not rock the boat, and to keep money flowing through the system no matter how bad the weapons, because creating a stir might prevent one's promotion. These officers spend so little time at any one post that they are not experts at much of anything, except playing departmental politics and obtaining promotions.

Most officers above the brigade level have been away from the battlefield for ten years or longer, and are in personnel, procurement, or research and development. This means they are sometimes short on tactical expertise. They also outrank most officers in the field who are better-equipped to make sound decisions about what weapons are necessary, so they can ignore requests from the field and do what they think best. And once an ego becomes inextricably wrapped up in a bad idea, the bad idea invariably triumphs over good sense. The result is service personnel getting ineffective weapons with which to defend themselves and their country.

REFORM EFFORTS

Attempts to change the way DoD does business have often been long on intention and short on effect. An embedded bureaucracy, 'revolving door' relationships between the military and major defense contractors, and the extended lead time on weapon system development all make reform efforts difficult. But in recent years, Congress has taken an increasingly critical look at DoD buying habits, and has tried to implement serveral requirements to correct obvious flaws.

The "Procurement Czar"

In 1984, Defense Secretary Caspar Weinberger charged Undersecretary of Defense for Research and Engineering Richard D. DeLauer with responsibility for all major procurement programs. The new "procurement czar" lacked a substructure for such responsibility and was ineffective. Oversight responsibility for procurement was later redivided and reassigned to separate assistant defense secretaries.

The Packard Commission

The Commission on Defense Management, headed by David Packard, chairman of Hewlett-Packard Co. and a former undersecretary of defense, focused its criticism on the complexity of the procurement process. In its Final Report, released in June, 1986, the Commission wrote, "Federal law governing acquisition has become steadily more complex, the acquisition system more bureaucratic and acquisition management more encumbered and unproductive." To relieve this burden, the Commission urged the creation of the position of Undersecretary of Defense for Acquisition, bearing "full-time responsibility for managing the defense acquisition system."

The Pentagon appointed former Bechtel executive Richard Godwin to the post. In keeping with another Packard Commission recommendation, DoD abolished the Defense Systems Acquisition Review Council (DSARC), replacing it with the Joint Requirements and Management Board (JRMB). Godwin, however, abolished JRMB in favor of a Defense Acquisition Board that was supposed to expand his control over the procurement process. In September 1987, less than a year after his appointment, Godwin resigned, citing his continued inability to gain control of the unwieldy bureaucracy his position was supposed to eliminate.

The Packard Commission's biggest push, though, was for increased "voluntary" policing by defense contractors themselves. Many major contractors announced shortly after the Commission's report was published that they were implementing voluntary guidelines. Results of this effort, as news disclosures continue to demonstrate, have been less than spectacular.

Warranties: The Rise and Fall of a Good Idea

An amendment to the 1984 Defense Appropriations Bill ordered DoD to secure warranties on all new weapons, stating that funds could not be spent without written guarantees from contractors that systems were "free from all defects." The law makes prime contractors responsible for the "whole system," meaning it must get guarantees from its subcontractors for all sub-systems. Under the law the prime contractor is also responsible for repairing or replacing faulty parts, or reimbursing the government for the expense of doing so.

Large loopholes built into the law, however, allow the Secretary of Defense to waive the warranty requirements if he or she believes they would somehow be contrary to the national interest or not cost-effective.

Deputy Defense Secretary William Howard Taft, IV used the cost-effectiveness provision to sidestep the law. Only four months after Congress ordered DoD to require warranties, Taft sent a memo to the three Service secretarys declaring that the Pentagon had determined that warranties are *never* cost-effective, and imposing a blanket waiver of the warranty requirement for all weapon systems. Taft then delegated authority for waiving the warranty provision of a contract to the secretaries of the Army, Navy and Air Force, at the same time permitting them to re-delegate such authority. Taft also issued "class waivers" that allow guarantees on the separate components of a weapon system to be waived.

There has been considerable debate within the Pentagon about the warranty law. A few in the top echelon of DoD, such as former Navy Secretary John Lehman, favored the law, but most opposed it, as did, not surprisingly, defense contractors.

DoD and the contractors offered Congress a number of objections to the warranty law. Warranties, they argued, are an obligation in the private sector, and should not be applied to the government purchase of weapons; warranties in the marketplace deal only with the limited application of sophisticated weaponry, and it is difficult to apply them to the state-of-the-art weaponry bought by DoD; and, finally, warranty requirements would inhibit innovation and result in much higher costs that would be passed on to the taxpayer.

To the average consumer, however, requiring warranties is perfectly reasonable. The government is a consumer like any other, so the distinction, between private and public sector purchasing is misleading. Warranties may be difficult, though not necessarily impossible, to apply to some very sophisticated weapons. Nonetheless, DoD has also exempted many less sophisticated purchases, such as jeeps, trucks and ammunition. If repairs and other long-run costs are taken into account, warranties on weapons should save taxpayers money. Warranty demands would discourage procurement of hopelessly complicated weapons in favor of more reliable and cost-effective ones. And with a warranty provision, contractors would have a real interest in making sure OT&E does its job.

RECOMMENDATIONS

While much has been made in Congress, the media and elsewhere of the various procurement scandals that surface regularly in DoD -- the current bribery and "insider information" cases currently making headlines, the spare parts fiascos of a couple years ago and the astronomical prices paid for ordinary items -- too little attention has been paid to the problem of defective weapon systems and ways to address it. Most reform proposals in recent years have focused on the cost of weapon systems, procurement waste, fraud and abuse, and the cozy relationship between DoD and defense contractors. These are, to be sure, important issues well worth addressing, but they do not explain the frequently poor quality of weapons this country buys.

At the same time, these problems share one feature: only fundamental and far-reaching reforms will solve them.

Our suggestions:

The Procurement Corps

The idea of creating a special organization with overall responsibility for weapon system acquisition has surfaced in numerous formats in the last several years. The procurement czar idea, as well as some of the Packard Commission recommendations, entailed consolidating the procurement process. Both proposals, however, leave this responsibility with the military, merely shifting the process within DoD.

What is needed, instead, is a procurement office *independent* of the Defense Department and the services, with responsibility for all phases of weapon system acquisition. The Procurement Corps would eliminate the conflicts of interest that DoD procurement officers bring to their jobs, lessen the "momentum" weapon systems invariably gather and reduce the problem of "requirement creep."

In practice, the Procurement Corps would analyze threat assessments and weapon system requests from each branch of the military, integrating requests where possible to allow individual servcies to use the same or similar weapons. It would make determinations on whether to use existing, "off the shelf" technology or to develop a new system. The Corps would award development and production contracts, undertake operational testing and have singular authority for approving or disapproving a weapon system.

William Lind, in his book, *America Can Win*, describes some of the benefits this system could bring to weapons procurement. "We should get soldiers, sailors, airmen and marines out of the development and procurement business," Lind writes. "These businesses are just that, businesses. They are inherently corrupting for any soldier, not because money is passed under the table, but because ... they make a real soldier's education in and concern with warfare irrelevant, and force him to become a manager and a businessman."

Former Assistant Secretary of Defense James Wade in 1985 described his idea of a model procurement corps as a special "professional service," along the lines of the Foreign Service. The Corps, Wade said, "would be based on education, experience and examination. This Corps must be highly professional with required degrees in science, engineering, business, financial management, or other related disciplines. This heightens DoD's ability to lead the way in high-technology research, development, testing and manufacturing. The Acquisition Corps would have as an aim a total professional career."

Wade would like to see the Pentagon establish an umbrella defense acquisition university, encompassing all existing acquisition-related schools which offer accredited degrees. Wade's procurement corps would be managed by civilians, but military officers would occupy key positions for which they are qualified.

Most importantly, procurement officers would not be allowed to jump from the corps to defense industry employment for a minimum of five years after they leave the government.

While Wade's proposal would leave procurement within DoD, a position with which we disagree, much of what he suggests is valid in addressing weaknesses in the procurement system.

A Procurement Corps, however, can be effective only if supported by a series of smaller, but vital, reforms.

Increase Competitive Bidding

Competition should be gradually increased until a substantial majority (70 percent or more) of all DoD contracts are competitively bid. That percentage should be mandated by law. Congress should also impose a penalty if that percentage is not met: mandatory funding cuts to programs not competitively bid.

Competition in the designing of weapon systems, before a production contract is awarded, is another way to weed out ineffective weapons. All prototypes should compete in "fly-offs" or "shoot-offs" against one another and against the weapon they are meant to replace. Assessing weapons on paper is simply inadequate. Actually, on some occasions when prototypes have been tested against each other, the Pentagon picked the loser. The M-1 tank, DIVAD, and the F/A-18 are prime examples.

Though the services are reluctant to do so, foreign military contractors should be invited to participate in design competitions. While some concerns about reliance on foreign manufacturers are warranted, the performance record of many weapon systems manufactured in other countries might prompt the U.S. defense industry to improve the effectiveness of domestically-designed weapons. The highly concentrated nature of the domestic defense industry makes such a step important.

Increase Split Sourcing

To ensure that defense contractors -- even on competitively bid contracts -- do not increase prices after weapons go into production, contracts should be "split source" whenever possible, allowing two or more companies to produce a weapon system or component.

Split-sourcing has several benefits. Lockheed Corp., for example, builds two transport planes for the Pentagon: the C-130, considered one of the most cost-effective and trouble-free aircraft, and the C-5 transport plane, one of the most problem-plagued. Several companies build planes similar to the C-130, so Lockheed remains under pressure to keep the Pentagon's business through good workmanship. By contrast, the company is the sole manufacturer of the

C-5 transport.

Similarly, Ford Aerospace builds the very effective anti-aircraft weapon, the Sidewinder and is also responsible for that greatest of boondoggles, the DIVAD anti-aircraft gun. Raytheon Corporation also builds the Sidewinder, but Ford was the lone manufacturer of the DIVAD.

In split-sourcing, the government awards the lion's share of a contract, say 65 percent, to the contractor with the lowest bid. The contractor with the next lowest bid is allowed to fill the remaining 35 percent of the contract, which keeps that contractor in the race (and in business) for the next round of bidding.

Sometimes, even the threat of split-sourcing can work wonders. When DoD began considering split-sourcing contracts for the HARM anti-radiation missile, the manufacturer, Texas Instruments, decided to cut the weapon's price from $1 million each to $400,000.

Share Development Risks

In order to give contractors incentive to produce high quality weapon systems, at least two companies should be given development contracts for any weapon system being considered. The government should assume 50 percent of development costs. The resulting prototypes will be compared and contrasted with each other and the system they are designed to replace. If a new system is deemed desirable, the contractor which designed the selected system will get the majority of the production contract, with the other getting a smaller share. The benefits would be twofold: first, split-source production provides quality and price incentives; and second, contractors will be more likely to enter development competitions if they know they will recoup their investment in production contracts later.

End Concurrent Development

Citing the need to get weapons from the drawing board into the U.S. arsenal faster, the Pentagon allows some weapons to go into production before they have been fully developed and tested. Too often this saddles taxpayers and service personnel with badly designed, dangerous, and ineffective weapons that are in need of extensive modifications and repairs. Concurrent development is counterproductive, and should be prohibited. No weapon system should be deployed until it has undergone a full battery of operational tests and found to be free from defects and effective in realistic, combat-like situations.

Reinvigorate Independent Testing

The single most effective means of preventing flaws in weapon systems is a program of rigorous, independent testing. The creation in 1983 of the congressionally-mandated office of Operational Testing and Evaluation (OT&E) was only a first step. The testing function should be removed from the Pentagon (and placed in an independent Procurement Corps) because of existing conflicts of interest. Moreover, the orchestration of tests to produce favorable results, regardless of actual performance, needs to be replaced with a testing program that uses the service personnel who would actually use the weapon, in an environment that simulates the rigors of battlefield performance.

Insist on Warranties

Weapons should work as promised by the companies that build them, or the U.S. government should demand a refund. Laws meant to enforce this basic tenet of consumerism have been undermined by DoD and powerful defense contractors. DoD warranty law should be amended to require prior congressional approval for any waiver from warranty requirements.

Jam the Revolving Door

The prospect of landing a job with a defense company can motivate civilian and military government personnel to make procurement decisions in the interests not of taxpayers and soldiers, but of defense contractors. DoD employees, whether military or civilian, should be prohibited from taking a job with any company receiving money from DoD for a minimum of five years. In addition, regulations for disclosure of such employment need to be strengthened, as do resources for enforcement of the law.

Encourage Whistleblowers

Aside from vigorous, independent auditing, the largest source of information on problems with weapons procurement are employees -- government and private sector -- who are directly involved with those weapons and are willing to expose problems to the public, even when their superiors are not. Whistleblowers such as A. Ernest Fitzgerald and Col. James Burton have brought to light serious problems with some major weapon systems that would have otherwise gone undiscovered. More important, these men have, through their determination and integrity, inspired many lesser known individuals to step forward. For some, the decision to blow the whistle has had grave repercussions for their professional careers. Burton ultimately chose to resign from the Air Force rather than accept a forced transfer after writing a report critical of the testing program for the Bradley Fighting Vehicle, which he claimed was biased and designed to hide flaws in the system. Fitzgerald has been subjected to years of harrassment, stemming from his mid-1970s revelations of deadly flaws in the wings of the C-5A transport plane and his subsequent stubborness in rooting out and disclosing defects, waste and fraud in other military procurement programs. Ethical government whistleblowers need to be encouraged and protected. Retribution should be strictly prohibited, and incentives for disclosing waste, fraud or abuse established. The whistleblower protection legislation signed by President Bush this spring is a welcome start, and should provide ethical whistleblowers with more practical rights and remedies.

Declassify "Black" Weapons

Senior members of the House Armed Services Committee contend that 70 percent of the black budget could be declassified at no risk to national security. The increasing tendency to shroud weapon systems in secrecy exacerbates all other flaws in the procurement system. Legislation should be enacted requiring a "preference toward disclosure" of items in the black budget.

Make Contractors Assume Liability

Shielding defense contractors from liability for defectively designed or manufactured weapon systems removes what could be a strong incentive for quality production. Manufacturers of military equipment should be liable for damages resulting from their products, as most manufacturers already are. Moreover, the U.S. government should be liable for design or manufacturing defects it identifies but fails to correct.

Reinvigorate Public Yards

Ten percent of all defense procurement should be assigned to "public yards." This will help the country maintain a military industrial base and also provide a "yardstick" for determining if private contractors -- who would receive the other 90 percent of procurement projects -- are doing an adequate job.

In his final testimony to Congress before retiring in 1982, Admiral Hyman G. Rickover (Ret.) called for the U.S. government to perform more work in its own yards. "I believe in private industry," Rickover explained, "but without the present abuse .... We have permitted considerable abuse, and I think some of that can be changed ... One means [used] in World War II ... was to do work in public yards to set a mark, what it should cost. We no longer do this and contractors went all overboard."

PART TWO

A CATALOG OF CARELESSNESS

A-6E Intruder

Service: Navy

Prime Contractor: Grumman Aerospace Corp.

Mission: Carrier-based attack jet.

Program Costs	Quantity	Unit Cost
$4.59 billion	205	$22.43 million

The A-6E is the Navy's only all weather attack bomber. The subsonic, 2-seat plane incorporates a new miniature digital computer, a solid state weapons release system, and a single integrated track and search radar.

Delivery of the Intruder was temporarily suspended in September of 1984, when questions were raised about the quality of the Texas Instruments microchips used in the planes.

In December 1984, the Navy grounded 64 A-6Es because it was discovered the plane's wings would likely not last as long as had originally been planned. In addition, flight restrictions were imposed on 112 other A-6Es. The grounding was ordered "because of a number of factors, including the development of a more precise method of determining fatigue and as a result of greater-than-original flight loadings," a Navy spokesman said at the time. He said the planes would all be given new wings, at a cost of $2.5 million per plane.

A Grumman Aerospace spokesman asserted, "This is not a defect ... The aircraft were grounded because they exceeded 150 percent of their estimated fatigue ...."

The Navy was expected to assume the costs of rewinging the craft, the Grumman spokesman said. "That has been a cost borne by the Navy in the past and we don't see any reason why that would change."

The death of Lt. Col. Jack Cabin in January 1987 served to underscore the severity of the wing problem crippling the A-6E fleet. In perfect weather, without any distress calls, Cabin's aircraft crashed in the California desert outside the Naval Air Facility outside El Centro. Fatigue cracks in the wings of the aircraft were found to have caused the crash, and 115 A-6Es were grounded in March 1987 as a result of the finding.

The Navy has in place a $1.2 billion program for re-winging of the craft with new and stronger wings. But the re-winging program has been financed out of the budget of aircraft modifications which has been nearly halved. In fiscal 1988, $668 million has been earmarked for modification projects on about 30 different aircraft. Of that $688 million, $133 million has been allocated for re-winging of the A-6.

Apparently undaunted by the problems of the A-6E, the Navy has embarked upon the production of an A-6F jet. The A-6F is a planned upgrade of the A-6E.

According to an internal Pentagon report obtained by *Defense Week*, the A-6F already has problems. The Navy will not strengthen landing gear on the A-6F, despite evidence that the heavier plane will crush the gear during landings on aircraft carriers, possibly resulting in fatal crashes. "Our analysis indicates that without a stronger landing gear, the A-6F will ... either have to land with a very low fuel load or dump unused, expensive munitions into the ocean," wrote John Melchner, formerly the Pentagon's assistant Inspector General for auditing. The Navy has set a maximum landing weight of 36,000 pounds for the A-6E, while the A-6F is designed to have a 42,000 pound landing weight.

The A-6 has a distressing history of landing gear. In 1971, the Navy increased the maximum landing weight of an A-6 from 33,500 pounds to 36,000 pounds. Three jets crashed onto carriers "suffering catastrophic landing gear failures."

Melchner shrugs off the Navy's claim that it will alter the aerodynamics of the plane to lessen the impact of landings. His report suggests that the Navy install landing gear now used on the EA-6B, a heavier electronic warfare version of the A-6. But the Navy does not want to make that change "because it would reduce the [A-6F] aircraft range by a maximum of 13.5 nautical miles."

