BY THE COMPTROLLER GENERAL

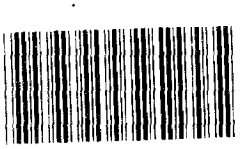
Report To The Congress

OF THE UNITED STATES

Implications Of Highly Sophisticated Weapon Systems On Military Capabilities

A host of factors surrounding the reliability, availability, maintainability, and sustainability of major weapon systems being acquired today contributes to serious problems. These systems developed by the United States have grown in sophistication, complexity, and cost to a point where only relatively low quantities are being acquired. High operating and support costs for these weapons compound budgetary problems. A low state of readiness can result when the systems do not work properly.

As recommended in a previous report, the Congress should carefully examine lower cost alternative programs before approving new weapon systems. In particular, it should explore with senior military officials the pros and cons of larger quantities of alternative weapons versus smaller numbers of highly sophisticated and expensive systems.



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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This report identifies the highly sophisticated nature of deployed weapons as a contributor to budgetary problems, inventory shortfalls, and a low state of readiness for certain combat categories. It points out that Defense efforts to introduce lower cost weapon systems that are more reliable, available, and maintainable have not been as successful as desired. The review, requested by the chairman of the Senate Committee on Foreign Relations, was prompted by our November 8, 1979, report on "Impediments to Reducing the Costs of Weapon Systems," PSAD-80-6.

We are sending copies of this report to the Director, Office of Management and Budget; the Secretary of Defense; and the Secretaries of the Army, Navy, and Air Force.

Milton J. Socolar

Acting Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

IMPLICATIONS OF HIGHLY SOPHISTICATED WEAPON SYSTEMS ON MILITARY CAPABILITIES

D I G E S T

A widely held view in the Congress, military, industry, media, and general public is that many of the weapon systems deployed by the United States today are too technologically complex to permit a reasonable degree of confidence that they will work properly when needed. Consequently, the Nation's ability to be sufficiently prepared to sustain itself in a major war is of serious concern.

GAO believes that the sophistication of many weapon systems deployed today is one of the contributing factors that has led to budget problems, inventory shortfalls, and a low state of readiness for certain combat categories. High technology, sophisticated, complex, weapon systems by themselves do not automatically create readiness problems. They do, however, set the stage. Other influences include high performance demands, inadequate testing of systems, design deficiencies, supply issues, maintenance issues, logistics concepts, management, and training.

GAO is not advocating that Defense elements do anything which would tend to lessen any technological advantages currently existing or that they use cheap or simple weapons in quantity as substitutes for more costly, more capable equipment. However, it believes that, although high performance systems adequate to meet the threat must be acquired, a much better balance between performance and reliability must be obtained.

TRENDS AFFECTING CAPABILITY

Although the United States has historically procured military equipment in quantities sufficient to present a credible defense posture, concern rose in the 1960s as the unit cost of equipment increased significantly due to the introduction of highly complex and sophisticated equipment. Concern built up as the U.S.

qualitative edge over the Soviets began to slip. (See p. 4.)

The cost, quantities, reliability, availability, and maintainability of many highly sophisticated systems deployed in the early 1970s raised serious concerns about the emphasis on performance. Although the Department of Defense introduced policies to help overcome these problems, it could have no effect on systems entering production and little effect on many of the weapons already in advanced development, some of which have not yet been deployed. (See pp. 4 to 13.)

Some development programs in the mid to late 1970s were structured to reflect the intent of the new Defense policies and emphasized larger quantities; lower cost; and better reliability, availability, and maintainability. These programs were initiated in response to direction by the Congress or the Office of the Secretary of Defense; rarely have the services initiated development of low cost alternatives. Moreover, even in these programs the degree of success in lowering acquisition costs is nowhere near the magnitude desired. The results of efforts to provide increased reliability and lower operating costs will not be known for some time. (See pp. 8 and 22.)

In summary, several problems have resulted from acquisitions during the 1970s:

--Few weapons are available due to high unit cost.

--Weapons have reliability, availability, and maintainability problems.

--Small annual procurement quantities are uneconomical.

--High operating costs tax training resources.

--Complexity and sophistication aggravate personnel problems.

While Defense has tried to reverse this trend, it has not been as successful as desired. (See p. 8.)