Aegis Ship Defense System

Service: Navy

Prime Contractor: RCA Corp.

Mission: Integrated ship defense, providing target identification and tracking, fire control systems, and radar.

Program Costs	Quantity	Unit Cost
$24.071 billion	27 Battleships	$891.5 million
$27.057 billion	33 Destroyers	$819.9 million

The 1982 war between Great Britain and Argentina over the Falkland Islands provoked considerable controversy over the security of all fleets when the British destroyer HMS Sheffield was hit and sunk by a French-made Exocet missile -- a basic, inexpensive, low-technology weapon. The U.S. Navy's solution has been the Aegis ship defense system. Originally conceived only as an antiaircraft weapon, Aegis has been expanded and redesigned to incorporate the functions of a total ship defense system. In addition to the antiaircraft component, the modern Aegis includes shipboard missile systems, fire control systems, electronics systems and phased array radar, sonar, and navigation systems. These components are supplemented by decoys, electronic countermeasures, and a passive detection system to help detect, classify, and confuse enemy weapons and forces. The entire system is controlled by an on-board computer that takes radar readings, identifies enemy weapons, and directs five-inch guns, torpedoes, and depth charges. According to the Navy, Aegis is supposed to be able to track 200 targets simultaneously, and to hit as many as 18 simultaneously.

The Navy plans to acquire 27 guided missile cruisers and 33 multi-mission destroyers equipped with Aegis by 1994.

But Aegis, instead of being the state-of-the-art weapon system envisioned by its proponents, has become a fiasco, a lesson in the hazards of reaching too far, too soon.

The first Aegis-equipped cruiser, the U.S.S. Ticonderoga, was launched in April, 1981. Less than a year later, a former technical director of the Naval Weapons Laboratory declared that the radar system used by Aegis (and other weapons and vehicles) was the "most extreme example" of "self-defeating" weaponry. Writing in *Spectrum*, Thomas S. Amlie said, "No sane infantryman engaged in heavy combat would run to the top of a nearby hill, light a flare, and dare the enemy to hit him. Yet...[these] radar systems... do the electronic equivalent of exactly that." In addition, Amlie said, the radar could be used by enemy forces to guide missiles to the heart of the system, making it a virtual sitting duck. He noted:

"[Aegis] radar transmits very strong signals very different from those of any other radar in the world, making it a superb target for [anti-radiation missiles] that could be launched by an airplane, a ship over the horizon, or a land installation."

A Defense Department official admitted that the vulnerability of the radar to detection and targeting by an enemy was a problem, but proffered, "You're sort of stuck with radar." He also noted that there are certain conflict situations in which radar systems are shut down (to hide from or deceive the opponent, for example).

Shutting down radar to avoid detection, however, also shuts down Aegis's ability to perform its mission -- to detect, target, and destroy enemy aircraft, missiles, or other weapons. One critic pointed out that once you shut the radar off, "the ships become totally unsuitable for the task at hand."

Thus, Aegis, in a military conflict, would be its own worst enemy. It may be anyway. Besides a lack of design cohesiveness, Aegis has been plagued by technical shortcomings ever since it hit the water.

As early as August 1982, the staff of the House Appropriations Committee was documenting problems in the production of the Ticonderoga that left it "overweight, sluggish, and in possible danger of capsizing." The staff report warned that the Aegis system would be "ineffectual" unless the problems were corrected.

The report concluded that "add-ons" -- equipment and weaponry not included in the original design -- had left the ship grossly overweight. The Navy had added "antisubmarine helicopters and their support equipment, depth charges to attack submarines, rocket-launched torpedoes, five-inch guns to fire at ships or shore targets, and more radar and sonar than initially planned" as the expectations and responsibilities of Aegis grew, according to the report. Much of the added weight was equipment installed above the ship's waterline, making it top-heavy. To counteract that, ballast was added to the keel.

As the weight of the Ticonderoga grew -- from 8,900 tons to 9,600 tons -- larger fuel tanks were installed to provide the range required in the ship's contract specifications. This, in turn, added even more weight, and it was discovered that the ship would be "unable to keep pace with a carrier battle group steaming at 34 knots."

Former Secretary of Defense Caspar Weinberger disputed the charges, calling the committee staff report "completely wrong" and "false." A GAO report the following year, however, stated that "the CG47's [Ticonderoga] displacement and center of gravity exceed design goals, which could have an adverse effect on the ship's speed and stability."

Although the House Committee was berating the seafaring capabilities of the Aegis ship, and Amlie was condemning its technology, Aegis had yet to begin operational testing. Indeed, the ship was commissioned into service in January, 1983, even though the first operational tests were not scheduled to begin until May of that year. Had the Navy waited for test results before deploying the system, it is unlikely Aegis would have ever seen water.

The tests actually began in April. After the first round, Navy officials jubilantly announced that the Aegis system was "setting the standards of excellence," having successfully hit all 13 of the targets involved in the exercise.

It turned out, however, that the early April test was pretty much a rote exercise. It had been a carefully rehearsed and choreographed "warm-up" performed by system engineers and program managers. It wasn't until April 11 that the Navy testing team took the controls and put Aegis through simulated combat exercises. The tests were concluded April 17. This time, official Navy accolades for Aegis performance were starkly absent. Indeed, the test results were swiftly classified for reasons that would later become obvious: in the actual operational tests conducted by the Navy team, Aegis was able to hit only 4 of 15 targets, and experienced significant equipment and computer malfunctions throughout the tests, as well as mistakes by the crew of the Ticonderoga.

When the test discrepancies and the contradictory public relations strategy of the Navy began to surface, former Aegis program manager Rear Admiral Wayne E. Meyer explained to a Wall Street Journal reporter that "there was no intentional effort to mislead....[R]elease of [negative test results] is closely controlled. The reason for that is that this was a complex test and the results are easily misunderstood."

The conflicts between the public statements and classified reality of Aegis performance would continue. On October 17, 1983, the Navy again announced successful test results, claiming that Aegis had hit all 11 targets in a "recent" exercise. But in February, 1984, Representative

Denny Smith told colleagues that "a serious mismatch" existed between the Navy's public statements and the Aegis system's actual performance. Smith had been shown the classified results of the April tests, and of additional operational tests that had taken place in September, 1983. An unidentified source told the New York Times that, in the September tests, Aegis had hit only two of six targets. While it is unknown whether these were the tests referred to in the Oct. 17 Navy announcement, the different performance descriptions raised questions about the integrity of the Navy's testing process, prompting Senator Gary Hart (D-Colo.) to suggest publicly that the Navy's testing and reporting system was "fundamentally dishonest."

It took only until May, 1984 for the Navy to try again to convince Congress and the public that Aegis performance was acceptable. Eight days of tests in the Caribbean were described by Admiral Watkins as "incredibly impressive," with Aegis destroying 10 of 11 targets. Later that month, the Navy tried to nail the point home by testing Aegis against sea-skimming missiles, including the Exocet. Using a new Phalanx gatling gun capable of firing 3,000 rounds per minute -- yet another addition to the Aegis system -- the Navy claimed that three of four Exocets were downed.

On July 3, 1988 an Aegis-equipped ship in the Persian Gulf, the U.S.S. Vincennes, shot down an Iranian passenger plane, killing all 290 travellers and crew members aboard. The Vincennes' crew mistook the airplane for an Iranian F-14 military jet, and while it is not clear if the Aegis system provided inaccurate data on such things as the aircraft's altitude, angle of descent or ascent, and size, it is clear that the information the system did provide was insufficient to allow the commander of the Vincennes to make the right decision. Rep. Denny Smith (R-Ore.) says it is at least the third time the Aegis has made an operational error.

In October, 1988 the GAO's Eleanor Chelimsky stated that the Vincennes experience "gave us no new knowledge about Aegis' ability to engage simultaneous targets, or to defeat those tactics the British faced in the Falkland's war." Chelimsky accused the Defense Department of ignoring the biggest threat to ships -- anti-ship missiles skimming just a few feet above the surface of the water to avoid detection by radar. Tests of the system "fall far short of what is possible in terms of realism," another GAO official noted. Chelimsky said that most Aegis tests had been conducted against higher-flying missiles, which are easier to both track and destroy. The Navy conceded that, of 55 test firings on the Aegis system, only 16 had been at targets flying less than 100 feet.

Moreover, Chelimsky claimed that Aegis test failures were routinely classified and kept hidden from the public and members of Congress.

In March of 1986, off the coast of Libya in the Gulf of Sidra, the Aegis-equipped carrier U.S.S. Yorktown fired two harpoon missiles at what the radar identified as a missile attack vessel bearing down on the Yorktown. The Pentagon claimed it was a ship that was sunk, but later withdrew the claim and said it could not confirm if a ship had either been seen or sunk.

AGM-65D Maverick Missile

Service: Air Force

Prime Contractor: Hughes Aircraft

Mission: Air-to-ground anti-tank missile

Program Costs	Quantity	Unit Cost
$3.2 billion	23,529	$140,000

The Maverick was first developed in the late 1960s, and was guided by a television/computer system in the cockpit of the plane. But the television could not produce an image of sufficient clarity to allow the computer to lock onto the target, except in the most favorable weather and without the debris, smoke, and other distractions of a battlefield. A December 1970 GAO report found fault with both the technology and the strategy behind Maverick, noting that, "[f]or the close-air support mission, most guided missiles ... involve danger to friendly troops." GAO also criticized the testing program for Maverick, calling it "more or less emasculated."

In response to GAO's conclusion that Maverick wasn't ready for production, Congress ordered "more reliable development and test results" before it would appropriate funds. The subsequent tests in 1971 -- in the deserts of Nevada -- exploited the ability of the television system to illustrate contrasts and suppressed its weaknesses. The tests were called "highly satisfactory" by the House Armed Services Committee, and Congress gave the Air Force the go-ahead on full production.

But the Air Force's plan to send several thousand Mavericks to Europe prompted subsequent tests in Germany in 1975, ordered by a General who had used the missile with little success in Vietnam. The tests determined that the television guidance system could lock on to a target only 23 percent of the time, and no efforts to use the Maverick against moving tanks were successful.

In 1978, the Air Force abandoned the TV-guided Maverick. For two years, it had been developing a new Maverick utilizing infrared technology to replace it. The second-generation Maverick applies the same technology employed by the LANTIRN, and, unfortunately, no more effectively. IIR Maverick, as the infrared version is known, projects the thermal image of a potential target onto a five-inch screen in the cockpit, allowing the pilot to lock on. Tests of the new system in 1977, however, showed that it was easily distracted by non-targets that happen to emit heat, including bonfires, or even sun-heated rocks. Only 60 percent of the 123 Maverick test runs were successful, according to a GAO report. Not all the runs were counted, though. Pilots were allowed "practice runs" that they would never have an opportunity for in a real conflict. Inclusion of those runs would bring the 60 percent figure even lower.

Upon hearing of the test results, Congress again refused to fund the Maverick -- turning down an Air Force request for $38 million in development money.

More tests were ordered for 1978. This time, Maverick was successful in only 113 of 215 counted runs, or 53 percent. The results were more humiliating given that the tanks followed six prepared routes. In addition, pilots were given 317 practice runs -- more than were counted in the test.

Congress released funds for Maverick development in 1979 after the Air Force conducted additional tests, which it claimed had a high success rate. Both the House Armed Services Committee staff and the GAO questioned the decision, and a 1980 GAO report called for "realistic battlefield" testing of Maverick before beginning production.

Between October 1981 and January 1982, the Air Force planned five additional Maverick tests. After the first three failed, the other two were postponed. Then, on February 22, 1982, the Air Force announced that it was cancelling its plans to ask Congress to fund production of 490 Mavericks, and instead would request only 200, to be used for testing.

The following day the Defense Department announced that it was postponing a decision on long-term Maverick production, and that a final decision would not be made until 1984.

Congress appropriated about $300 million in 1984 for the Air Force to buy 3,000 Mavericks. But only 42 had been delivered when, on August 3, 1984, the Air Force suspended acceptance of the missile. In an August 22 announcement, the Defense Department accused Hughes Aircraft of having "systematic" shortcomings in the production of the Maverick and two other missile systems. The DoD statement cited "poor workmanship, inadequate translation of engineering specifications to production planning, failure of manufacturing personnel to following planning documentation, and ... failure of management to ensure the flow-down of contractual requirements to operating levels." The quality control problems, DoD said, "directly affect the integrity of products delivered to the military." In November 1984, the Air Force resumed some payments to Hughes, after Hughes had submitted a plan to correct the production flaws to the Air Force. The Air Force planned to provide approximately half its normal monthly payments to Hughes, gradually raising the amount until the improvement plan was fully implemented.

The Air Force has come under fire for not having adequately tested whether the infrared imaging Maverick would increase the survivability of fighter and attack jets. A report released by the DoD Inspector General criticized the Air Force for using test pilots who were familiar with the testing terrain, and for not simulating realistic combat conditions. The IG report also claimed the Air Force did not test the Maverick's ability to provide close ground support for soldiers, supposedly a key function of the missile. The Air Force contends its directive for the Office of the Secretary of Defense did not clarify the need to test for close air support capability. John Krings, head of operational test and evaluation has said he favors more realistic, live-fire tests for the Maverick and other systems.

The technologically discredited television-guided Maverick remains the mainstay of the NATO anti-tank force.

AH-64 Apache Helicopter

Service: Army

Prime Contractor: McDonnell Douglas

Mission: Attack Helicopter

Program Costs	Quantity	Unit Cost
$13.845 billion	984	$14.07 million

A slick promotional brochure for the AH-64 helicopter says the aircraft was named after the Apache Indians because, like the Apache, the chopper attacks from nowhere under overwhelming odds and fades away to strike again from an unbelievable distance. There is mounting evidence, however, the Apache does not live up to its name.

The $14 million Apache is designed to replace the Army's Cobra helicopter. The Apache is the first chopper built solely as an attack helicopter for use at night and in poor weather. It is also designed to provide foot soldiers with close combat support against enemy tanks. The Army hopes to buy nearly 1,000 Apaches at a total cost of about $14 billion. The cost of the AH-64 is up by almost 50% of its original projected cost.

In January of 1986, the Army grounded its fleet of 68 AH-64 Apache helicopters after the discovery of cracks in the rotor blades of 13 of them. A spokesman for the Army said the cracks had been found about 10 feet from the tip of the blades, and were in the opposite direction of the rotation. They did not affect the flight performance of the craft, nor have the cracks caused any accidents.

The 22-foot long blades are made of a combination of metals and composite materials, and are designed to withstand gunfire and collision with tree branches. They are also designed to have a life of 4,500 flight hours. The first blade found to have a crack had flown only 330 hours, and some of the cracked blades had not been taken out of storage.

By July of 1986, 100 Apache helicopters were delivered to the Army, and none met the contract requirements. The GAO has cited three major problems with the choppers. First, the tail boom, which is fitted with a tail rotor, develops cracks during hard landings despite shock absorbing landing gear. The second problem deals with wiring around the ammunition chute, which was not installed correctly. Lastly, the contractor is in charge of installing a special attachment that will hold the heavy electronic countermeasure equipment in place. This "hard spot" was not required in the original contract.

In the past, the GAO has cited other problems with the Apache. During operational testing, 49% of maintenance actions were performed with contractors' assistance or solely by contractors, a reliance that cannot be depended on in combat.

In September 1987, the Army grounded the entire fleet of Apaches after a crash in which the pilot was killed.

A February 1989 letter to Army officials from a field commander said that Apache defects are "killing us." The letter from Col. R. Dennis Kerr, an Army field commander stationed at Fort Bragg, reported that all 12 of Kerr's Apache fleet failed during war game exercises the previous month. Kerr, according to excerpts from the letter reported in the Washington Post in March, told his superiors, "If we went to war tomorrow, I'd have to recommend taking all of our AH-1s [a Vietnam-era helicopter] before we outload one AH-64." According to the Post article, cracked rotor blades prevented two of Kerr's 12 helicopters from ever leaving the ground during the exercise. Other problems included repeated jamming of the cannons, "burned-out" motors and broken drive shafts. Vibrations from firing of the cannons, Kerr reported, set off circuit breakers which cut off electricity to the fire control system.

AIM-7M Sparrow

Service: Navy

Mission: Radar-guided air-to-air missile.

Program Costs	Quantity	Unit Cost
$2.751 billion	15,588	$180,000

In testimony before Congress in September, 1984, the General Accounting Office said that one-third of the Navy's Sparrow missiles -- a cornerstone of its anti-aircraft arsenal -- were "unserviceable" for combat. The director of GAO's national security and international relations division, Frank Conahan, told a House Government Operations subcommittee that defects or maintenance problems left one-third of the 2,077 Navy Sparrows useless. The Sparrow inventory, he said, met only 32 percent of the Defense Department's war-fighting objective. (This figure included the 9,680 Sparrows the Air Force had at the time.)

AIM-9 Sidewinder

Service: Navy

Prime Contractors: 14 companies, led by Raytheon Co. and Ford Aerospace and Communications Co., share in Sidewinder production.

Mission: Heat-seeking air-to-air missile.

Program Costs	Quantity	Unit Cost
$260.7 million*	3,139	$80,000

* Fiscal Years 87-89 only

In the same testimony that disclosed widespread problems in the Sparrow program in September 1984, the GAO's Frank Conahan said that one-fourth of the Navy's Sidewinder missiles -- a cornerstone of its anti-aircraft arsenal -- were effectively useless for combat. Defects or maintenance problems, Conahan stated, rendered more than 1,000 of the Navy's 4,289 Sidewinders inoperable. (The Air Force had 15,000 Sidewinders at the time.)

Just the previous month, an inspection of 200 tail fins of the Sidewinder turned up 190 with defects, leading to the suspension of the fins. In a letter to Secretary of Defense Caspar Weinberger, the owner of Genii Research, which manufactured the fins, said that the firm had produced about 40,000 of the fins in the six years prior to the inspection for about 10,000 missiles, and that if they were indeed defective, "all 10,000 Sidewinder missiles must be grounded immediately."

AIM-54C Phoenix Missile

Service: Navy

Prime Contractor: Hughes Aircraft

Mission: Radar-guided air-to-air missile for use on F14.

Program Costs	Quantity	Unit Cost
$3.760 billion	3,401	$1.11 million

The Navy refused delivery of the Phoenix in June 1984, citing "marginal workmanship" at the Hughes plant in Tucson, Arizona. Problems included welding, wiring, and tolerance shortcomings in the missile components. The action prompted the Defense Department to suspend payments for two additional Hughes manufactured missiles, the Air Force's Maverick and the Army TOW, the following month. The Air Force stopped Maverick deliveries in early August. Six days later, Hughes announced, "As part of a far-reaching effort to improve production quality, Hughes Aircraft Co. has suspended all assembly operations at its Tucson facility until corrective actions are in place." Quality control problems at the Hughes radar manufacturing plant in El Segundo, California prompted the company to suspend work there, also. The Pentagon resumed payments in November, after Hughes submitted a detailed plan for correcting the production problems.

In September 1986, an inspection of a Phoenix uncovered 2,694 defects in the missile. Although several hundred Phoenix missiles had already been delivered to the Navy, none had yet been deployed because of ongoing doubts about its reliability. Tests had indicated that the target detection system used by the Phoenix (built by Motorola Corp.) was flawed, and that the missile was subject to electrical short circuits. In addition, the rocket motor ignition fuse was found to be susceptible to corrosion.

AIM-120A AMRAAM

Service: Air Force

Prime Contractor: Hughes Electronics

Mission: Medium-range air-to-air missile

Program Costs	Quantity	Unit Cost
$11.592 billion	24,431	$470,000

The Advanced Medium-Range Air-to-Air Missile (AMRAAM) is designed to replace the Sparrow and Sidewinder missiles. AMRAAM is an all-weather, radar-guided missile.

The Sparrow relies on its aircraft's radar to guide it to its target, while the Sidewinder zeroes in on the heat from an enemy plane. AMRAAM will have an independent radar guidance system.

Critics charge that AMRAAM has not been fully tested. "The thought horrifies me," Thomas S. Amlie, an Air Force weapons expert, told a Washington Post reporter in discussing the transition to AMRAAM. "We're gambling the nation's future air superiority."

Tests have revealed serious flaws in AMRAAM, but Hughes Aircraft, the prime contractor for the system, says those problems are over. AMRAAM "has gone through a more extensive test program" than any other missile and is now "ready for war," the company says.

The first AMRAAMS for operational use are to be delivered to the 33rd Tactical Fighter Wing at Eglin Air Force Base in Florida in December, 1989. AMRAAM production will continue until 1998.

Besides Hughes, the Air Force has contracted with Raytheon Corp. to build the missiles.

The AMRAAM program has been delayed by at least three years. Many of the recent delays were the result of test failures. Another delay resulted from development of modified software to allow the missile to be used with four different types of aircraft using four different types of radar. The missile will be deployed on the Air Force F-15 and F-16, the Navy's F-14 and F/A-18, and, at a later date, the Advanced Tactical Fighter. The Air Force will buy 17,000 of the missiles, with the Navy buying the rest of the planned production run of 24,431.

Reports released by GAO during the last three years have detailed numerous engineering problems. A July 1988 report criticized the Air Force's decision to proceed with production even though the second phase of flight tests on the system had not been completed. "Through April 1988, only 59 of the planned 89 live-fire missiles, or about 66 percent, had been launched," the GAO report states. "The Air Force determined that 44 missiles successfully accomplished their test objectives, 12 others failed, and the remaining three were recorded as no-tests because external factors prevented the testing of the missiles. The Air Force data reflects a 75 percent success rate when the three no-tests are not included in the count."

While the 75 percent success rate can be considered moderately acceptable, the report also noted that problems revealed by the tests have gone uncorrected. "Some test missiles have identified performance problems that have not been resolved. For example, missiles failed to perform effectively when the targets used certain combinations of tactics and electronic countermeasures. In addition, the missile was not effective against a very small target intended to demonstrate AMRAAM's capabilities against a cruise missile."

Test firings of AMRAAM began in 1984. Eighty-nine of the full-scale development (FSD) model AMRAAMs are scheduled to be test launched.

The GAO criticisms are only the most recent in a long-line. Hughes was first awarded a full-scale development contract for the AMRAAM in 1981. Raytheon Corp. was selected as a second source to prod a better price, and better quality, out of the weapons manufacturer, but both goals failed.

The Hughes plant in Tucson, Arizona where AMRAAM is manufactured was shut down in August, 1984 after all three service branches stopped missile production at the facility, citing quality control problems.

A year later, a DoD official with oversight on the program concluded that the AMRAAM was not ready for production. In a May 21, 1985 memorandum Jerry Miller, then the AMRAAM project officer at the Defense Logistics Agency's Product Engineering Services Office, stated that Hughes was little better prepared to produce the system than it had been when the Tucson plant was closed. The memo stated that quality control problems, poor management and flawed production processes still plagued the firm, both at Tucson and at Hughes' Canoga Park, Cal. research facility. The company, Miller wrote, "has the facilities and capacity required to build [AMRAAM], but they do not have the capability. They have not yet learned how to use or control the equipment and/or processes used in building many of the components of the missiles."

The price tag for AMRAAM was originally estimated at $3.4 billion for 20,000 missiles, expressed in 1984 dollars. That rose to $8.2 billion for 24,335 in 1987, and the latest estimate is $11.6 billion for 24,000.

Antisatellite System (ASAT)

Service: Air Force

Prime Contractor: LTV Corp.

Mission: The ASAT uses an infrared homing device to locate a target in space, which it destroys by impact. The system is launched in flight by an F-15 fighter.

Program Costs	Quantity
$1.675 billion	R&D only

The ASAT is one of the most controversial programs in the defense budget. Critics assert that deployment of such a system would spur the Soviet Union to develop a more capable ASAT system, and that the U.S. would suffer more from advanced ASAT capability, since this country is heavily dependent on satellites for reconnaissance, communications, and other military needs.

But in addition to questions of the wisdom of targeting satellites, doubts about the practicality and performance of the U.S. ASAT program have surfaced. A 1985 GAO report disclosed that the Air Force could classify a November, 1984 test of the ASAT as only a "partial success." The Washington Post reported in July 1985 that, during the test, the homing vehicle malfunctioned and could not locate the target.

The GAO report also cited 30 "technical concerns" discovered in the 1984 test, including two "high risk" concerns that directly affect the ability of the ASAT to perform its mission.

The GAO study says that the engine on the F-15 fighter, which carries the ASAT, may not be capable of boosting the weapon to the proper altitude. The engine problem is not considered insurmountable. It will, however, require a substantial financial outlay.

Aquila Remotely Piloted Vehicle (RPV)

Service: Army

Prime Contractor: Lockheed

Mission: Designed to conduct unmanned battlefield surveillance and target acquisition over enemy territory.

Program Costs	Quantity	Unit Cost
$811.8 million	1.4	$579.9 million

The Army has been trying to develop an RPV capability since 1979. RPVs are remote-controlled reconnaissance drones, designed to select targets for field artillery and precision-guided weapons, and provide other information to forces on the battlefield (troop strength and location, for example). But the RPV program has never been very successful, and the latest efforts show no more promise than earlier ones.

GAO reports in 1982 and 1984 pointed out the technical difficulties being experienced in developing the RPV, notably with computer software and the communications system. As a result, Congress refused to fund production of the system, which the Army had requested to begin before the RPV's developmental testing could be conducted.

Ten of 66 test flights conducted in 1984 ended with the vehicle either crashing or aborting its mission and parachuting to the ground. Developmental testing also failed to demonstrate several critical capabilities, including "acquiring, tracking, and designating moving targets," the automatic recovery system, and navigational ability.

An Army task force reported other serious problems with the Aquila, such as poor reliability of several subsystems and system durability.

In response to the poor performance of Aquila, the Army restructured the program in August, 1985. Operational testing of the system was postponed for one year, from September 1985 to September 1986, and the production decision, originally scheduled to be made in March 1986, was moved to March, 1987.

The following month, the Army suspended developmental testing of the Aquila, because the crash rate of the vehicle threatened to destroy all of those already built before the tests could be completed. Lockheed then sponsored a series of tests for the Army in January, 1986 and offered to put up $50 million to correct the problems and split development costs with the Army. The Army accepted the offer, and announced the resumption of full-scale development in February of that year.

According to *Defense Week*, the Aquila failed another set of tests in the summer of 1987. The initial results showed crews had trouble launching the Aquila, and that once launched, it failed to recognize stationary and moving targets.

The Army spent over $800 million on the Aquila, trying to move it into full-scale development. According to the GAO, "Because of the Aquila's problems with launch and detecting targets, and in performing the sequence of functions needed for successful missions, the Aquila ... could not dependably perform its primary mission." The Army has cancelled the Aquila.

B-1 Bomber

Service: Air Force

Prime Contractor: Rockwell International (although the plane has over 1,500 contractors and subcontractors).

Mission: A long-range bomber designed to penetrate Soviet air defenses and destroy heavily reinforced targets. The B-1 can be armed with 22 air-launched cruise missiles, as well as up to 84 conventional short-range attack missiles and gravity bombs.

Program Costs	Quantity	Unit Cost
$27.437 billion	100	$274.37 million

The B-1 is a system that has been plagued with problems since its resurrection by the Reagan administration.

Faulty design and malfunctioning equipment were blamed for an August 26, 1984 crash of a B-1 prototype which killed one person. Although the Air Force concluded that the accident had been caused by crew error, it was later disclosed that the warning light designed to alert the crew to imbalances in the craft was hidden by one of the crew members and could not be seen. (The B-1 features wings which can be swept forward to provide extra lift. Doing so, however, alters the center of gravity of the plane, and the fuel must be shifted to counteract this effect. Otherwise, the craft becomes unstable.) In addition, the bomber's automatic flight control system continued to show the plane on a steady course, even as the craft began tumbling from the sky. As a result of the inaccurate equipment and poor warning light location, the crew members were unaware of their pending fate until it was too late to save the bomber from crashing into the desert floor.

The Strategic Air Command ordered inspections of the ejection systems on the B-1 after a September, 1987 crash in which three pilots were killed. The crash was caused by a flock of birds which flew into the plane's engines, and those on board were unable to evacuate.

In a less serious embarrassment for the program, the first operational B-1 had to make an emergency landing on its way to a ceremony celebrating its introduction into the U.S. force when two of its four engines were damaged by parts of an air conditioner that had broken loose. The 30,000 people gathered for the ceremony were presented instead with a test model B-1 flown in from California.

The B-1B's electronic jamming system, the AN/ALQ-161, is fraught with difficulties. The AN/ALQ-161 is critical to the B-1B's mission of penetrating Soviet airspace undetected and unleashing nuclear weapons. The system is supposed to identify and jam Soviet radar signals automatically. The contracts for both development and production of the system were signed with Eaton Corp. on the same day in 1982. As a result, a fully integrated system of 108 separate units was not tested until production was underway. The Air Force admitted in 1987 that the ECM system might be "unfixable," but estimated that the bomber could still attain 80 percent mission effectiveness. In July 1988, that estimate was reduced to 50 percent.

The Project on Military Procurement (PMP), a Pentagon watchdog group, found that the testing and evaluation process at Eaton was "marginal." The group also found the quality of manufacturing unsatisfactory. Of 911 B-1 hardware items inspected, 196 were defective. "Obvious solder defects were not being detected," said the report. "Product quality remains a concern."

House Armed Services Committee Chairman, Les Aspin (D-Wis.) says that problems with the B-

1 are even greater than reported in the press. Fixing the problems with the 100 B-1s that the service is buying will cost $3 billion -- nearly four times the Air Force's estimate, according to Aspin. The Pentagon is paying Rockwell International $27.5 billion for the 100 bombers.

In a letter to the House Armed Services Committee, Aspin spelled out six major problems with the B-1:

* Each plane is equipped with a diagnostic set that is intended to electronically reveal repair needs in the aircraft. But 80 percent of the messages reported are false alarms, making maintenance a nightmare.

* The bomber stalls in what should be normal flying situations. To avoid this, the B-1 cannot fly with its fully designated load. Furthermore, the plane lacks stability in the air. Engineers have added 41 tons to the B-1 prototypes, causing the plane to pitch up and down, making operation very difficult.

* The B-1 suffers from fuel leaks severe enough to keep it on the ground. The bomber's fuel system is in "integral tanks" actually stored in the wings and fuselage, designed to save space. A spokesman for the B-1 program at the Wright Patterson Base in Ohio told *Defense Week*, "After a couple of hundred hours in the air, the system settles in and seems to work a lot better."

* The B-1's Terrain Following Radar (TRF) is faulty. The TRF, in its automatic mode, is designed to allow the aircraft to fly as low as 200 feet for low-level penetrating missions. The TRF has not yet been released to the Strategic Air Command, because the radar shows spikes, instructing the plane to avoid mountains that don't exist.

* The B-1B is equipped with sophisticated avionics that don't work properly. Each plane has two electronic systems: one for offense -- bombing raids -- and one for defense, i.e., countering Soviet attacks. But the two systems jam one another, and so cannot be used at the same time.

According to Aspin, the problems with the bomber are essentially "teething problems" but he is concerned that the potential exists for more serious problems. He points out that the plane will not be ready until 1990 because of the difficulties it has experienced, and further problems in the developmental and operational tests will be enormously expensive for the Air Force.

It will cost over $600 million merely to fix the problems with the aircraft. It cannot penetrate Soviet air defense because of its flawed avionics and inability to carry air-launched cruise missiles. According to Gen. Larry Welch, Air Force Chief of Staff, it will take two years to bring the penetration gear of the B-1 up to the capabilities specified in its contract. The B-1 is merely an interim replacement for the B-52, and will itself be replaced in 1990 by the Advanced Technology Bomber (ATB), popularly known as the Stealth.

The GAO found in August 1988 that much of the B-1 force was grounded, the result of spare parts shortages and a lack of pilot training. Air Force records indicate that in April of 1988, 54 percent of the bombers at the Dyess Air Force Base in Abilene, Tex. were not "fully or partially" capable of flying a mission. The GAO report also noted that B-1 contractors had received more than 1,000 waivers allowing delivery of parts that failed tests or were substandard.

On November 8, 1988 a B-1 flying at Dyess Air Force Base experienced a fire in its engines before crashing. The Air Force suspended flights of the bombers for two days in response to the crash, in order to conduct safety inspections. Ten days later, another B-1 crashed attempting to land at Ellsworth Air Force Base in South Dakota. According to the Washington Post, a classified Air Force report on the November 8 accident concluded that the crash may have been caused by "serious problems in the fuel system, lack of any way for the crew to shut off a fuel line leak and the absence of a fire alarm at a critical location."

In November 1988, workers at a Rockwell International plant in Columbus, Ohio told reporters for WBNS-TV that they believed substandard parts were used in building the B-1 even after being rejected by plant inspectors.

A GAO report released in February 1989 concluded that the B-1 continued to suffer shortcomings in its range, airborne stability, ECM, fire control system, fuel system and engines. It also estimated that fixing the problems would raise the cost of each aircraft to $400 million.

The B-1 fleet was again grounded in March 1989 after a fuel tank was ruptured by one of the plane's wings during a pre-flight check of the sweep-back wings. In the course of investigating the accident, the Air Force discovered that lubricants for the gears that swing the wings had leaked from the gear casings of 70 of the 80 planes inspected, according to the Washington Post.

The day after the leaks were disclosed, officials announced that escape hatches on two B-1s "blew off" in mid-air the previous week. The B-1 has four escape hatches for crew members, and in both cases the hatch which blew off was the one designed for the offensive operations officer.

B-2 Stealth Bomber

Service: Air Force

Prime Contractor: Northrop Corp.

Mission: Long-range nuclear weapon delivery vehicle.

Program Costs	Quantity	Unit Cost
$68 billion	132	$515.2 million

In early 1980, word leaked out that the Pentagon was conducting research on a plane so advanced it would be able to fly through Soviet airspace virtually undetected by radar. Research on the Stealth bomber, as it is popularly known, began about thirteen years ago and was accelerated during the Carter adminstration as a replacement for the B-1 bomber which Carter had cancelled.

The plane is supposed to negotiate Soviet airspace undetected by radar because of its design. The special Stealth coating absorbs radar waves rather than bouncing them back to the enemy. The engines have mufflers, rather like silencers on a gun, to reduce heat and exhaust, protecting the plane from infrared heat sensors.

The Pentagon refuses to respond to charges that the Stealth's ability to evade radar may have been outstripped by advances in radar technology. In fact, the Soviets may have the capability to foil the Stealth in place. After the second World War, the Russians built huge Yagi antennas similar to television antennas. These radar installations emit radar waves 8-16 feet, as opposed to the newer American radar which emits shorter waves. The Stealth would require four feet of coating to become impervious to 16-foot radar waves -- and with that weight if it could get off the ground, it would not have the agility or maneuverability to make it viable.

The first B-2 was unveiled in January, 1989. The craft has yet, however, to actually fly, and many skeptics claim the system's complex computer system, required to keep the tailless craft stable in flight, is too prone to failure for the B-2 to ever be effective.

Bell Helicopters

Service: Army

Prime Contractor: Bell Helicopter

Mission: Close-air support.

Program Costs	Quantity	Unit Cost
Not available		

At least 250 U.S. servicemen have been killed in at least 67 accidents aboard Bell UH-1 Huey and AH-1 Cobra helicopters since 1967, victims of a design flaw that both Bell and the Army knew existed.

The Bell helicopters are vulnerable under certain conditions to a phenomenon known as "mast bumping," in which the tiltable rotor blades of the vehicles cut into the mast. Severe or repeated contact can lead to a break in the mast, causing the rotor to fly off the helicopter or slice through the passenger compartment.

The Fort Worth (Texas) Star-Telegram reported in March, 1984 that the Army had known of the problem since 1973, when an internal study by the Army Safety Center concluded that Bell had made an "error in design" in building the helicopters around the teeter rotor system, and urged the military to stop buying the helicopters because the flaw was "intolerable."