BUDGET IMPLICATIONS

The operation and maintenance budget, portions of which are used to support deployed weapon systems, has increased substantially over the past few years; and it is expected to further increase in fiscal year 1981. However, the operations and maintenance budget supports so many activities that it is difficult to determine whether or not the projected increases will be sufficient to significantly improve readiness. (See p. 21.)

The cause of any deficiencies in operations and maintenance funding is not totally clear. However, it seems that the services have chosen to develop a variety of high performance systems in lieu of seriously addressing the problems found in today's deployed systems. (See p. 22.)

CONCLUSIONS

High performance systems are costly. Those responsible for developing and acquiring new weapon systems must be just as concerned with the capability of the equipment when it is deployed as they were with the acquisition.

Although some yet-to-be deployed systems designed in the mid-1970s are likely to exhibit many of the same problems occurring in the high performance weapons deployed today, recently developed systems should benefit from emphasis on reliability, availability, and maintainability, therefore presenting a brighter future. However, a reappraisal of some may be in order. (See pp. 11 and 12.)

As shown by recent directives, more attention should be paid in the early design of weapons to the best mix of high performance and support characteristics, considering expected force resources and operations. Defense's emphasis on lower cost weapon systems and greater reliability, although well placed, does not appear to have been sufficient. While established inventory objectives for new weapons are high, rapidly rising unit costs make it unlikely that they can be achieved without major

increases in or realinement of the defense budget. (See pp. 5 to 10.)

RECOMMENDATIONS TO THE CONGRESS

As recommended in a previous report, 1/ the Congress should carefully examine lower cost alternative programs before approving new weapon systems. In particular, the committees should explore with senior military officials the pros and cons of larger quantities of alternative weapons versus smaller numbers of highly sophisticated and expensive systems.

In accordance with the wishes of the chairman of the Senate Committee on Foreign Relations, GAO did not solicit comments on this report from the Department of Defense. This was because he wanted to have this report in the hands of the Congress before completing congressional actions on the fiscal year 1981 Defense authorizations and appropriations.

1/"Impediments to Reducing the Costs of Weapon Systems," PSAD-80-6, Nov. 8, 1979.

Contents

ABBREVIATIONS

DOD	Department of Defense
GAO	General Accounting Office
NATO	North Atlantic Treaty Organization
OSD	Office of the Secretary of Defense
O&M	operation and maintenance

CHAPTER 1

INTRODUCTION

This review, requested by the chairman, Senate Committee on Foreign Relations, was prompted by our report to the Congress entitled, "Impediments to Reducing the Costs of Weapon Systems," (PSAD-80-6, Nov. 8, 1979). That report addressed the military's tendency to procure expensive, high technology weapon systems.

In his request, dated February 1, 1980 (app. I), the chairman asked that we take a closer look at this trend and its impact on the cost and size of the Armed Forces and the implications of these developments on the military's capability to perform its missions. In subsequent discussions with the committee staff, the scope of the request was reduced. Consequently, force structure, personnel, and the rapid deployment force issues are not discussed herein.

BACKGROUND

In the November 8, 1979, report, we identified a number of factors leading to increased weapon systems costs, discussed steps that have been taken to control those costs, and recommended further actions which could be helpful in restraining future costs.

We reported the major effects on costs have resulted from

--attempts to deploy systems with new technology and high performance;

--low rates of production due to budget constraints and desires to maintain active production bases as long as possible;

--absence of price competition between contractors;

--lack of real motivation on the part of contractors to reduce costs;

--the impact of socioeconomic programs, Government controls, and red tape; and

--a nationwide problem of reduced research and development expenditures and lessening productivity.

In our opinion, one of the principal factors that tends to drive costs upward is the desire for high technology systems. In addressing this issue, we stresed the drive for

greater capability usually means complex electronic, avionics, fire control systems, and so forth, that keep adding to the cost in three ways. First, the research, development, and test costs are driven up by the need to design, test, and integrate these complex subsystems to make them all work together to do the desired job. Secondly, the cost of producing these items is extremely high, pushing the acquisition costs way up. Third, and probably the greatest cost, is the high maintenance and support costs of the deployed system.

HISTORICAL PERSPECTIVE ON CONCERN FOR EXCESSIVE COMPLEXITY

The concern about excessive complexity and its ramifications is not a new issue. Over the years, numerous studies and hearings by various congressional committees have expressed concern about complex and sophisticated weapon systems. 1/ The following illustrates the type of problems and some corrective actions cited in hearings held in the late 1960s and early 1970s:

Problems	Corrective actions
Complexity degrades performance	Increase reliability
Designs too sophisticated	Build on an austere, low cost basis
System rewards complexity and penalizes simplicity	Change motivation and attitude
Not enough attention given to systems reliability, maintainability, and durability	Build into initial design
Difficult to tell in advance if system is too complex, goldplating discovered too late	Take positive action to reduce goldplating and institute continuous trade-off reviews
Force effectiveness not emphasized in mission planning	Need to balance simplicity with complexity and cost with quantities and quality

The hearings usually reference well-known cases such as the Cheyenne helicopter, Gamma Goat, predecessor tanks to the current XM-1 tank, the F-111 (TFX) program, C-5A, and aircraft

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1/The terms "complexity" and "sophistication" have been used interchangeably in this report because source documents from which the report was drawn used them in this manner.

engine programs. The development of sophisticated missiles, surface-to-air weapons, destroyers, submarines, communications equipment, early warning radars, and so forth, were also questioned during these hearings.

SCOPE OF REVIEW

Primarily, we examined reports and studies on major weapons issued by the Congress, Congressional Research Service, Congressional Budget Office, Logistic Management Institute, Defense Science Board, and the Department of Defense (DOD), and GAO.

In accordance with the wishes of the chairman, Senate Committee on Foreign Relations, we did not request comments on the report from DOD. This was because he wanted to have this report in the hands of the Congress before completing congressional actions on fiscal year 1981 Defense authorizations and appropriations.

CHAPTER 2

TRENDS IN THE ACQUISITION OF HIGH PERFORMANCE EQUIPMENT

THE MOVEMENT AWAY FROM QUANTITY TO QUALITY WEAPON SYSTEMS

Historically, the United States has relied more on the use of large quantities of weapons rather than low numbers of highly sophisticated "quality" weapons to help win its wars. The switch to a strategy of quality versus quantity started after World War II when we had the atomic bomb and the Russians retained a large Army. Neither the United States nor other North Atlantic Treaty Organization (NATO) countries wanted to maintain large armies, so the strategy of small forces backed up by nuclear weapons was adapted. Subsequently, the Russians developed tactical nuclear weapons and the strategy had to be reconsidered. Although the Warsaw Pact outnumbered NATO in some areas, overall Allied capability was considered superior due to the quality of equipment furnished to our forces. Thus, the concept of flexible response was adopted based on the assumption that a conventional war was not hopeless. For example, quality forces could offset a greater quantity force, and a conventional war need not escalate to a nuclear war. The United States felt it could contain a conventional war by a modest increase of forces in Europe and by maintaining a qualitative weapon edge.

During the 1970s the United States began to realize that it had underestimated the Russian buildup, particularly in the quality of weapons being produced for its ground forces. The qualitative decline in the Army's weapons compared with those of the Soviets was addressed by the Assistant Secretary of the Army for Research, Development and Acquisition in early 1980. He said that the U.S. Army is facing superior hardware in virtually every major combat category: tanks, firepower, rockets, fighting vehicles, air defense equipment, chemical warfare ordnance, electronic warfare gear, bridging, and others. He attributed the qualitative decline to a series of factors like the Vietnam war, insufficient modernization resources, and developmental failures.

The Secretary seems to have been reiterating a concern on quality and quantity appearing in a 1979 Army Science Board summer study. The study reported that:

> "The idea that superior system quality (assuming it exists) can substitute for system quantity must

be addressed, because it suggests that it is all right to be substantially outnumbered. Except for the generally accepted advantage accorded to defensive forces, there appears to be no substantial basis for claims about quality. * * * Higher quality can be expected to have only a small influence on the outcome. Anyway, the issue is made moot by the fact that the Soviets have maintained general equivalence in the quality of fielded equipment."

It should be noted that this same complaint about an inferior quality of equipment is not apparent in the testimony of Air Force or Navy officials.