Bell virtually ignored the study, and its findings were disputed by then-director of Army aviation, Gen. William J. Maddox, Jr., who was later hired to run Bell's Asian operations. But an internal memo written in 1979 by Bell's chief legal counsel, George Galerstein, concluded that the mast bumping problem was "very serious," and warned that the company was "very likely to be the subject of attempts at punitive damages."

Bell and many military officials long insisted that the mast bumping incidents were the result of mechanical failures, or of pilots flying outside the crafts' "envelope," or capability limits. Col. Larry B. Higgins, however, disputed that contention in August, 1983 after a helicopter he was piloting experienced mast bumping. Higgins told his superiors that his Cobra was within its operating limits when a rotor blade cut into the cockpit.

In 1970, a jury in El Paso, Texas awarded $600,000 -- later upheld on appeal -- to the widow of an Army pilot killed in a 1965 accident in a Bell helicopter. The jury called the rotor system "unreasonably dangerous." Bell has settled out of court in all subsequent suits arising from mast bumping accidents.

In April, 1973 Bell recommended that the Army purchase thicker masts to help protect against mast disintegration. An Army engineer, however, warned that increasing the thickness was futile. It would delay mast destruction for only one or two seconds, he said, and would give pilots only a "false security."

After a $97,000 Pentagon-funded study, Bell recommended in 1976 that a model of a "hub spring" -- a relatively inexepensive device to protect the mast -- be built and tested. The report also suggested that the Army modify its tactics "to minimize situations where mast bumping might occur." The Army gave Bell a $500,000 follow-on contract in September, 1977 to analyze the effectiveness of the hub spring in preventing mast bumping. In the interim, the Army agreed to purchase thicker masts for the helicopters, and to purchase "plugs" to use on thin-walled masts until the thick-walled masts could be installed.

The first mast plugs were delivered in May, 1978. In the first few months of 1979, the hub spring was tested on a Bell UH-1 helicopter and reported to be successful. At about the same time, an internal Army investigation concluded that installing hub springs on Bell helicopters would save six lives per year.

Although both Bell and the Army agreed in 1979 that hub springs offered "the greatest potential for improved mast bumping safety margins," the Army nonetheless opted for installing thicker masts rather than the $4,000 hub springs. The Army cited other costs related to installing the spring as the reason for its decision.

Bigeye Binary Chemical Weapon

Service: Designed and developed by the Navy to be used by the Navy and the Air Force; the Army is responsible for testing the chemical agents and manufacturing one of the agents under the Navy's direction.

Prime Contractor: Army

Mission: The Bigeye is designed to replace older U.S. chemical munitions (which have not been produced since 1969). Launched from aircraft (Navy A-6 and Air Force F-111), Bigeye features a "binary" system, segregating two non-lethal chemicals in separate canisters until beginning preparations for use. Then, the chemicals are mixed, producing the deadly nerve agent VX. As the bomb falls to earth, it releases the liquidic VX, which sticks to materials on the ground, where, colorless and odorless, it remains deadly for up to three weeks.

Program Costs	Quantity	Unit Cost
$1.2 billion	40,000	$30,000

One of the biggest selling points of the Bigeye chemical weapon is its supposedly increased safety over the older Weteye chemical weapon, which Bigeye is supposed to replace. But safety is the area where Bigeye has experienced the most severe setbacks.

In 1983, the Pentagon asked Congress to defer $43 million requested in the FY84 budget for Bigeye production after uncovering evidence that the bomb could spontaneously explode in flight because of pressure built up by the reaction of the mixed chemicals if the bomb was not dropped within one hour. DoD later changed the design of the Bigeye to allow mixing to occur after the bomb has been launched.

But a 1984 GAO report asserted that the new mixing system, while diminishing the "danger of [the crew and aircraft] being exposed to the nerve agent," increased the likelihood of the plane being shot down, since the bomber has to climb to an altitude of 700 feet in order to hurl the weapon toward its target while still allowing time for the chemicals to mix. (Bombers normally fly at "treetop" levels when approaching a target to avoid detection by radar.) The report charged that "[t]echnical problems still plague the Bigeye bomb development," citing test failures that occurred in January and February of 1984. In addition, the "proximity fuse" that blasts holes in the nose of the bomb to allow the liquid VX agent to spray out failed an electromagnetic test, the report said. The GAO report also stated that the Bigeye "cannot meet the operational temperature requirement for producing VX with the minimum [acceptable] purity."

In May, 1985 GAO again reported that the Bigeye had failed to produce a "sufficiently lethal" chemical reaction at higher temperatures. The agency said the Bigeye had not met specifications for toxicity in eight of nine tests conducted at over 120 degrees Fahrenheit. At these temperatures, the bomb "explodes, leaks, or falls short" of the toxicity requirements. Nevertheless, a month later Congress voted to provide $124.5 million to begin production of the Bigeye, ending a 16-year moratorium on chemical weapons production.

The GAO published another highly critical report of the Bigeye in May 1986, raising questions about the testing of the chemical compounds and the need for using it in battle, dealing the Reagan administration another setback in its quest to modernize the U.S. arsenal of chemical weapons.

Eleanor Chelimsky, of GAO's Program Evaluation and Methodology Division, testifed before Congress in June, 1986. The Bigeye test program, she said, "presents major and continuing inconsistencies .... Test criteria have been ambiguous, shifting and uncertain .... In some cases we found that tests were performed with no stated criteria at all, yet success/failure rates were given for those tests .... The DoD design for testing Bigeye is itself of uncertain validity because it omits many crucial aspects of system performance. Most troubling of all, perhaps ... is the way in which important evaluation questions are posed at the start of a test, fail to be answered (or are answered inconclusively), and then disappear from serious consideration."

The GAO is not alone in its criticism of the Bigeye. Harvard biochemist Matthew Meselson, an expert on chemical weapons, told *Defense Week* that the Department of Defense "has not demonstrated to the degree necessary that binary weapons are an improvement over unitary weapons." Developmental testing of the weapons takes place in a controlled laboratory environment, and Meselson feels it is unsafe to deploy the Bigeye without field testing, primarily open air operational testing. This is against the law, but the law can be circumvented if the Secretary of Defense decides that open air tests are necessary, and if the Surgeon General can prove there will be no danger to the public safety. Existing unitary weapons have been thoroughly tested and are based on fairly simple technology, said Meselson, and it would be a grave mistake to deploy the Bigeye without thorough testing.

Navy Capt. Richard Marsden, overseer of the program, claimed in 1987 that the bomb's reliability had dramatically improved in operational tests. But in the summer of 1988, civilian Navy officials accused Marsden of "misrepresenting" the test results, conveniently omitting information that reflected less favorably, yet more accurately, on Bigeye performance. A GAO report noted that Navy officials "now state that almost all the data [behind Marsden's claim] cannot be replicated because ... [Marsden] selectively chose the data to portray the program in a favorable way."

In one test series in 1987, several Bigeye bombs "tumbled aimlessly to Earth" because of problems with the tail fins. Another of the weapons failed to stir its liquid cargo properly. GAO declared in May 1988 that Bigeye tests had been conducted so poorly that no definitive conclusions could be drawn. It said the Navy used a "changing and loose definition of success," and that continuing defects might cause the chemicals to burn up or the bomb to explode accidentally.

Congress last fall deferred full-scale production for two years as a result of Marsden's misrepresentation, although it approved development of 100 of the weapons for additional tests.

Bradley Fighting Vehicle (M-2/3)

Service: Army

Prime Contractor: FMC Corp.

Mission: The Bradley is designed to provide "in-close" support to the M-1 tank in battlefield situations. Armed with a 25mm chain gun, coaxial machine gun, and TOW antitank guided missile launcher, the Bradley is supposed to "suppress" enemy infantry and lightly armored vehicles. The vehicle comes in two versions. The M-2, which can carry a nine-man infantry squad, includes six firing ports so that weapons can be fired from within or without the vehicle. The M-3 carries five soldiers, and is used as a scouting and reconnaissance vehicle by armored cavalry units.

Program Costs	Quantity	Unit Cost
$12.053 billion	8485	$1.42 million

> "We knew from day one if you shot a 105mm round at the Bradley, it would go right through it. If you hit it in the side with an RPG-7 [a common Soviet hand-held anti-armor missile], you'd put a large hole in it."
>
> -- *Maj. Gen. Stan Sheridan, U.S. Army (Retired), in an interview with Defense News published April 7, 1986.*

The $12 billion Bradley project is one of the Army's premier hardware programs. The Army intends to buy 8,485 M-2 and M-3 vehicles by the 1990s. FMC has delivered about 3,500. The Bradley was first envisioned as a simple replacement for the M-113 armored personnel carrier. There was conflict within the Army, and between the Army and the Office of the Secretary of Defense, over the role of the Bradley: should it remain a simple battle taxi, to ferry infantry to and from battle areas, or be armed with tank-killing weapons? Because of this debate, specifications of the Bradley often changed.

Rep. Sam Stratton (D-N.Y.), on the House Armed Services subcommittee on procurement, criticized the Pentagon's system of testing new weapons -- particularly the Bradley. "There isn't agreement on how to do the tests," he said. "The management is simply chaotic." Stratton claims that the Bradley reveals a system that is "flying blind."

Air Force Col. James Burton, head of the Pentagon's joint live-fire testing program and Pentagon whistleblower, has criticized the Army's methods of live-fire testing the Bradley. Burton was threatened with retirement from the service when he tried to have the Army conduct the live fire tests he considered necessary. In testimony before the House Armed services committee, Burton noted that his own test results on the Bradley were different from those of the Army because his calculations placed a higher priority on casualties that would be incurred in combat, while the Army places a higher value on vehicle destruction and damage.

Burton's conclusions are as follows:

* "Ammunition stored in the troop compartment is the major cause of unnecessary casualties. When this ammunition is hit, Bradley casualties increase by factors of 2 or 3. The same, incidentally, is true of the BMP, the Soviet infantry fighting vehicle.

* Fuel and fire extinguishers in the troop compartment may force the troops out of the vehicle almost every time it is hit, thereby causing greater risk of added casualties. The atmosphere inside the tank is simply intolerable.

* Bradley casualties can be significantly reduced. Moving ammunition, fuel, extinguishers out of the troop compartment would provide the greatest combat casualty reduction."

* When ammunition is hit, M-2 Bradley casualties are about the same as the Soviet BMP casualties; the Bradley ammunition presents about three times as much area to hits as does the BMP's ammunition. Thus in combat, greater total casualties can be expected.

Col. Burton has also accused the Army of attempting to skew the casualty figures in tests of the Bradley. Four investigators submitted a report to the House Armed Services Committee that review Burton's allegation that "since 1984 there had been a pattern of key Army Ballistic Research Laboratory (BRL) attempts to reduce the apparent casualties caused the Bradley during tests." While the main body of the report stepped gingerly around Burton's chief allegation, an "additional views" section written by staff member Joseph Cirincione notes, "the evidence the team examined suggests that there is a pattern of BRL testing methods which have had the effect of reducing apparent casualties reported from these tests." He said it was not clear whether the pattern was intentional or the result of the test methods employed by the Army.

An armor expert who served as an observer for the Office of the Secretary of Defense (OSD) submitted a report to the House Armed Services Committee that seems to uphold Burton's principal criticisms. According to the letter, there are ways in which one can make a weapon appear in a more or less favorable light. Total combat validity is almost impossible, but if "a whole series of test parameters are selected in one direction only, the results should be suspect," says the report.

At the beginning of the tests, the BRL testers fired smaller, Rumanian 73mm RPG's against the Bradley instead of the standard 85mm Soviet model. Col. Burton found out by accident that the smaller version was being used, says the report. The emphasis was placed on the least destructive weapon, and 14 out of the 15 shots fired were fired at a "zero degree shot obliquity" angle. The shots fired in previous tests indicated that heavier damage was inflicted inside the vehicle at higher obliquity angles. "The least damage occurred at zero obliquity," says the report, "... a benign shot line was artificially chosen. This tended to minimize casualties."

Nearly half the Bradleys in the Army's inventory were repaired in 1986 to correct critical transmission defects. The Army paid General Electric $2.4 million to make the repairs because the warranty on the transmissions had lapsed. The move to repair the transmissions came as a result of the failure of 56 Bradleys during field maneuvers in 1985.

Most of the defects can be traced back to GE's production line, according to both Army and GE spokesmen. The General Electric officials, who spoke to Defense Week magazine on the condition they not be named, said five out of seven defects were production line defects. They went on to say that 85 percent of the defects had been corrected. Army officials blamed the problems on poor quality control at GE, since General Electric did not inspect the transmission parts obtained from subcontractors. The transmissions under question were made in 1981 and 1982, during which time 1,000 were made.

Both the Army and General Electric agree that it takes three years of use for the bugs to be ironed out of a system. Nevertheless, the Army asked for only a one-year warranty. Lt. Col. McNab has told Congress that most problems in transmissions show up within a year, and to have gotten a longer warranty would have been prohibitively expensive.

FMC officials have consistently maintained that the Bradley is safe, both on land and in water. A former FMC employee who has brought suit against the company for covering up serious defects in the personnel carrier, however, has videotaped evidence that the Bradley cannot meet its amphibeous requirements.

Henry Boisvert, the former FMC test analyst, provided the San Jose Mercury with a tape showing the Bradley flooding with nearly 6,000 pounds of water during a test in a concrete-lined pond on FMC property. The tape shows the vehicle performing maneuvers in the pond while outfitted with a device called a "swim curtain" which allows the Bradley to float. At first the tape shows the Bradley swimming and reversing without a problem. But when the Bradley descended the ramp -- at 8 m.p.h as specified by Army manuals -- a huge wave poured over the swim curtain into the vehicle. The tape informs us that in the short time it took for the Bradley to enter the pond, 5,588 pounds of water entered. Steam from the water impairs vision, and the bilge pumps do not work quickly enough to empty the vehicle. The center of gravity in the Bradley becomes incredibly unstable due to the added weight, and maneuverability becomes very difficult. Meanwhile, the swim curtain has been damaged by the water.

Boisvert claims that even if the Bradley can be made to swim, it will not be practical for the battlefield because it takes far to long to install the swim curtain. Boisvert's attorney says one FMC employee told him it took three days to make the Bradley ready for a swim. According to the Army, four Bradleys have sunk during field operations, according to Army materials. So far, one soldier has drowned.

The problem, according to *Defense Week*, is really the Army, not FMC. Its rigging of the tests, and incomplete testimony in Congress has earned it the distrust of Congress, and done nothing to improve the capability of the Bradley. Nor has it proven that the Bradley can survive in a war.

The Army announced in November 1987 that new protective devices would be installed on half of the vehicles already deployed. The devices, at a cost of $113,000 per vehicle, will increase the Bradley's survivability by 50 percent, the Army estimates.

C-5A Transport Plane

Service: Air Force

Prime Contractor: Lockheed

Mission: To transport soldiers, material, and equipment.

Program Costs	Quantity	Unit Cost
$4.5 billion	81	$55.6 million

The C-5A is perhaps the classic story of a procurement program wildly out of control. Almost since the day it was designed, the program was besieged by technical shortcomings, design flaws, and defective manufacturing. Yet, the Air Force pressed ahead with its plans to purchase it.

The costs the service would pay for C-5A problems would go well beyond mere dollars. The system became a monstrous symbol of the implacability of Pentagon planners, and demonstrated more than any other program the "momentum" that builds up during the procurement process that often renders all objection and criticism futile.

As early as 1965, the Air Force knew the C-5A had problems. Lockheed's design indicated the plane was drastically overweight. To correct this, Lockheed reduced the thickness of the plane's wing material.

In 1967, engineering data gave the Air Force indication that the modified wing design "might impair future C-5A operational capabilities," according to a GAO report. And, although the Air Force requested acceleration of planned tests on the structural soundness of the wings, the concurrent development schedule left no time to conduct them before beginning production.By 1970, additional test results pointed to serious flaws in the durability of the C-5A wings. Fatigue cracks actually appeared on one test craft. Under the terms of the Air Force contract with Lockheed, the service had the right to renegotiate the contract to correct any deficiencies it discovered. Instead of doing so, however, the Air Force in 1971 -- at the direction of the Department of Defense -- converted its Lockheed contract from fixed-price to cost-reimbursement, "fixed-loss" status (Lockheed agreed to accept a $200 million loss), effectively relieving Lockheed of any financial liability for structural flaws in aircraft already delivered to the Air Force. By then, the Air Force had purchased 40 C-5As.

According to GAO, it wasn't until September, 1971 that the Air Force had sufficient test data to conclude that the C-5A "might require significant rework, modification, or replacement." The new contract, designed to protect the financially-suffering Lockheed from bankruptcy, put all financial responsibility for any such work squarely on the shoulders of the Air Force.

In September, 1975, the first consequences of the renegotiated contract came to light. The Pentagon announced that it would spend $1.5 billion to replace the defective wings on the 77 aircraft then in the U.S. forces.

But other C-5A problems were being exposed at the same time. The April 1975 crash of a C-5A near Saigon was blamed on a cargo door that didn't seal properly -- a problem that had existed since the first C-5A took off in 1969. The Saigon crash killed 155 people, including 98 Vietnamese children. A "20/20" report 10 years later would conclude that the children aboard the plane died long before it hit the ground, suffocated by lack of oxygen as a result of the leaky cargo door that ultimately caused the crash.

CH-47 Chinook Helicopter

Service: Army

Prime Contractor: Boeing Vertol

Mission: Attack Helicopter

Program Costs	Quantity	Unit Cost
$3.322 billion	475	$6.99 million

The CH-47 drew international attention in September, 1982 when 46 persons were killed in a crash in Mannheim, West Germany. The helicopter, carrying German, French and British parachutists, as well as its American crew, plummeted 1,000 feet to the earth during an air show celebrating Mannheim's 375th anniversary.

The Army blamed the accident on a bearing failure in one of the helicopter's transmission systems "due to inadequate lubrication." The transmission is supposed to synchronize the spinning of the helicopter's twin vertical rotors.

A lawsuit against Boeing Vertol, however, charged that a design defect had made the failure of the transmission bearing unnecessarily fatal. The bearing failure caused the shaft of one of the copter's rotors to slip and rub against the side of the craft. The rubbing effect cut the shaft, causing the helicopter to crash, the suit charged.

In a deposition related to the suit, Frances S. McGlade, a former chief of Army safety (the position is now filled by a military officer), stated that there had been "22 identical cases" of synchronization failure in the year and a half preceding the Mannheim incident. In addition, an investigation by a Boeing Vertol engineer of a similar accident in 1966 with the Chinook recommended that the opening for the connecting shaft be enlarged. An Army investigation into the Mannheim accident resulted in four recommendations for increasing the safety of the Chinook. The Army, however, rejected the report's suggestion that the clearance space for the shaft be increased. In addition, two other recommendations were rejected. The only recommendation adopted by the Army was that it stop using walnut shells to clean the bearing housing.

Copperhead Artillery Shell

Service: Army

Prime Contractor: Martin Marietta

Mission: The Copperhead is a laser-guided, anti-tank device.

Program Costs	Quantity	Unit Cost
$1.237 billion	24,865	$50,000

Problems with the Copperhead first surfaced in 1983 when the Project on Military Procurement released official Army reports on the results of the weapon's first operational tests, which had occurred in 1979.

The Army documents disclosed that Copperhead "does not function in anything but perfect weather," calling into question its ability to perform in the often-dismal weather of Northern Europe. In addition, it was noted, "fog, snow, [and] heavy rain severely hamper versatility of it and render it quite useless."

Copperhead may not function all that well even in "perfect weather," however. Dust on the battlefield, generated either by the general chaos of conflict or even hits by other Copperhead shells, obscures and dilutes the laser beam the weapon depends on for targeting.

But poor performance was not the only problem plaguing Copperhead. The system leaves those operating it exposed to hostile fire, and demonstrates that weapons are often designed with little regard for the realities of battlefield logistics.

The Copperhead requires two people to operate. At the front lines, a soldier aims a 90-pound, shoulder-held laser device at a tank; several miles back, another soldier fires the actual Copperhead shell from a standard howitzer. The laser beam must remain focused on the tank for at least 13 seconds. This leaves the targeting soldier exposed to easy detection by an enemy. In addition, constant radio communication is required between the two operators prior to and during firing of the Copperhead, broadcasting the positions of both to anyone who wants to find out.

Finally, the Project on Military Procurement noted that because the Copperhead has a minimum range of one kilometer, "it will be unusable for approximately 85 percent of real tank engagements."

Cruise Missiles

Service: Navy/Air Force

Prime Contractor: General Dynamics/Northrop

Mission: Cruise missiles are strategic weapons designed to attack military installations, missile silos, or other "hard" targets. Cruise missiles can be armed with nuclear or conventional (non-nuclear) warheads.

Program Costs	Quantity	Unit Cost
$10.728 billion	4,104	$2.61 million

The controversial cruise missile program has been beset by problems in its short history. Promoted as "the fastest and least expensive way to deploy additional credible deterrence against the Soviet Union," the program instead has been delayed, plagued by cost overruns, and found lacking in its performance.

The Navy Tomahawk program was restructured in January 1983, the result of miserable test results and production shortcomings, and the director of the Navy-Air Force joint program was fired. Frank Carlucci, then Deputy Defense Secretary, told reporters that a review of the Navy cruise missile program "identified a number of deficiencies."

Some of these deficiencies came to light in August 1983, when the Navy requested that $39.5 million designated for cruise missile procurement be transferred instead to research and development efforts on the missile. Cruise missiles had already been deployed on the battleship New Jersey when the request was made. Rear Admiral Daniel Cooper, testifying before Congress, admitted that both the missile and the complex computer-driven guidance system utilized by the weapon were seriously flawed. Indeed, the guidance system had already been "decertified" (declared unfit for use) when Cooper appeared before Congress. "Test flight failures, manufacturing deficiencies, delays in flight tests and decertification of the theater mission planning system (TMPS)" [the cruise missile guidance system] were among the problems cited by Cooper.

The Tomahawk cruise missile program in FY 1988-1989 shows a reduction of $1.2 billion in total estimated procurement cost which the Navy says is due to competitive procurement and less than expected inflation. All missiles in the Tomahawk family demonstrated initial operational capability by June 1984. Further information on schedule and performance is classified.

The air-launched cruise missile, manufactured by Northrop, is also beset by problems. Two former Northrop employees filed suit against the company in November 1987, claiming they were asked to falsify test data on the missile's guidance system. The U.S. Attorney's office in Los Angeles, which joined the suit in February, 1989, asserts that Northrop "systematically" falsified test data, "failed to perform certain tests, and manipulated test equipment to obtain false results on the guidance system of the nuclear warhead missile," according to a report by the Associated Press. There are roughly 1,800 air-launched cruise missiles deployed on B-52 and B-1 bombers.

D-4 Trident I Missile

Service: Navy

Prime Contractor: Lockheed Corp.

Mission: Sea-launched intercontinental nuclear weapon

Program Costs	Quantity	Unit Cost
Not available		$10 million

In congressional testimony in April 1983, Undersecretary of Defense Richard DeLauer mentioned that the Trident I missile was experiencing problems. The Navy released a statement admitting that "recent tests [had] identified possible malfunctions ... of the missile," but denied any "inherent" problems. Then, less than a month later, DeLauer disclosed that the Trident I missile had failed two of its last five tests, and called the missile's performance "lousy." This time, the Navy strongly disputed DeLauer's comments, saying, "the Navy considers the performance of the missile to be very good."

The next day, however, the Navy reversed itself. Chief of naval operations Admiral James Watkins told reporters that at least 37 Trident I missiles might have a design flaw that could let the missile fuel burn through its motor casing. The problem was in the first batch of 79 missiles delivered by Lockheed, Watkins said. Eleven of the 37 remaining first stage motors were deployed at sea at the time.

The Navy also disclosed that more than 100 Trident I first stages might have defective O-rings. These two problems were blamed for four of the ten test failures Trident I experienced.

In August 1984, a House Appropriations Committee investigation revealed that 12 deployed Trident I missiles and 23 undeployed ones had been recalled because their first stage engines contained faulty propellant. The committee report also said that improper cleaning of the engine by a subcontractor had resulted in additional recalls. The Navy issued a statement shortly thereafter saying that the first 67 Trident I motors delivered to the Navy had been found defective, but that all had been removed from service and the existing arsenal had "a high demonstrated reliability."

D-5 Trident II Missile

Service: Navy

Prime Contractor: Lockheed Corp.

Mission: Sea-launched intercontinental nuclear weapon capable of carrying up to 12 warheads.

Program Costs	Quantity	Unit Cost
$ 35.486 billion	899	$39.47 million

The Trident II missile, to be deployed on 11 Trident submarines, has suffered numerous setbacks since its inception. Although the missile is still in its testing stages, and has yet to complete an underwater-launched flight test, the Navy hopes to deploy the first 24 Trident IIs on the U.S.S. Tennessee later this year.

After a largely successful round of launch pad tests, Trident II's test program has experienced a series of failures. In January 1988, a Trident II was destroyed by remote control after it began to behave "erratically" in flight. A second Trident II was destroyed in flight accidentally in September of the same year.

The Trident II failed its first underwater test launch in a fiery explosion off the coast of Cape Canaveral, Florida on March 21, 1989. After bursting through the water's surface, the missile's engines ignited, but four seconds later it began a series of cartwheels above the water, finally exploding and falling to the sea. The Defense Department announced later that one of the control nozzles at the missile's base had failed to respond to a command to fire to straighten out the flight path after the missile had been tilted at a 19-degree angle. The Defense Department stated that the missile's self-destruct system had activated after it went off course, causing the explosion.

F-14 Tomcat

Service: Navy

Prime Contractor: Grumman Corp.

Mission: Carrier-based fighter jet.

Program Costs	Quantity	Unit Cost
$25.022 billion	527	$47.48 million

The Navy suspended routine flight operations for 139 F-14s in June 1975, in the wake of two serious mishaps within one week. In the first incident, an F-14 was forced to make an emergency landing when "a muffled explosion was heard and fire erupted from the port engine." The Navy cited "similarities" between this accident and the second, in which "damage occurred in the left engine fan and compressor action." The F-14 is powered by two TF30 engines, manufactured by Pratt & Whitney.

Only three months earlier, the Navy Board of Inspection and Survey had reported finding 67 "major deficiencies" in the F-14, including missile stations that did not work and cockpit locking mechanisms that were susceptible to failure at extreme temperatures.

In June 1976, Rep. Les Aspin disclosed that only 18 of the 67 problems had been fully corrected. "The 49 uncorrected deficiencies include inadequate engine thrust which may require a new engine and limits on the F-14's range because the engine consumes fuel faster than planned," Aspin said in announcing the flaws. Other defects included an "unreliable" computer, limited maneuverability, excessive vibration, defective warning lights, and the repeated failure of fin caps.

Aspin also revealed that only one-fourth of the F-14s in the fleet were available in December of the previous year. The rest, he said, "were inoperative because of maintenance problems or a shortage of spare parts."

A GAO report in August 1976 estimated that it would cost $1.7 billion to replace the F-14 engines. The report also disclosed that the reliability of the F-14's electronic components was "extremely low, about 6 percent to 14 percent of the desired objective."

Eight years later, the Navy officially joined the growing list of critics of the F-14 engine. In an extraordinary appearance before Congress in the spring of 1984, Navy Secretary John F. Lehman, Jr. declared that the TF30 engine "is probably the worst engine-airplane mismatch we have had in many years." Calling the engine "terrible," Lehman blamed it for 24 F-14 crashes.

Lehman went on to announce that the Navy was considering replacing existing F-14 engines with a General Electric Co. model that had been chosen earlier in the year for use in 300 F-14s which will be purchased through the end of the decade. While TF30 engines would be replaced only as they wore out, Lehman noted that "one of the problems with the TF30 is that it wears out so fast."

Engine problems are not the only ones the F-14 has confronted. In August, 1984, Hughes Aircraft Co., then already under suspension for flaws in its missile production programs, voluntarily stopped shipments of the F-14's AN/AWG9 radar system. Quality control problems with the radar included unacceptable soldering, insufficiently tightened screws, and the existence of "debris" inside the system, a Navy examination revealed. (The radar system is also used on the F-15 and F/A-18.)

The F-14 was also the victim of the "microchip scandal" of 1984. The Department of Defense found irregularities in the procedures used by Texas Instruments Co. to test its microchips and had refused delivery of F-14s until the Navy obtained an extended warranty from Grumman Corp., which purchases the microchips. Grumman extended the warranty from its normal six months to two years.

Two years later, in August of 1986, Grumman Corp. and the Navy were at odds over who should pay to fix defects in the new F-14D's central processing computer. The computer is vital to the aircraft. It integrates information from all other aircraft systems and allows them to talk to one another. While the computer is technically government supplied equipment, Grumman is under a fixed price contract with the Navy to research and develop the computer for both the F-14D and the A-6F Intruder. Since Grumman subcontracted Softech to provide the software, Navy feels that Grumman should bear the cost. Delivery of the first F-14D is scheduled for March of 1990. The Navy is planning to acquire 85 F-14Ds through fiscal 1991, but the dispute over the computer contract will probably delay delivery of the new planes.

F-15 Eagle

Service: Air Force

Prime Contractor: McDonnell Douglas Corp.

Mission: Fighter and interceptor.

Program Costs	Quantity	Unit Cost
$33.533 billion	1,172	$28.61 million

Like the F-14, the F-15 uses an engine manufactured by Pratt & Whitney, a division of United Technologies Corp. And, like the F-14's TF30, the F-15's F100 engine has been wracked with problems almost since the day it first roared off a runway.

On May 1, 1975, the Air Force grounded 20 F-15s after finding cracks in the turbine blades of an F100 engine. The Air Force attributed the problem to "a manufacturing process flaw." The planes were allowed to resume flight after each was inspected, but restrictions on operation at top speed were maintained.

To reduce the engine wear that could cause turbine blade cracks, the Air Force in 1976 and 1979 "tuned down" the engine, reducing the amount of fuel going into the engine, thereby reducing the thrust of the aircraft by about 4 percent.

One immediate result of the tune down was that F-15s began losing mock combat confrontations with slower, older, and less expensive fighters. Pilots complained of F-15 performance below what they expected. Special tests revealed that the detuning had left 15 percent of the F-15's operating well below the level sought from the detuning.

The entire 650-plane F-15 fleet was grounded in 1983 because of a defective horizontal stabilator actuator. The actuator, which helps control the plane, was found to be defective on F-15s deployed at Langley Air Force Base in Virginia. A total of 450 of the craft required a 17-hour inspection before being able to fly again.

The F-15 shares another common trait with the F-14 in addition to the maker of their engines: both utilize the Hughes Aircraft Co. manufactured radar that was found to have serious quality control problems in August 1984. Although no problems were found in any F-15s that could be traced to the radar, Hughes' voluntary suspension of shipments of the radar system caused the Air Force to have to reschedule F-15 deliveries until the problems were resolved.

In May 1985, the Air Force disclosed that 80 percent of the engines held in reserve for the F-15 fleet, which had grown to 750 planes, were "unusable." There were 110 spare F-15 engines at the time. A shortage of spare parts attributed to an underestimated "wear-out rate" left the Air Force far short of the inventory levels of only the previous January, when roughly 60 percent of the engines could be used. An Air Force spokesman said that the readiness of the F-15 fleet was not affected, insisting that over 75 percent of the F-15s had "serviceable engines."

The F100 engine was again the target of criticism in July 1986, when Rep. John Dingell (D-Mich.) charged that defective turbine blades had been "routinely installed" on F-15s, and that the Air Force knew the blades could cause crashes. Almost one-third of 30,000 blades which had supposedly been repaired by the Chromalloy Corp. were defective, Dingell said, adding that the Air Force was delaying plans to recall them. "The Air Force admits there could be a catastrophic failure of the blades, with the blades ripping through the engine, threatening the life of the pilot, and undoubtedly resulting in the destruction of the $30 million aircraft," Dingell said.

Despite Dingell's complaint, Pratt & Whitney claims it has fulfilled its obligations as far as the blades are concerned. In a letter to Rep. Dingell, the president of Pratt & Whitney said his company had no financial responsibility for the defective blades, because there is no explicit warranty to cover the problems.

According to Dingell, Pratt & Whitney has delivered 77,000 blades worth $35 million to the Air Force, which the service "is now throwing away because they contain a latent manufacturing defect and cannot be used."

A GAO investigation in the summer of 1986 uncovered a number of instances where repaired blades that were still defective were recycled into the Air Force inventory. Rep. Dingell accused the Air Force of dallying in their efforts to return them to the manufacturer. The GAO report castigates the Air Force for not catching the problem when the blades were first removed from the aircraft. "In no case should these blades have been repaired or re-used in an overhaul." According to a reporter at *Defense Week*, a toned-down version of the GAO report was submitted to top level officials in the Air Force in a briefing that failed to convey the GAO's sense of urgency about the problem. The hollow, nickel-based alloy blades are located in the second row or "stage" of the turbine.

F-16 Falcon

Service: Air Force

Prime Contractor: General Dynamics

Mission: Fighter-bomber

Program Costs	Quantity	Unit Cost
$53.770 billion	3,007	$17.88 million

The F-16 Falcon, mainstay of the Air Force's fighter fleet, was cited by the General Accounting Office in March 1979 as being propelled through its procurement cycle on the basis of inaccurate and misleading reports on system performance to Congress by the Pentagon. The GAO charged that the Department of Defense ignored "major deficiencies" in the performance of 15 major weapon systems in the weapon testing data sheets it sends to Congress. One such report on the F-16, which recommended full production of the system, conveniently failed to mention problems with the plane's engine, safety and navigation systems, and fuel system.

Later that year, all F-16 flights were grounded when it was disclosed that bolts used in the engine mounts and nose wheels of the aircraft were defective.

The F-16 was again grounded in August, 1981 when failure of its flight-control computers caused a plane to crash in Utah, killing the pilot.

The F-16 was one of the systems cited by Thomas Amlie in *Spectrum* magazine as a "magnet" for anti-aircraft weapons that home in on radar signals, raising the specter of "appalling losses" in a military conflict.

Most F-16s use the same Pratt & Whitney F-100 engine used in the F-15, and have shared many of the same problems as the other cornerstone of Air Force aircraft.

In 1985, the Air Force announced that over one-fourth of the spare F-16 engines were "unusable." Air Force spokesperson Maj. Jim Jannette said a high "wear-out rate" of parts on engines installed on F-16s had led to the shortage.

In July 1986, Rep. John Dingell disclosed that the Air Force knowingly allowed the F-16 engine to be outfitted with defective turbine blades. The blades, 30,000 of which had been removed and supposedly been repaired when the defect was uncovered by GAO, could easily cause a "catastrophic" accident, "threatening the life of the pilot ..."

Pratt & Whitney has declined to reimburse the Air Force some $9.5 million for damages caused by its defective engines. A clause in the contract, common in government contracts, "is designed to avoid the high cost of contingencies that contractors might otherwise include in their prices to cover increased financial expenditure that might occur [from mishaps]," one industry official explained.

F/A-18 Hornet

Service: Navy

Prime Contractor: McDonnell Douglas

Mission: Fighter-Attack aircraft

Program Costs	Quantity	Unit Cost
$37.610 billion	1,168	$32.2 million

The F/A-18 was conceived as a low-cost, "low-tech," lightweight fighter for the Navy. Designated first as simply the F-18, it entered production in 1979 and was first deployed in 1983. But, from the day McDonnell-Douglas began producing it, the Navy began altering the aircraft's design and mission.

Although it was designed to be only a fighter (to shoot down other aircraft), as the system's cost began to skyrocket ($310 million in cost overruns between 1979 and 1983), the Pentagon began to look for other ways to make it affordable. The solution settled on was to expand the F-18's mission to include attack functions, so that it could replace the A-7 carrier-based bomber as well as the F-14. The plane's designation was accordingly changed to F/A-18.