TRENDS--COST, QUANTITY, AND EMPHASIS ON PERFORMANCE

The cost of a weapon system can be an indicator of the degree of sophistication, complexity, and performance expected in that system. Obviously, that is not always the case, but in looking at weapons within a class of equipment, it does give some indication. For example, in the listing that follows, the F-16 and F-18 were planned as the low elements of the high/low mix with the F-15 and F-14 representing the high elements. Overall, the listing shows examples of how costly our high performance systems have come to be and that some of the most recently developed systems--the XM-1, the F-16, F-18, and UH-60A--are in line with the stated Office of the Secretary of Defense (OSD) objectives to procure in larger quantities. (OSD's objective to procure at lower unit costs has been a major goal for these systems, but it has not been achieved due in part to the effects of inflation.) The relatively larger quantities planned for acquisition present the opportunity for improved economical production and procurement. However, these large inventory objectives can only be realized if complexity and unit cost can be kept under control or if larger DOD budgets are assumed.

High Cost Weapon Systems

Systems	Escalated program unit cost estimate		Initial deployment	
	Original	Current	Quantity	Date
	-------(millions)-------			
Tanks:				
XM803/MBT-70	$ .6	$ .9 (1971$)	2,406	Canceled
XM-1	1.4	1.8 (1979$)	7,071	Early 1980s
Aircraft--Navy:				
F-14	12.6	22.9 (1979$)	491	1973
F-18	15.9	21.2 (1979$)	1,377	Future
Ships:				
FFG-7	64.9	207.7 (1979$)	55	1977
CG-47	880.2	951.9 (1979$)	18	Future
Aircraft--Air Force:				
F-15	9.8	19.0 (1979$)	749	1975
F-16	9.2	13.2 (1979$)	1,396	1978
Surface-to-air firing units:				
Improved Hawk	5.7	11.8 (1978$)	100	1972
Patriot	21.8	56.8 (1979$)	108	Future
Helicopters:				
UH-60A	2.1	5.3 (1979$)	1,117	1979
AH-64	6.9	10.6 (1979$)	545	Future
CH-53E	7.8	16.5 (1979$)	53	1981
LAMPS MK III	15.5	17.5 (1979$)	209	Future

As early as 1973, OSD's Defense Science Board reported that the drive for performance is a cultural problem--that is, the tendency to bias the decision in favor of the high performance option is present in all levels of the acquisition process, operational requirements, technical approach, system program office practices, and staff biases. The Board reported that it is the kind of a problem that directives will not remedy, although directives can aid to change DOD processes. Rather, individual values have to be changed and incentives must be established to promote individual awareness that the tendency towards high performance is not the only way to go. The Board also stated that until the awareness of the impact of high unit cost systems on the readiness and overall capability of the military becomes widely known, no progress will be made in slowing the trends.

The problem of high unit costs and high performance, however, still persists as a major problem. A 1979 study by the Defense Science Board entitled "Reducing The Unit Cost Of Equipment" was published in March 1980. This study was initiated because the unit cost of equipment had been growing at a faster rate than the defense budget. An example cited indicates that the unit cost of fighter aircraft has grown at a rate of almost 10 percent per year over the last two decades while DOD procurement outlays have remained roughly the same in real terms. The study addressed a number of specific questions, but it also pointed out the need to consider quantity versus quality in generating requirements. Specifically, the study stated:

> "It is clear that, in order to reduce unit cost, we need to consider cost in the specifications for, and the selection of weapon system concepts prior to the development cycle. The requirements process should explicitly consider quantity versus quality of equipment. Some recent tests suggest that the quality of U.S. equipment is not making up for numerical deficiencies. We must provide incentives to the requirements process to prevent gold-plating and reduce recurring costs, so we can buy new equipment in larger quantities that better support total force capability."

The task force proposed a number of recommendations and concluded that within limits, cost reductions can be accomplished. However, such reductions will not solve the problem of adequately maintaining the current inventory. One recommendation related to high performance weapons was proposed.

> "The Task Force concluded that the Defense Department creates requirements to meet threat projections that often do not materialize. This drives the costs of systems to higher and higher levels. There is, irrationally, a general reluctance to permit development of a future system unless it can be proven to meet even the most inflated, postulated threat. This subject should be reviewed at the national level as a matter of priority."

The emphasis on performance is also driven by the inflexibility of the force structure. The services argue that as long as they are constrained in force size (for example, the number of divisions, ships, and aircraft), they must develop and procure high performance. However,

there is an inconsistency here because frequently a service after acquiring a high cost, highly sophisticated system which requires a large number of skilled personnel in support functions can only afford to maintain it in a low state of readiness because it is difficult to operate and maintain. At the same time, however, it may be acquiring additional high cost systems. Under such a condition, the readiness of existing high performance forces rather than new acquisitions should receive priority funding.

One last aspect pointing out the preference of the services for highly sophisticated equipment is the fact that the recent acquisitions suggesting a new "trend" towards larger quantities of somewhat lower cost and less complex equipment were initiated either by the Congress or at the OSD level--not at a service level. Rarely does a service initiate development of a lower cost alternative on its own. The XM-1 tank; the A-10, F-16, and F-18 aircraft; and the F-101X jet engine were all initiated at the OSD or congressional level.

TRENDS--DOD's POLICIES

In the mid-1970s, DOD began to try to correct the trend toward buying high performance, high cost weapon systems in low quantities. While some additional procurement funds were requested, the main effort was an attempt to reverse the trend of some of the "controllable" costs in future acquisitions. DOD took action to reduce these costs during the early phases of the design and development cycle. Actions emphasized included

--design-to-cost,

--high-low mix of weapons,

--reduce production costs,

--standardization,

--affordability,

--reduce support costs, and

--improve acquisition management.

By 1976 DOD had realized how critical the affordability issue was. Projection of the dollars likely to be available to support defense needs showed that the services could not afford to have the quantities of high performance, high cost systems considered necessary for a high confidence defense

posture. Two of these initiatives began to receive more attention, the so-called "high-low" mix whereby the inventory would include high performance, high cost systems and a relatively larger quantity of lower cost, lower performance systems. The second initiative--design-to-cost--was aimed at designing weapon systems to affordable costs.

DOD guidance began to emphasize also the importance of designing to both unit production and life-cycle costs. The guidance directed trade-offs between capability, cost, and schedule recognizing that trying to obtain maximum performance capability in each system would destroy affordability goals. In essence, developers were directed to consider not only the cost of acquisition but also the cost of ownership. This emphasis, however, would have no effect on the systems in production and little effect on the many weapon systems then in advanced development. To date, some of these systems have not been deployed.

DEFENSE POLICY EMPHASIS ON LESS SOPHISTICATED WEAPON SYSTEMS

The 1976 Defense Policy and Planning Guidance set forth the then current objectives, policies, and general planning guidance for the fiscal year 1976-80 U.S. defense program. It highlighted the fact the overall effectiveness of the defense program requires understanding of U.S. international goals, treaty obligations, and other defense commitments; the relationships between DOD and other U.S. institutions; the military capabilities of potential adversaries; and the dedication and sense of responsibility of the men and women of the Armed Forces.

Key considerations discussed which affect defense planning included the need to (1) maintain balanced forces, (2) recognize the close relationship between force balance and achieving effective deterrence, particularly with regard to the relative emphasis on quality versus quantity in modernization programs, (3) encourage U.S. allies to make defense improvements, (4) rely on the all volunteer force for attracting and retaining the appropriate quantity and quality of personnel, and (5) maintain a technical base generally superior to that of potential adversaries.

One of the issues received particular attention. The guidance directed that:

> "Particular emphasis should be given in the near term to developing less sophisticated weapons

systems of lower unit cost, but with high reliability and maintainability, which can be acquired in sufficient numbers to maintain or improve overall U.S. combat effectiveness against realistically assessed threats. * * *"

In presenting the military posture to the Congress for fiscal year 1976, the Chairman of the Joint Chiefs of Staff outlined various programs implementing this guidance. Examples included the XM-1 tank, the UH-60A helicopter, and the F-16 aircraft.

In January 1980 DOD established new policy and responsibilities for integrated logistics support, including manpower planning as an inherent part of the major systems acquisition process. This direction sets the groundwork for continued emphasis on ownership considerations. However, the impact this will have greatly depends on how this direction is actually implemented.