But in trying to fulfill two vastly different -- and mutually demanding -- functions, the new F/A-18 instead did neither well. The system quickly surpassed the F-14 in unit cost, defeating the purpose for which it had originally been developed, and was woefully deficient in serving as a bomber.

An "initial operational evaluation" prepared by the Navy in 1981 found "many limitations to air-to-ground weapon employment," the attack aspect of the F/A-18. In November 1982, Navy test pilots concluded that the F/A-18 was "not operationally suitable," and refused to endorse deployment of the system.

The tests also indicated that the range of the F/A-18 would be only half that of the A-7 it was to replace because of its size and weight. Projections indicated that aircraft carriers would have to sail as much as 200 miles closer to targets for the F/A-18 to have enough fuel to perform its mission. The Navy planned to deploy additional refueling tankers on aircraft carriers to compensate for the decreased range.

In July 1984, slightly more than one year after its initial deployment, flight restrictions were imposed on the F/A-18 fleet after it was discovered that stress induced by a design defect had caused the plane's twin tails to crack. An extension of the F/A-18 wings tapering forward to the cockpit allows the plane to climb at high angles. The extension was declared innovative at the time. Only later did the Navy discover that the extensions produce "spiraling" air currents that smash against the tails of the plane. The stress created under these circumstances is greater than the tails were designed to withstand, causing the cracks. Further deliveries of the F/A-18 were suspended until November 1984. The Navy strengthened the area where the tails meet the fuselage and ordered McDonnell-Douglas to redesign the tails and implement modifications in the production line by early 1986.

In August, 1984, the Navy suspended delivery of the F/A-18 radar system, manufactured by Hughes Aircraft Co., after a series of quality control problems were discovered in a similar system used on the F-14. Payments to Hughes were suspended by all three services in response to wide ranging problems at the company's Tucson, Arizona plant.

Just a month later, in September 1984, the Navy rejected 14 General Electric F404 engines --

used in the F/A-18 -- citing defective parts. No indication was given of plans to inspect any of the other 161 F404 engines ordered that year, or the 400 that had been delivered since 1979. The F404 engine is largely similar to the one being used in the A-6E Intruder jet that has caused such problems in that plane.

In all, 1984 was a difficult year for the F/A-18. Ironically, Secretary of the Navy John F. Lehman had told Congress in February, "This unique dual mission-capable aircraft adds a new dimension of flexibility to Navy and Marine Corps aviation ...."

The F/A-18's difficulties are clearly not over: despite months of tests, the Navy and McDonnell Douglas have been unable to find the problem with the Hornet's landing gear that causes it to buckle during landings. Ever since the jets began their service with the Navy, they have experienced problems with the landing gear. During the attack on Libya, for example, at least six F/A-18s suffered problems with their landing gear.

The problem part is called a "planning link" and looks not unlike a shock absorber. The link tucks the wheel into the proper position so it can fit into the jet's hold. During aircraft landings, the link bows.

There have not been any serious injuries or fatalities because of the malfunction, but it can cause a jet to spin sideways during a carrier landing. The Navy is considering a stronger titanium link instead of the current one made of aluminum.

High-Speed Anti-Radiation Missile (HARM)

Service: Navy, Air Force

Prime Contractor: Texas Instruments

Mission: To destroy ground-based radar systems

Program Costs	Quantity	Unit Cost
$6.877 billion	22,157	$310,000

The Navy and Air Force first sought out an anti-radar missile in the late 1960s to combat the radar-guided anti-aircraft missiles then being used by the North Vietnamese in the Vietnam war. Twenty-five years later, they began to deploy the HARM system. Between the two dates, the unit cost increased ten-fold from its original $30,000 price tag, and the simple, 'throwaway' weapon meant to saturate enemy radar sites was transformed into a sophisticated, highly specialized weapon too expensive to use except against "high priority ... air defense systems."

When the Department of Defense began to examine the possibility of establishing a second-source for the HARM in the early 1980s, Texas Instruments reduced the price of the missile to less than $400,000 each.

It is not clear that they are worth even that "reduced" price. The HARM failed five of eight test firings conducted between May 1984 and February 1985, and Texas Instruments has experienced repeated difficulty with the missiles computer system software. Then, in February 1986, the Navy suspended delivery of the missile after an inspection uncovered 26 significant shortfalls in Texas Instrument's quality control.

Current plans call for the Defense Department to buy 22,000 HARMs, but because the high cost of the HARM eliminates its usefulness as a "saturation" weapon -- the purpose for which it was originally developed -- the Department of Defense is attempting to develop low-cost alternatives to replace the system.

High-Mobility Multi-Purpose Wheel Vehicle (HUMMER)

Service: Replacement for Army, Marine Corps, and Air Force tactical vehicles, the jeep and cargo trucks.

Contractor: LTV Corporation.

Mission: To ferry personnel and equipment to and from the battlefield.

Program Costs	Quantity	Unit Cost
$1.48 billion	55,000	$27,000

For more than fifty years, the jeep has been the Army's trusty infantry vehicle, carrying soldiers to the front, transporting the wounded to safety. But the Pentagon has determined that the jeep that is in the field is obsolete. The replacement for the jeep is something called the High Mobility Multi-purpose Wheel Vehicle inaptly nicknamed the Hummer. The Pentagon says the Hummer offers greater facility in handling, particularly at great speeds, increased stability when turning quickly, power brakes and an automatic transmission that is meant to make a soldier's life easier.

But the Hummer has its problems, problems that are big ones. Peter Lance of ABC News reported in 1986 that the the Hummer radiator clogged, tires wore out very quickly, and frequent frame and body cracks occurred.

Two years earlier, the General Accounting Office (GAO) reported that the Hummer could not travel the requisite 320 miles before unscheduled maintenance actions -- it was only able to go 105 miles during operational testing before it broke down. The GAO pointed out that the Hummer's cooling system was defective, allowing the vehicle to overheat. The radiator became clogged with dirt and dust, and was difficult to clean because it was placed too close to the engine. Dirt and water thrown up against the front of the vehicle during fording of shallow streams and bodies of water caused the dirt and moisture to enter the engine.

The Pentagon has placed the blame for poor test results on the drivers, suggesting that driving too fast caused problems like cracks in the frame and worn tires.

The GAO concurs that better trained drivers would be an asset to Hummer reliability, but stresses that greater operational testing -- conducted in the conditions most resembling the battlefield -- would be of more help to correct problems with the vehicle.

As the GAO has pointed out, the main problems with the Hummer are the result of a flawed design. The flaws may have gone undetected because the Pentagon decreased the time for acquisition from seven years to five. The vehicle's development began in 1981, and by 1983, the DoD had awarded LTV Corp. a $1.2 billion contract to deliver 55,000 Hummers. The Pentagon has not gone back to the drawing board, but rather has decided to fix the defects as they go along. The Pentagon has likened the problems with the Hummer to those of a defective car -- when it breaks down, it gets fixed. As anyone who has had a "lemon" for an automobile can attest, it is tough to fix something that should have been made differently to begin with. And unlike a car, it will be difficult to recall Hummers once they have gone to war.

Low Altitude Navigation and Targeting Infrared System (LANTIRN)

Service: Air Force

Prime Contractor: Martin Marietta

Mission: A heat-seeking tank detection and targeting system.

Program Costs	Quantity	Unit Cost
$4.030 billion	1,268	$3.18 million

A 1983 report by a committee of the Defense Science Board -- which advises the Secretary of Defense on weapon system technologies -- called the LANTIRN "unreliable and vulnerable to countermeasures." LANTIRN is supposed to detect tanks at night through infrared technology by comparing heat patterns stored in the system's computer memory to those on a battlefield. The aircraft-based system is composed of a navigation pod which features a low-altitude, terrain-following radar designed to allow pilots to navigate at night, and a targeting pod, consisting of an infrared sensor, laser range designator, and tracking and targeting subsystems. Both pods are integrated with the plane's fire control system, allowing LANTIRN to lock onto a target and direct any number of weapons to it.

But, the DSB committee report doubted whether LANTIRN could tell the difference between tanks and other objects. A Pentagon official told the Washington Post that automobiles could easily be mistaken by the system for tanks. In addition, the report called the computer memory too limited to be useful. "It is extremely unlikely ... that the Air Force approach would lead to a target auto-recognition system on which one could rely," the director of the study on which the report was based wrote in the report's preface. The report also questioned the usefulness of LANTIRN testing, noting that "data on Soviet tanks operating in German forests, with camouflage, do not exist."

Three years later, the Air Force announced plans to begin initial production of the LANTIRN targeting pod, although the Pentagon's Operational Testing and Evaluation office expressed concern about the focusing ability of the system's infrared radar.

M-1 Abrams Tank

Service: Army

Prime Contractor: General Dynamics

Mission: Main Battle Tank.

Program Costs	Quantity	Unit Cost
$26.401 billion	9,317	$2.83 million

> "The M-1 tank has got to be the biggest self-inflicted wound the Army has ever eagerly sought ..."
> -- *Maj. Ronald C. Frier, Jr., 1981.*

Production of the M-1 Tank, billed at the time as the Army's biggest breakthrough in the generation of advanced new weaponry, had barely begun in 1979 before huge shortcomings in its design and performance became painfully obvious. A decade later, little about the M-1 has changed except its price.

The M-1 tank was first proposed in 1972 as a replacement for the M-60 in order to provide greater crew survivability, speed, and agility in conflicts. In addition, the M-1 promised to add an important new feature to tank performance: the ability to target and shoot while moving.

But as early as 1981, the General Accounting Office disclosed that moving across a battlefield, even with its guns silent, was a major feat for the M-1, produced at that time by Chrysler Defense, Inc., a subsidiary of the auto manufacturing corporation. According to GAO, a series of tests in 1979 demonstrated that the M-1 was capable of going only 45 miles before requiring "essential maintenance" -- in other words, before it ground to a halt. ("Essential maintenance" refers to repairs that cannot be performed on-site by the tank crew and that prevent the crew from completing its mission.)

The 1979 tests also uncovered other problems with M-1 reliability. The tank's 500-gallon fuel supply provided a range of only 130 miles in battle simulation, 250 miles in non-battle situations. Moreover, there was a 70 percent chance that after 4,000 miles of use the vehicle would require replacement of the engine, transmission, or other power-train components, even with the estimated 2,000 man-hours of maintenance the tank would undergo before then.

The same GAO report also questioned whether M-1 performance was not even more dismal. Accusations of test fixing and cover-ups were made by M-1 critics when GAO disclosed that 763 of 1,007 "incidents" during the 1979 tests were not included in the final test scores. For example, 91 mishaps were ignored because the tank crew was able to fix them within 30 minutes, even though 30 minutes of idle repair work in an actual military confrontation would be tantamount to suicide. Noted the GAO report:

> "During extended phase II testing, 1,007 incidents occurred which required maintenance actions. However, in scoring the test, most incidents were determined not to be chargeable against the tank's combat mission reliability."

The M-1 procurement program was operating under concurrent development. Thus, at the same time the 1979 test series was being conducted, Chrysler Defense was producing not prototype vehicles for further tests, but actual, front-line tanks that were expected to perform acceptably in military operations. The Defense Department ordered 110 M-1s in 1979.

Concurrent production, because it fails to disclose flaws before a system is purchased in quantity, requires much follow-up, modification and repair to the already existing systems, and production system modification to alleviate problems in systems yet to be manufactured. As a result of these modifications and repairs, the per unit cost of the M-1, projected at $500,000 in 1972 when the system was first proposed, was estimated at about $1 million in 1979, and then readjusted to $2.68 million per tank in 1981. Because of the rising cost, the Pentagon scaled back its 1979 order (which Chrysler had not yet filled due to ongoing production problems) to 90 tanks, and cut its 1980 order from 352 to 309 tanks.

In response to the flaws in M-1 performance disclosed during the 1979 tests, then-Secretary of Defense Harold Brown limited the initial production to 30 units per month. Chrysler Defense, however, was unable to maintain production at even this rate. Although the company had been scheduled to deliver 363 tanks by October 1981, only 205 had actually been built by that time.

In 1981, the production limit was lifted after the new Secretary of Defense, Caspar Weinberger, received a report from a "blue ribbon panel" convened by DoD itself to look into M-1 problems. The report concluded that, although M-1 power-train and other problems still existed, they would show "substantial improvement" if specific modifications were made.

Two months later, however, GAO released a follow-up report indicating the power-train problems had still not been resolved satisfactorily, and recommending that large-scale production be delayed until questions about transmission, engine, and other performance and durability shortcomings had been fully addressed. Nevertheless, the Army requested $1.6 billion for Fiscal Year 1982 to purchase 665 M-1s. After paring the request by $200,000, Congress agreed.

It was not long before other problems came to light. In February of 1982, just six months after Caspar Weinberger had lifted the production limitation, a Washington Post report noted that the M-1 transmission was "so delicate that it cannot do what previous tanks have traditionally done and dig itself in when it arrives where it wants to be." To solve this dilemma, the Army proposed purchasing a new Armored Combat Earthmover (more accurately described by the Post reporter as "a bulldozer"). The ACE would follow M-1s into battle and dig out ground for them as needed. The cost of each ACE would be $1.1 million, and the Army would need 600 of them for the 7,000 M-1s planned.

Less than a month later, the cost of the ACE was re-estimated at $1.6 million each. Writing in the Washington Post, Walter Pincus wryly noted that in FY 78, when the ACE had first been proposed, the cost was estimated at $200,000 each and Congress did not buy any. Reintroduced the following year, the price had jumped to $600,000 each, and Congress still would not buy any. It wasn't until 1981, "when the Army came back a third time [and] the cost per unit was put at about $1.1 million ... [that] Congress voted 'aye'."

By September of 1982, while performance and durability problems were still unresolved, questions of crew safety and design flaws were being raised. The Project on Military Procurement released a report charging that hydraulic fluid used in the M-1 had been linked to at least two tank fires, that the tank hatches leaked in the rain, and that its .50 caliber machine gun was "susceptible to accidental firing." The group also said that heat from the M-1 engine made the tank and its crew highly vulnerable to the infrared thermal imagers used for detection and targeting purposes. Finally, PMP charged that "test results show that the durability of the Chrysler-made M-1 actually has worsened since it was tested in early 1980," and accused the Department of Defense of using misleading reports and test-scoring methodology to hide the M-1's ineffectiveness.

The most recent problems with the M-1 occurred in the spring of 1987 when sudden cracks appeared in M-1A1 engines, resulting in a sudden loss of horsepower. Four of 22 engines' cracks were linked directly to faulty welding procedures at Bell Textron's Avco Lycoming Division. The cracks cause the gas turbine engine of the tank to lose 25 percent of its power. The driver is not immediately aware of anything wrong, and the Army claims the power loss does not affect his ability to maneuver. The M-1 and M-1A1 are the first armored vehicles in the world to be equipped with the turbine engine. Avco has produced 5,000 of the engines since 1979, and is expected to supply the Army with 3,299 additional engines for a cost of $1.4 billion, negotiated under a recent contract. The Army does not expect to recall any of the faulty engines but will supply patch kits to repair the damaged machines.

Cracked engines are not the M-1A1's only problem: test firings for the tank's 120mm cannon were suspended when it was discovered that the M-1A1's fire control system threw off the cannon's aim. The Army has determined that the flaw is in the prototype's design, and has redesigned the cannon, which is produced by General Dynamics. It remains to be seen if the new MRS system will be on all the M-1A1s and who will pay for the re-design.

M-247 Sgt. York Division Air Defense Gun (DIVAD)

Service: Army

Prime Contractor: Ford Aerospace

Mission: Anti-aircraft support for infantry troops.

Program Costs	Quantity	Unit Cost
$1.8 billion	65	$27.7 million

The Army first proposed DIVAD in early 1970s as a replacement for the Vulcan Air Defense System, which had first been deployed in the Korean war. The anti-aircraft gun, as envisioned, would have a range of 4 kilometers (quadruple that of the Vulcan), and would use radar and laser technology, as well as a sophisticated computer guidance system, to identify and target aircraft even at night or in inclement weather.

DIVAD was also meant to be a "model" procurement program, demonstrating the Army's ability to develop new weapon systems quickly and cheaply. To do this, the system would rely on off-the-shelf technology as the basis of its design, and the procurement program would utilize competition in awarding contracts, insist on a fixed price for the system, and demand warranties.

By the time the first DIVAD prototypes rolled off the Ford Aerospace assembly line, however, the weapon had become a boondoggle. Instead of being a "model" for how-to procurement, it became a "how-not-to" example of most everything that can -- and does -- go awry in weapon system acquisition. By the time Defense Secretary Weinberger cancelled the DIVAD program in August, 1985, more than $1.8 billion had been spent to develop and produce 65 DIVAD systems, which were ordered dismantled for spare parts and scrap metal to be used in other weapons.

DIVAD's problems first began in 1980, before Ford had been awarded the contract for the system. The Army put the Ford prototype up against a system designed by General Dynamics as part of the competitive contracting plan for DIVAD. In the shoot-off, the General Dynamics system hit 19 moving targets, compared to only nine for the Ford system. The Army, however, determined, through a "computer interpretation," that the "proximity-fused" 40mm rounds on the Ford system could be effective in destroying enemy aircraft when detonated from as far as 45 feet from the planes. As Harper's magazine put it in 1984, "Thus, 'misses' became 'hits,' and in May 1980, Ford won the contract."

More problems followed when the first DIVAD was delivered in the spring of 1982. A preliminary demonstration revealed flaws in the system's fire control unit, graphic display and armament feed system. In addition, DIVAD's control computer also worked only "erratically" at temperatures less than 25 degrees, a problem that also plagued the hydraulic system, which sprung leaks. To counter this, the hydraulics had to be pre-heated.

DIVAD was operating under a policy of concurrent procurement, part of the "model" the Army hoped would speed up the acquisition process. As a result, reliability, maintainability, and durability (RAM-D) tests on the system were not scheduled to occur until after the first production units were delivered, scheduled for March, 1984. After the demonstration, GAO recommended that RAM-D tests be performed "before awarding the second increment production contract." The Army had already contracted for 50 DIVAD units.