READINESS PROBLEMS CONNECTED WITH HIGH PERFORMANCE SYSTEMS

It is generally accepted that the tendency to procure high cost, sophisticated systems places severe limits on the quantity that may be procured. However, there is another aspect beyond the high cost, low quantity issue. There is a pattern of "readiness" problems connected with equipment purchased for deployment in different eras (for example, early 1970 deployments, mid-to-late 1970s deployments, and current deployments).

Many of the systems developed for deployment in the early 1970s were performance oriented and turned out to be very complex and costly. Some examples are shown in the chart below. Some other equipment under design in the early 1970s has yet to be deployed. These systems include the high cost Army's Patriot surface-to-air missile system, the Navy's Aegis surface-to-air missile system, and the HARM antiradiation missile.

Weapon system	Major issues
F-111 aircraft S-3A aircraft F-14 aircraft	The aircraft systems have caused concern due to reliability, availability, maintainability, complexity, and cost
MBT-70/XM-803 tank Cheyenne helicopter	The tank and helicopter programs were canceled because of cost and complexity

The F-15 aircraft, deployed in 1975, was designed to be more reliable and maintainable than the F-4 aircraft it replaced. However, unanticipated engine reliability problems have affected operating and maintenance cost and availability.

Equipment developed for deployment in the mid to late 1970s, to some extent, reflects DOD's objectives to reduce unit costs and to increase the number of units being acquired.

Weapon system	Major objectives
FFG-7 guided missile ships	Low cost, minimize personnel requirement, and procure in larger quantities
F-16A aircraft	Low cost, procure in quantity
UH-60A helicopter	Reliability, availability, and maintainability emphasized

Some equipment developed for deployment in the early 1980s also shows the same intent to emphasize reliability, availability, and maintainability aspects.

Weapon system	Major objectives
F/A-18 aircraft	Reliability, availability, maintainability, and large quantity procurement
XM-1 tank	Reliability, availability, maintainability, durability, low cost, and large quantity procurement
F-101X engine	Reliability, availability, maintainability, and lower cost

While there has been pressure to consider logistic aspects during development of these weapons, there is still no assurance at this time that they will be as reliable, available, and maintainable as anticipated. Recent information raises concern on two of these examples. Our report 1/ on the Navy's F/A-18 aircraft shows that the Navy expects to achieve enormous benefits from the reliability and maintainability applied to the F/A-18 design. However, it also points out that personnel requirements are now being based on the F/A-18

1/"Operational and Support Costs on the Navy's F/A-18 Can Be Substantially Reduced," (LCD-80-65, June 6, 1980).

requiring 18 maintenance hours per flight hour instead of the design goal of 11 hours. Our report on the XM-1 tank 1/ has raised questions on reliability of the high technology gas turbine engine.

There are other major weapon systems scheduled for deployment at later dates, which would allow time for re-appraisal of cost, complexity, reliability, availability, and maintainability goals. These include the following:

--AH-64, Advanced Attack Helicopter.

--PLSS, Precision Location Strike System.

--DIVAD, Air Defense Gun.

--MLRS, Multiple Launch Rocket System.

--SOTAS, Standoff Target Acquisition System.

--AEGIS, Surface-to-Air Missile System.

--JTIDS, Joint Tactical Information Distribution System.

The readiness of deployed weapon systems is discussed in chapter 3.

SUMMARY

Historically, the United States has procured military equipment in quantities sufficient to present a credible defense posture. However, beginning in the 1960s the United States encountered a serious dilemma--procurement money available for new systems to replace old systems did not increase as fast as the unit cost of equipment, which rose rapidly as the military introduced highly complex and sophisticated equipment. The end result has been the acquisition of fewer systems. This is now further complicated because in some combat categories, U.S. equipment is reported by the Army to be inferior to Soviet weapons.

It was realized by the mid-1970s that, given limited resources, if the quantities of equipment required in the future for a credible defense posture were to be acquired, production and support costs for each system must be reduced.

1/"XM-1 Tank's Reliability Is Still Uncertain," (PSAD-9-20, Jan. 29, 1980).

This was to be done by giving greater consideration to designing lower production and support costs into the system during its development. Technology would be used not only to obtain high performance, but to lower cost and increase reliability. This was a "cultural change" and, since it takes years to design and develop new systems, the effect of the management initiatives will not be seen for many years. Debate will continue about the wisdom of the U.S. weapons acquisition policies--should we stress high cost, high capabilities, and low quantities or lower cost, lesser capabilities, and larger quantities?

Although DOD has had many initatives over the years to reduce acquisition and support costs, sophistication, and complexity, the problems related to costs, although distorted by high inflation, are as acute today as ever. Some success has been achieved, but historically, it has been difficult to get the services to balance system performance with other requirements. Most often, acquisition of a less complex, less costly system has been in response to directions from the Congress or OSD. This is not to say that high cost systems have not been sanctioned by OSD and the Congress.

Equally as serious is that priorities, ultimately the responsibility of the services, result in some fielded systems being in less than desired readiness conditions while the services introduce new systems into advanced development or production.

CHAPTER 3

READINESS OF HIGH PERFORMANCE WEAPON SYSTEMS

Chapter 2 discussed major problems resulting from acquisition of high performance equipment--high cost and low quantities--and touched briefly on an equally important concern: the current state of readiness resulting from introducing high performance systems.

Has the introduction of high technology weapon systems affected the reliability and maintainability of equipment and the combat readiness of using forces? High technology, sophisticated, complex weapon systems by themselves do not automatically create readiness problems. They do, however, set the stage. There are a host of factors surrounding the reliability, availability, maintainability, and sustainability issue which makes it difficult to pinpoint the degree which readiness is being impaired due to use of high technology weapons. Some of these factors are cited below.

--Overemphasis on high performance in design. The failure to trade off some aspect of desired performance for better reliability.

--Inadequate testing before deployment. The failure to test the system fully or failure to restructure as a result of testing.

--Design deficiencies. The failure to emphasize the need to design in reliability, availability, and maintainability.

--Supply issues. Predicted versus actual reliability experience, funding, and parts/components availability.

--Maintenance issues. Workload predicted and actual experience, quantity of personnel, and skill levels predicted versus actual experience, personnel actually available.

--Logistics concepts employed. Parts replacement intensive versus skilled people intensive.

--Logistics management. The failure to emphasize/fund logistics early in development and to manage logistics properly after the system is deployed.

--Training concepts. Planned and actual.

The key to high readiness of weapon systems is obtaining a proper balance of these type factors. The desire for highly sophisticated, high performance systems has caused less attention to be given during the acquisition cycle to overall life-cycle considerations such as reliability, availability, and maintainability.

GROWING CONCERN WITH THE READINESS OF U.S. FORCES

The apparent insufficient level of readiness of U.S. forces for battle has become of increasing concern to the Congress, members of the media, leaders of the military services, and the general public. Various reports, including the services' internal reporting systems, portray too much military equipment standing idle for lack of trained personnel, spare parts, maintenance, and overhaul.

Our recent report 1/ pointed this out and further reported that:

--There are currently large shortages in U.S. war reserve stocks of the modern, more effective, air and ground munitions.

--Shortages of secondary item war reserves continue to degrade the combat readiness of U.S. forces.

--The United States and its allies' policies for war reserve stockpiles are not consistent.

--The Army needs additional modern weapons and equipment for its active duty use, for the reserve units it plans for early mobilization and deployment, and for its program of prepositioning equipment overseas for use in event of war.

--The Navy could have a great deal of difficulty meeting its commitment of shipping to the NATO countries.

--Because of inefficient allocations of resources, the Marine Corps faces problems in accomplishing its primary mission of amphibious assault.

1/"GAO Concerns With the Readiness of U.S. Forces," (LCD-79-423, Aug. 20, 1979).

--The Air Force's Tactical Air Command is only marginally ready to meet its NATO contingency requirements because of aircraft maintenance problems, shortages of supplies and equipment, and insufficient mission ready aircrews.

Among the reasons we reported as causing these problems were:

--DOD is not effectively allocating its resources to achieve optimum readiness levels.

--DOD's procurement planning does not give sufficient consideration to developing weapons that can be maintained at optimum levels of readiness when they are put to use.

Examples of maintainability problems noted in three specific weapon systems are reported below.

S-3A aircraft

The principal role of the Navy S-3A carrier-based antisubmarine warfare aircraft is to protect U.S. surface ships from attack by enemy submarines.