DIVAD was fitted with a radar tracking system designed for the F-16, and the system itself was mounted on the chassis of an M-48 tank. But this off-the-shelf technology posed insurmountable problems for the system. First, the F-16 radar had difficulty distinguishing low-flying aircraft from trees, buildings, and other ground level background "clutter," a shortcoming that was not a problem for a high-flying jet fighter like the F-16. Moreover, the 750-horsepower engine of the M-48 was designed for that 50-ton tank, not the 60-ton DIVAD. DIVAD was designed to protect the M-1 tank, outfitted with a 1,500-horsepower engine, which raised the potential that DIVAD would be unable to keep up with the M-1 in combat.

Test failures continued to plague DIVAD. In one test, Army personnel attached radar reflectors to the mast of a helicopter being used as a target, a move some said was an effort "to devise a test the weapon could pass." In another, the F-16 derived radar system honed in on -- and blasted -- an Army latrine. The radar had been duped by the latrine's ventilation fan.

The Washington Post reported that tests conducted in the summer of 1984 failed miserably. DIVAD "mistook almost half the 180 decoys sent against it for real targets," the Post reported, "and could hit only about one-third of the aerial attackers when they employed electronic countermeasures to fool the gun's radars."

In September, 1984 the Pentagon Inspector General and the GAO reported that the Army had failed to disclose information on DIVAD's performance and vulnerabilities. Key shortcomings the Army kept hidden included the effectiveness of the gun against long-range targets and susceptibility to electronic countermeasures, according to Inspector General Joseph H. Sherick.

The GAO's Henry W. Connor said that the Army had "ommitted certain information on testing limitations and safety-related deficiencies that should have been included" in its reports on the system. He noted that in reliability testing earlier that summer, the Army had planned to fire 15,000 rounds of ammunition and drive the system 4,000 miles. But equipment failures left the Army unable to drive the system more than 300 miles, and the delays caused by the failures permitted only 3,600 rounds to be fired before the conclusion of the tests. Instead of reporting these as shortfalls, however, the Army, according to Connor, "only noted that the number of events conducted was less than planned." Connor also noted other flaws in the weapon, particularly in its radar-controlled aiming system, the gun's reaction time to threats, and its continuing difficulty in targeting hovering helicopters.

DIVAD was given one more chance. The Pentagon scheduled what it admitted were "do or die" tests for the system for May of 1985. Once again, the tests failed to prove that DIVAD could work. Ford attempted to portray the tests as a success, claiming that the system had destroyed six of seven jet fighters and all three helicopters "flown into its sights" during the tests. But Rep. Denny Smith (R-Ore.) criticized the structure of the tests as unrealistic. "I do not believe that either the force-on-force tests or the tracking test performed in May 1985 have much, if anything, to do with ... Sgt. York's ability to provide air defense," Smith wrote in a July 23 letter to OT&E director John Krings. Smith said that the testers had "doubled up" Sgt. York units, and also doubled up targets, in effect quadrupling DIVAD's chances of hitting a single target. Moreover, he accused the Army of choreographing the flight paths of targets in advance, and charged that none of the target drones utilized the escape manuevers pilots would normally exercise. Finally, the Army, Smith charged, had destroyed the targets "only seconds" after DIVAD shot at them, and used this to credit "combat kills" to the system that might not have been justified.

While DIVAD's pathetic testing history alone should have been enough to kill the program, what finally prompted Weinberger to cancel DIVAD was the fact that the new generation of Soviet helicopters could easily hover beyond range of the anti-aircraft gun and, armed with long-range missiles, attack without reprisal from U.S. tanks. Weinberger announced on August 27, 1985 that DIVAD was being abandoned as an air-defense weapon, and that the Army would seek proposals for a new air-defense gun.

Midgetman ICBM

Service: Air Force

Mission: Intercontinental ballistic missile

Program Costs	Quantity	Unit Cost
$24.8 billion	500	$49.6 million

The mobile-launched, single warhead ICBM, being developed as an alternative to the MX, has run into problems long before its scheduled deployment in the early 1990s. A GAO report released in July 1985 said that the Midgetman is too small to fulfill its mission. The GAO said the 15-ton missile is not big enough to carry its fuel, guidance equipment, "penetration devices," and 1,000 pound nuclear warhead to certain targets in the Soviet Union.

The $44 billion program also faces problems in developing a mobile launch system light enough to transport the missiles quickly and yet strong enough to withstand a nuclear explosion in the area, the GAO report said.

MX Peacekeeper Missile

Service: Air Force

Major Contractors: Martin Marietta, Avco Corp., Rockwell International, Northrop Corp., Honeywell, Inc., Morton Thiokol, Aeroject Strategic Propulsion, Hercules, Inc.

Mission: 10-warhead intercontinental ballistic missile.

Program Costs	Quantity	Unit Cost
$22 billion	100	$220 million

(plus $6.827 billion for the proposed rail-basing system)

The MX missile has been controversial since its inception. Longstanding disputes on whether to purchase the system at all, and later on how -- and where -- it should be deployed, have kept the MX under intense political heat for more than a decade. Fifty MX missiles have been built to date and are deployed in silos in Wyoming. (Plans for building and deploying 50 additional MX missiles appear unlikely to come to fruition.)

Largely ignored in this dispute, however, are numerous problems with the MX, particularly its guidance system, that could prevent the missile from ever being successfully launched.

Problems with the MX first came to light in late 1987, when a motor on one missile burst into flames at a Morton Thiokol plant, killing five employees. Shortly thereafter, the Air Force discovered that Northrop Corp., which manufactures the guidance system for the MX, had systematically falsified test results on guidance system components, raising questions about the effectiveness of the missiles already deployed.

An internal Air Force report disclosed that Northrop had at one point been making an average of 4,702 changes per week in the designs for manufacturing the guidance system. In addition, some tests on the system were never conducted, results of others were falsified, and Northrop established "paper" corporations that circumvented company inspection processes.

It was revealed that Northrop lacked the equipment to properly test heat exchangers, used to prevent overheating during launch, although it had claimed the units had passed quality control inspections. The company also lowered test standards for cracked electric components it had repaired, with Air Force approval, with epoxy, so that more of the repaired parts would pass inspection.

In September 1988, the GAO reported that, as of June 1987, 47 MX inertial measurement units were scheduled for installation in missiles to be deployed. The 47 units, the GAO noted, had experienced a combined total of 40 failures, 19 in missiles and an additional 21 before being installed. The report also noted that of the 22 MX missiles deployed at that time, eight were not operational because of shortages of the units.

The Air Force removed the warheads from five MX missiles in late 1988, the Washington Post reported in January 1989, after one MX detached itself from its moorings and "fell" at least six inches in its silo. Shortly after the incident, officials at Warren Air Force Base in Wyoming, where all 50 MX missiles are deployed, declared that the MX force had reached "full operational capability" on December 30, 1988.

OH-6 Cayuse Helicopter

Service: Army

Mission: Observation helicopter

Program Costs	Quantity	Unit Cost
$1.427 billion	200	$7.14 million

A June 7, 1986 crash of an OH-6 prompted the Army to ground 350 of the helicopters for over a month. An investigation of the accident determined that an abrasive strip attached to the helicopter's tail rotor had fallen off, causing the crash. Modifications were made to the tail-rotor assemblies over several months and the helicopters were returned to force gradually.

Over-the-Horizon Backscatter (OTH-B)

Service: Air Force

Mission: To provide a "long-range tactical warning capability to help counter a threat of a Soviet precursor bomber attack on the continental United States."

Program Costs	Quantity	Unit Cost
$1.987 billion	10	$198.7 million

A 1983 GAO report stated that when initial testing of the OTH-B "showed that the radar would not meet performance requirements for an operational system," the Air Force simply lowered the performance requirements to meet the test results. The Air Force then began full-scale development.

GAO criticized Air Force plans to begin production before developmental testing was completed -- and long before operational testing would be possible -- and recommended that the Air Force "fully reassess the need and justify the decision to acquire the OTH-B radar system. Specifically, factors to be considered are the threat, the status of efforts to develop more endurable tactical warning systems, and the potential and cost-effectiveness of using existing airborne warning assets to strengthen surveillance coverage against a surprise bomber attack until a more endurable system than OTH-B can be deployed."

Patriot Missile System

Service: Army

Prime Contractor: Raytheon

Mission: Air-defense missile system.

Program Costs	Quantity	Unit Cost
$12.368 billion	108	$114.5 million

The Patriot is a self-contained anti-aircraft missile system designed to replace the Nike Hercules air defense system.

The Patriot entered initial production in 1980, limited to nine firing units (launch stations) and 176 missiles. In 1982, Congress increased the production rate to 12 launch stations and 376 missiles, although operational testing of the system wasn't slated to begin until August, 1983.

In October 1983, the El Paso Times reported that the August tests had uncovered "sloppy workmanship" by Raytheon that caused serious deficiencies in the performance of the system's radar. The Army suspended acceptance of units that failed to meet the system specifications, and Raytheon was forced to rework several units to Army satisfaction before deliveries were resumed.

Pershing II Missile

Service: Air Force

Prime Contractor: Martin Marietta

Mission: Intermediate-range nuclear weapon.

Program Costs	Quantity	Unit Cost
$2.7 billion	108	$25.0 million

In 1979, NATO^R
approved a U.S.-pushed plan to deploy 108 Pershing II missiles in West Germany, as well as 464 ground-launched cruise missiles there and in other NATO countries. The decision sparked a storm of protest by Europeans, and development of the Pershing II system was pushed forward one year -- to an initial deployment in December, 1983 -- to defuse the growing controversy engulfing allied governments.

To meet the accelerated schedule, the Army reduced the testing program from 28 to 18 launches, and combined developmental and operational tests.

By July 1983, the Pershing II had failed four of sixteen test shots. The first test Pershing II exploded 17 seconds after being launched. The warhead used in the 13th test went out of control. In the 15th test, conducted in July 1983, a safety device short-circuited the warhead's computer, effectively dismantling the guidance system. On July 27, 1983, another Pershing II rocket exploded in flight. (An early Pershing II test was only half-successful, managing to fly the full distance expected but missing its target by a wide margin.)

The Army met its deployment schedule, putting the first nine Pershing IIs in West Germany in December 1983. But the rushed timeline -- and the cut corners in development and testing -- had a price. In January 1985, just over a year after initial deployment, a faulty fuel igniter caused a flash fire as a Pershing II was being unloaded from a crate in Heilbronn, West Germany. The accident killed three American soldiers and injured 16 others.

Under an agreement with the Soviet Union reached in 1988, the Pershing II missiles in Europe will be removed and dismantled.

Stinger Missile

Service: Army and Marines

Prime Contractor: General Dynamics

Mission: Portable, hand-held air defense missile. The Army also plans to deploy 1,207 Stingers on the Hummer troop transport in a version known as the Pedestal Mounted Stinger, for which Boeing-Aerospace is the prime contractor.

Program Costs	Quantity	Unit Cost
$3.376 billion	63,278	$50,000

The second-generation Stinger utilizes what the Army calls a passive optical seeker technique (POST), a combination of infrared and ultraviolet detectors used to guide the missile to target aircraft. Stinger POST was initiated because the original Stinger, with a more primitive heat-seeking guidance system, was easily waylaid by decoys and other countermeasures.

A 1983 GAO report, written shortly after Stinger POST development was declared complete, noted that "the manufacturing processes tried so far have produced very low yields of high quality materials and components." The report also recommended hastening changes in Stinger POST design to improve the guidance system and allow the weapon to be used at night. The changes were not scheduled to begin until about 45 percent of the total planned Stinger POST purchase was contracted, and would have required modification to thousands of already-produced missiles. The Army began initial production anyway, and ordered full-rate production to begin in FY 1984.

The third-generation Stinger, known as the Stinger RMP, was found in May of 1988 to have problems with the software that runs its computerized infrared targeting system. The Stinger's Reprogrammable Microprocessor (RMP) contains "memory modules" with data on enemy infrared countermeasures. The RMP can be updated as enemy capacities advance, allowing the Stinger to meet the new threat. The flaw prevents Stinger from processing new data, debilitating its targeting functions. The Army decided to refuse delivery of the missiles until the flaw had been corrected, and made only partial payments on the missile's contract.

The Army, in keeping with its June 1988 decision, refused delivery of Stingers from General Dynamics in March 1989 when it found that the software flaws in the RMP unit, discovered almost a year earlier, continued to prevent the missile from hitting hovering helicopters which fired certain types of flares as decoys.

Titan 34D Rocket

Service: Air Force

Prime Contractor: Martin Marietta

Mission: Satellite launch vehicle.

Program Costs	Quantity	Unit Cost
$12.201 billion	57	$214.05 million

Two consecutive in-flight explosions of the Titan 34D led the Air Force to declare in July 1986 that it would "beef up" its testing and inspection programs for the rocket.

An August 8, 1985 explosion was attributed to the failure of a fuel pump and the leaking of an oxidation agent. The April 18, 1986 explosion was laid to the loss of insulation on one of the rocket motors that allowed propellants to melt through the engine casing -- a chain of events remarkably similar to those causing the destruction of the Challenger shuttle in January 1986. The April accident led the Air Force to suspend Titan satellite launches, eliminating the only vehicle for large military satellites other than the space shuttle, which was also grounded at the time.

In a press conference announcing the findings of the Air Force committee that investigated the April launch failure, Brigadier General Nathan J. Lindsay told reporters that the motor segment that caused the accident "was approaching five years old." Although he insisted that the motor is a "storable long-term vehicle," he also noted that age may have been behind the failure of the insulation to maintain its seal.

TOW Missile

Service: Army and Marines

Prime Contractor: Hughes Aircraft

Mission: Anti-tank weapon.

Program Costs	Quantity	Unit Cost
$3.215 billion*	174,645	$20,000

* TOW 2 data

There were 370,000 tube-launched, optically-tracked, wire-guided missiles, commonly known as TOW, in the hands of the Army and NATO in August 1984 when the Department of Defense announced that, because of "problems ... systematic throughout the TOW [and other] programs [that] directly affect the integrity" of the system, it was suspending payments to Hughes Aircraft, the manufacturer.

Hughes had already stopped much of its production line in Tucson, where TOW is made, when the Defense Department made the announcement. By the time of the announcement, TOW was the only thing still being produced there, the Navy and Air Force having already refused to accept any Phoenix and Maverick missiles until the quality control problems were corrected.

Hughes Aircraft president D.H. White, before shutting down the plant, defended the performance of his company in a letter to the New York Times. Hughes Aircraft, he said, "is not correcting 'shoddy' workmanship, but achieving a higher degree of perfection."

Before the Hughes assembly line could start rolling again, Frank Conahan, national security division director of GAO, told Congress that 80 percent of the Marine Corps' TOW missiles had "safety problems," and could be used only in "emergency situations." Army TOWs had similar problems, he said.

Hughes submitted a proposed three-part quality improvement program with 800 progress milestones in September 1984, and the plan was accepted by the Defense Department October 30, 1984. Delivery of TOW missiles resumed in December of that year.

The Army has undertaken to improve its TOW 2 missiles to meet the challenge of new "reactive" armor on Soviet battle tanks. The new TOW will have a tandem warhead, in which one will hit the armor, blasting it out of the way, while the other warhead penetrates the tank. The reactive armor consists of explosive bricks arranged at angles on the front and sides of Soviet tanks. When the armor is hit, it is designed to explode outward, protecting the tank from severe damage. The new TOW 2 is expected to pierce the tank's surface.

SELECT BIBLIOGRAPHY

"22 Marines Die in Crash," Washington Post, p. A1, 3/20/89.

"30,000 Hail Bomber Debut But Settle for a Substitute," New York Times, p. 20, 6/20/85.

"64 Fighter Planes Grounded By Navy," New York Times, p. 1, 12/22/84.

"A Disease That Infects Weapons," Editorial, New York Times, 8/29/84.

"A Greenhorn Rides with 'Apaches'," Christian Science Monitor, p. 1, 8/18/86.

A Quest For Excellence: Final Report To the President by the President's Blue Ribbon Commission on Defense Management, June 1986.

"Accident Spurs A Debate on Faulty Military Products," New York Times, p. A27, 3/12/85.

Acquisition of the Over-the-Horizon Backscatter Radar System Should be Reconsidered, U.S. General Accounting Office, 3/15/83 (GAO/C-MASAD 83-14).

"Aegis Guided Missile System: How Emphasis on Quality Cut Navy's Cost," *Government Executive*, V. 18, No. 4 (April 1986), p. 8.

"AF Faulted on C-5 Repair Kits," Washington Post, p. A12, 3/23/89.

"Air Force Explains HARM Test Failures," Aerospace Daily, p. 316, 8/27/85.

"Air Force Grounds Fleet of B-1B Bombers," Washington Post, p. A4, 3/29/89.

"Air Force Inspects 25 Most-Used B-1s," New York Times, p. A18, 3/30/89.

"Air Force Probes Problems of F-15 Fighter That Are Hurting Its Combat Capability," Wall Street Journal, p. 6, 10/5/81.

"Air Force Reassesses Antisatellite Program," Washington Post, p. A13, 7/11/85.

"Air Force Said to Permit Use of Defective Engine Blades," Washington Post, p. A10, 7/16/86.

"Air Force Seeks F100 Warranty Price Cut," *Aviation Week & Space Technology*, p. 27, 10/22/84.

"Air Force Suspends Flight Operations of About 20 F-15s," Wall Street Journal, p. 1, 5/12/75.

"Air Force to Beef Up Titan Inspection, Test Program," Defense News, p. 24, 7/7/86.

"Air Force Will Produce LANTIRN Targeting Pods Despite Problems," Defense News, p. 3, 6/9/86.

"Air Force Won't Say When Ban Will End On Flights by F-16s,"Wall Street Journal, p. 13, 8/11/81.

"Air Force's Maverick Missile: Its Numbers Shrink; Its Price Grows," Washington Post, p. A19, 10/8/82.

"Aircraft Engine Cracks May Force GE Redesign," Defense News, p. 1, 6/6/88.

Analysis of HARM Procurement Strategies, U.S. General Accounting Office, September 1983 (GAO/NSIAD 83-59).

Anderson, Jack. "Army Faulted on Death Toll From Accidents," Washington Post, p. D.C. 11, 5/17/84.

Anderson, Jack. "F/A-18 Aircraft is Pentagon's Latest Lemon," Washington Post, p. E16, 2/17/84.

"Army Calls M-1 'Best Tank in the World'," Washington Post, p. A4, 3/6/82.

"Army Delays Accepting New Missile Until Homing Flaw is Corrected," New York Times, p. A15, 3/27/89.

"Army Evaluates Latest Patriot Test Firings," *Aviation Week & Space Technology*, p. 83, 10/22/84.

"Army Grounds More Copters," Washington Post, p. A7, 5/8/85.

"Army is Lifting Order that Grounded Copter," New York Times, 7/17/86.

Army Needs More Comprehensive Evaluations to Make Effective Use of Its Weapon System Testing, U.S. General Accounting Office, 2/24/84 (GAO/NSIAD 84-40).

Army Operational Test and Evaluation Needs Improvement, U.S. General Accounting Office, 11/13/79 (GAO/C-PSAD 80-2).

"Army Plans Radical Changes in M-1 Tank: Costly New Vehicle is Found Vulnerable," Wall Street Journal, p. 4, 3/1/82.

"Army to Probe Crash-Plagued Copter," USA Today, p. 5, 4/23/85.

Army's Advanced Attack Helicopter is Not Ready for Production, U.S. General Accounting Office, 12/1/81 (MASAD 82-8).

"Army's Pershing Missile Fails For Third time in Four Tests," Washington Post, p. A5, 7/28/83.

Aspin, Rep. Les. "49 Major Defects on F-14," News release, 6/15/76.

Aspin, Rep. Les. "Aspin Cites 'Conclusive' Evidence of Navy Negligence in Airplane Crashes," News Release, 3/20/79.

Aspin, Rep. Les. "Aspin Reveals Millions Spent for Less Effective Engine," News Release, 8/12/76.

Assessment of the Air Force's F-16 Aircraft Multiyear Contract, U.S. General Accounting Office, February 1986 (GAO/NSIAD 86-38).

"B-1 Investigators Focus on Fuel System," *Aviation Week & Space Technology*, p. 27, 10/1/84.

"Bigeye Bomb Still Flawed," Washington Post, p. A8, 5/31/85.

Boyle v. United Technologies, U.S. Supreme Court Case No. 86-402, Decided June 27, 1988.

Bradley Vehicle: Concerns About the Army's Vulnerability Testing, U.S. General Accounting Office, February 1986 (GAO/NSIAD 86-67).

"Builder of F-18s Ordered By Navy To Boost Repairs," Wall Street Journal, p. 4, 10/10/84.

C-5A Wing Modification: A Case Study Illustrating Problems in the Defense Weapons Acquisition Process, U.S. Comptroller General, U.S. General Accounting Office, 3/22/82 (GAO/PLRD 82-38).

"Chief of Army Assails Industry on Arms Flaws," New York Times, p. A1, 8/29/83.

"Chrysler Tank Scrutinized," New York Times, p. D3, 11/25/81.

Congress of the United States, Congressional Budget Office, *The B-1B Bomber and Options for Enhancements,* August 1988.

"Critic of Army Vehicle Tests Ordered to New Post in Ohio," Washington Post, p. A17, 4/10/86.

"Cruise Missile Fails Both Flight Tests Since Its Deployment on B-52 Bombers," Wall Street Journal, p. 4, 6/3/83.

"Cruise Missile Tests Suspended," New York Times, p. A17, 6/2/83.

"C-5A Jet Repairs to Cost $1.5 Billion," New York Times, p. 1, 12/15/75.

"Defect is Identified in Trident Missile," Washington Post, p. A15, 8/15/84.

"Defense Officials Say Other Companies May Have Computer-Gear Test Problems," Wall Street Journal, p. 7, 10/17/84.

"Defense Officials Say Other Companies May Have Computer-Gear Test Problems," Wall Street Journal, p. 7, 10/17/84.

Department of Defense, Inspector General, Office of Assistant Inspector General For Auditing, "Audit of the Modification Program for the A-6E Intruder Aircraft," (Memorandum For Undersecretary of Defense for Research and Engineering, Assistant Secretary of the Navy), 4/18/85.

Department of Defense, Office of the Inspector General, *Audit Report, Stinger Weapon System,* (unclassified version released in response to Freedom of Information Act Request), April 1, 1986.

"Design Flaws Cited in B-1 Crash," New York Times, 12/23/84.

"Dogfight of the Decade," (editorial) New York Times, p. 6, 7/8/88.

"Failure of Army Pershing Missile Focuses on Non-Critical Problem," Washington Post, p. A4, 7/30/83.

"Faulty Repairs Cited in Crash," Washington Post, p. A15, 7/10/86.

Fitzgerald, A. Ernest. *The Pentagonists: An Insider's View of Waste, Mismanagement and Fraud in Defense Spending,* (Boston: Houghton Mifflin, 1989).

"Flaws Delay B-1 Bomber, Navy Missile," Washington Post, p. A12, 4/5/89.

"Fuel System Suspected in B-1B Crash," Washington Post, p. A3, 3/24/89.

"F-18 Builder Says Test Missed Design Flaws," New York Times, p. 1, 7/28/84.

"GAO Aide Warns Many U.S. Missiles Would Be Useless," New York Times, p. A1, 9/19/84.

"GAO Report Urges Hard Look At F-14A Performance, Plans," United Press International, 8/8/76.

"GE May Lose U.S. Payments," Washington Post, p. A14, 10/24/84.

"General Dynamics Chairman Assailed Over Job Talks With Navy Official," Washington Post, p. A13, 3/26/85.

"Grand Jury Bores In On the Faulty Testing of U.S. Defense Gear," Wall Street Journal, p. 1, 10/4/82.

"Grumman Amends Warranty, Resumes Navy Deliveries," *Aviation Week & Space Technology*, p. 17, 11/12/84.

"Hatches Blow Off Two B1B Bombers," Washington Post, p. A8, 4/6/89.

Helicopter Gear Failures, U.S. General Accounting Office, September 1987 (GAO/NSIAD 87-160).

"Helicopters Grounded by Air Force," Washington Post, p. A8, 3/18/89.

"Hill Hearing Told of Faulty Work by Builder of Nuclear Submarines," Washington Post, p. A12, 3/13/81.

"House Panel Says MX Tests Indicate Serious Problems," New York Times, p. A1, 8/24/87.

"Hughes Missile Payments Suspended," Washington Post, p. A1, 8/23/84.

"Hughes Missile Problem Long Known," Washington Post, p. A1, 9/4/84.

"Hughes Outlines Production Restart Plan," *Aviation Week & Space Technology*, p. 24, 10/1/84.

"Hughes Resumes Deliveries of Two Radars," *Aviation Week & Space Technology*, p. 26, 10/15/84.

"Igniter Blamed in Pershing II Fire," New York Times, p. 3, 4/24/85.

"Inquiry in Trident Missile Loss Reports No Electrical Flaw," New York Times, p. A10, 3/31/89.

"Inquiry is Pressed on MX Plant Fire," New York Times, p. A19, 12/31/87.

"It's Hard to Flunk a Weapons Test," Newsweek, p. 18, 9/7/87.

"Jet-Fighter Radar Deliveries Halted After Defects Found," Washington Post, p. A1, 8/24/84.

Large Scale Production of the M-1 Tank Should be Delayed Until It's Power-Train is Made More Durable, U.S. General Accounting Office, 12/15/81 (GAO/MASAD 82-7).

"Lessons From a Government Lawsuit: Silicon Valley's Quality Problem," New York Times, p. F3, 3/25/84.

"Maverick: Pressing for Production," Washington Post, p. A1, 6/25/82.

"McDonnell Douglas Will Resume F-18 Deliveries to U.S. Navy, Canada," *Aviation Week & Space Technology*, p. 29, 10/15/84.

"Midgetman Missile Called Too Small," Washington Post, p. A1, 7/13/85.

"Military Failed to Put Missile to Real Test,"Washington Post, p. A1, 2/24/82.

"Mishap Reported for the MX Missile," New York Times, p. A18, 1/26/89.

"Missile Parts May Not Work, Courts Told," Washington Post, p. A21, 3/10/89.

"Most Spare F15, F16 Engines Unserviceable, Air Force Says," Washington Post, p. A7, 5/8/85.

"MX Reliability in Question: Widespread Control Problems Alleged at Northrop Corp.," Washington Post, p. A1, 12/28/87.

"MX Warheads Are Removed After Mishap," Washington Post, p. A1, 1/25/89.

"M-1 Tank Still Troubled By Breakdowns, Group Says," Washington Post, p. A12, 9/20/82.

"National Semiconductor May Be Barred by DOD," Washington Post, p. C1, 5/31/84.

"Navy Awaits Outcome of Sea Trials Before Fixing Cruiser's Crooked Prow," Defense News, p. 26, 4/14/86.

"Navy Battleship Deploys Carrying Missiles That May Be Faulty," Washington Post, p. A17, 7/4/83.

"Navy Discovers Fault in Design of New Ships," Washington Post, p. A6, 12/11/84.

"Navy Grounds F-14 Fleet After Explosion and Fire," Wall Street Journal, p. 1, 6/30/75.

"Navy is Now Confident of its Trident Missile," New York Times, p. 9, 8/18/84.

"Navy Missile Project Beset By Test Problems, Delays," Washington Post, p. A2, 1/5/83.

"Navy Orders New Missiles Rebuilt," Washington Post, p. A1, 9/4/86.

"Navy Refuses Faulty Engines," Washington Post, p. A10, 9/8/84.

"Navy Refuses Shipments of Missiles," Washington Post, p. A1, 7/6/84.

"Navy Rejects Ship, Citing Gear Produced by Texas Instruments," Wall Street Journal, p. 3, 10/31/84.

"Navy Says Some Trident I Missiles in Fleet May Have Flaws That Caused Test Failure," Wall Street Journal, p. 6, 5/19/83.

"Navy Trident II Missile Explodes in Its First Underwater Test Firing," New York Times, p. A1, 3/22/89.

Navy's Plan to Second Source Aegis Shipyard Integration and Testing, U.S. General Accounting Office, Decembewr 1985 (GAO/NSIAD 86-20 FS).

Need for More Accurate Weapon System Test Results to be Reported to Congress, U.S. General Accounting Office, 3/8/79 (GAO/PSAD 79-46).

"New Flaws Found in B-1 Bomber,"Washington Post, p. A1, 7/10/88.

"New Military Concern: Product Safety," Washington Post, p. A1, 5/5/85.

"New Navy Cruiser Reported Sluggish," New York Times, p. A9, 8/17/82.

"New Tank Needs an ACE to Dig a Hole," Washington Post, p. A1, 2/9/82.

"Northrop Offers Lower-Cost Fighter In Bid for Some Air Force Business," Washington Post, p. A6, 4/5/85.

"Nozzle Linked to Trident Blast," New York Times, p. A14, 3/24/89.

Operational Test and Evaluation Can Contribute More to Decisionmaking, U.S. General Accounting Office, December 1986 (GAO/NSIAD 87-57).

"Panel Finds Army Mismanaged Tests on Vehicle," New York Times, p. A27, 5/22/86.

"Pentagon Announces Delay Until 1984 for Mavericks," Washington Post, p. A1, 2/24/82.

"Pentagon Assailed Over Weapons Data," New York Times, p. D13, 3/16/79.

"Pentagon Assailed Over Weapons Data," Washington Post, p. D13, 3/16/79.

"Pentagon Finds Unexpected Danger in 'Bigeye' Bomb," Washington Post, p. A1, 5/7/83.

"Pentagon, Hill Clash on Fate of Bradley Live-Fire Test Advocate," Defense News, p. 3, 4/14/86.

"Pentagon Makes $1.6 Billion Bet on Shell," Washington Post, p. A12, 4/11/83.

"Pentagon Says Faulty Chips Threaten Arms," Washington Post, p. A1, 9/12/84.

"Pentagon's Report Doubts Value of Costly Tank Detection System," New York Times, p. A26, 9/20/83.

Performance Capabilities of the C-5 and C-17 Cargo Aircraft, U.S. General Accounting Office, 7/9/84 (GAO/NSIAD 84-119).

"Pershing Test Delayed for X-Ray of Engines," Washington Post, p. A1, 8/23/83.

"Phoenix Flight Tests Underway," Defense News, p. 10, 6/16/86.

"Problem Navy Missiles Put at 21% By Official, Who Faults Congress," New York Times, p. 14, 9/20/84.

"Problems Found in Nerve Gas Bomb," New York Times, p. 11, 10/26/84.

"Problems Ground Most B-1 Bombers, " Washington Post, p. A4, 8/28/88.

Procurement of the Army's AH-64 Helicopter, U.S. General Accounting Office, 8/3/82 (GAO/MASAD 82-40).

Production of Some Major Weapon Systems Began With Only Limited Operational Test and Evaluation Results, U.S. General Accounting Office, 6/19/85 (GAO/NSIAD 85-68).

"Repair Firm Suspended By Air Force," Washington Post, p. A17, 7/3/86.

"Report Says Bomber Had Fire Before Crash," New York Times, p. A25, 2/15/89.

Reporting on Chemical Testing of the Bigeye Binary Chemical Bomb, U.S. General Accounting Office, 10/30/84 (GAO/NSIAD 85-3).

Rickover, Adm. Hyman. *No Holds Barred,* (final congressional testimony), 1/31/82.

"Rough Riding: Costly New M-1 Tank Fails More Army Tests, Price Keeps Increasing," Wall Street Journal, p. 1, 4/20/81.

Selected Analyses of M-1 Tank Budgets for Fiscal Years 1980-85, U.S. General Accounting Office, February 1986 (GAO/NSIAD 86-75FS).

"Services 'Waste $300 Million' on Their Laser-Guided Weapons," Defense News, p. 23, 6/2/86.

"Sixty Percent of U.S. Navy's Intruder Fleet is Grounded or Restricted," Defense News, p. 3, 3/2/87.

Smith, Rep. Denny. "Big-Show, No-Go Weapons," Washington Post, p. C1, 7/31/88.

"Software Woes Plague New Version of Stinger," Defense News, p. 1, 5/16/88.

Stinger Post Air Defense Missile: Potential Production Problems, Planned Improvements, U.S. General Accounting Office, 1/26/83 (GAO/MASAD 83-10).

"Stinger Test Results Vex Experts," New York Times, p. 20, 5/27/84.

"System to Locate Enemy Tanks Called 'Unreliable' By Pentagon," Washington Post, p. A11, 9/20/83.

"Technical Woes Stall Navy's Huge Torpedo Defense Plan," Defense News, p. 9, 6/9/86.

"Terrible' F-14 Engine Criticized by Lehman," Washington Post, p. A2, 7/19/84.

Testing Oversight: Operational Test and Evaluation Oversight Improving, But More is Needed, U.S. General Accounting Office, March 1987 (GAO/NSIAD 87-108BR).

"Texas Instruments Says Testing Faulty on 10% of 2,000 Suspect Parts," Wall Street Journal, p. B3, 9/20/84.

"Third B-1 in 14 Months Crashes; Crew Safe," New York Times, p. 8, 11/19/88.

"Top Army Attack Helicopter Faulted," Washington Post, p. A12, 3/19/89.

"Trident I Missiles Misfired in Recent Tests, Sparking High-Level Concern in Pentagon," Wall Street Journal, p. 7, 5/18/83.

Trident II Acquisition, U.S. General Accounting Office, (GAO/NSIAD 89-40).

"Trident II Missiles Fails in First Undersea Launch," Washington Post, p. A12, 3/22/89.

"Two Tests of Navy's New Aegis Cruiser Give Widely Disparate Marks to Ship's Abilities," Wall Street Journal, p. 37, 11/4/83.

"U.S. Air Force Orders Engine Checks on F-16s," Defense News, p. 12, 10/17/88.

U.S. Comptroller General, *The Army's AH-64 Helicopter and Hellfire Missile Retain Risks As They Enter Production,* 1/26/83 (GAO/C-MASAD 83-9).

"U.S. Suit Says Northrop Failed to Text MX Device Properly," Washington Post, p. A6, 8/26/87.

"Unsafe at Any Altitude? Military Helicopters May be Defective," Washington Post National Weekly Edition, p. 6, 5/20/85.

"USAF Resumes Hughes Missile Funding," *Aviation Week & Space Technology,* p. 30, 11/26/84.

"Warplanes Grounded By Navy," Washington Post, p. A1, 12/22/84.

"Watchdog's Reports Lack Bite, Washington Post, p. A21, 3/27/87.

Weapon Systems Overview: A Summary of Recent GAO Reports, Observations and Recommendations on Major Weapon Systems, U.S. General Accounting Office, 9/30/83 (GAO/NSIAD 83-7).

"Weapon Test Was Fudged," Washington Post, p. A11, 1/25/86.

Weapons Acquisition: Processes of Selected Foreign Governments, U.S. General Accounting Office, February 1986 (GAO/NSIAD 86-51FS).

"Weapons' Radar Called A Magnet for Enemy," Washington Post, p. A1, 3/27/82.

Weapons Testing: Quality of DOD Operational Testing and Reporting, U.S. General Accounting Office, July 1988 (GAO/PEMD 88-32BR).

"Weinberger Says Report False, New Cruiser Not Unstable," Washington Post, p. A2, 8/19/82.

Welch, Thomas J., Deputy Assistant Secretary of Defense, Department of Defense, "The Bigeye Chemical Weapon: 'It's Ready'," Letter to the editor, Wall Street Journal, p. 12, 6/24/85.

"When Weapons Flunk," (Editorial) New York Times, p. A22, 7/14/83.

"Workers: B-1s Built With Defective Parts," New York Times, p. A5, 11/30/88.

"Years of 'Requirement Creep' Send 'Silver Bullet' Off Its Mark," Washington Post, p. A8, 5/19/85.

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