In our report entitled, "The Effectiveness and Readiness of the S-3A Aircraft Need Improvement," (PSAD-78-89, May 4, 1978), we discussed that since introduction into the fleet in February 1974, the S-3A aircraft has experienced low systems reliability that has heavily affected antisubmarine warfare effectiveness. The average flight hours between failure experienced by the fleet for critical S-3A systems was often much less than predicted and has resulted in the degradation of mission capability and/or premature termination or total cancellation of antisubmarine warfare missions.

S-3A problems have been caused by low equipment reliability, inadequate maintenance, and shortages of trained flight and maintenance personnel. Further, S-3A has experienced extensive cannibalization (serviceable parts removed from one aircraft for installation on another aircraft) because of low equipment reliability and inadequate spares support.

F-14A/Phoenix Weapon System

Our last report on the F-14A/Phoenix weapon system 1/ showed that readiness is still a major problem. The primary reason for the low readiness rates was attributed to inadequate supply support which, in turn, was due to lower than predicted reliability performance of some F-14A equipment.

Navy officials testified in February 1979 that the latest production versions to the F-14 have been proven to be highly maintainable, showing material readiness rating of over 80 percent during recent exercises. Overall, 51 percent were mission capable, a gain of 20 percent in the past 2 years. They indicated that for the overall F-14 force it has been a slow but steady readiness improvement.

F-101 Derivative Fighter Engine

Our report "Is the Joint Air Force/Navy Alternate Engine Program Workable? GAO Thinks Not As Presently Structured," (PSAD-80-40, May 9, 1980) shows the efforts underway to develop a more durable engine for jet fighters. The objective of the program is to develop and test an engine with greater reliability, availability, and maintainability than (1) the F-100 used to power the Air Force's F-15 and F-16s and (2) the TF-30 used by the Navy to power its F-14A aircraft. The report also points out the cost of various component improvement programs being carried out to improve the F-100 engine and the TF-30 engine. DOD has spent over $500 million to correct problems of compressor stalls and stagnations, turbine failures, and other engine components, and it plans to spend an additional $420 million from 1979 through 1984. DOD and the services fully expect these improvement programs to demonstrate that they can correct the TF-30 and F-100 engine problems.

The TF-30 and F-100 programs are examples of programs where the desire for high performance resulted in reliability, durability, and availability problems. Moreover, the F-101 engine is another example of where not the service but the Congress has been responsible for initiating action to develop a more durable system.

1/"The Effectiveness of the F-14A/Phoenix Weapon System Is Marginal at Best Against the Current and Postulated Threat," (PSAD-79-44, Feb. 28, 1979).

DOD EXPRESSED CONCERNS ON READINESS

The Secretary of Defense, in his annual report for fiscal year 1980, stated that weapons development practices have contributed to operational problems. For example:

> "* * * Past Defense Reports have emphasized unreliable and hard-to-support equipment designs as a major, and often the principal, contributor to less-than-desirable weapon system performance in the field."

Further,

> "Maintaining the combat readiness of our aircrews and their increasingly complex equipment has become an exceedingly difficult challenge that threatens to jeopardize our combat capability."

To correct these problems the Secretary is emphasizing increased reliability and maintainability provisions in new system designs and in modification programs for existing systems. Increased operational and maintenance funds were requested for fiscal year 1981 to accommodate improvements in systems as well as in crew training.

The issues were also highlighted in DOD's annual report for fiscal year 1980 where the Secretary of Defense noted that funding for new weapons procurement often has priority over funding needed to improve the readiness of deployed systems. The report states:

> "Because defense budgets are always limited to some level, and because we still act as though we believe we will have the time to mobilize, long-lead weapons and equipment often receive the highest spending priorities. Combat readiness, alertness, and mobility for the general purpose forces sometimes fall much lower on the list. As a consequence, many of our weapons are out of commission for lack of spare parts. Even though we may not have learned to operate some of our weapons to their full potential, we make plans to replace them. We log fewer flying hours and steaming days than a fully professional force requires."

CONGRESSIONAL CONCERN WITH READINESS OF FORCES

Congressional concern for readiness of U.S. forces is evident in the hearings and published reports of the House and Senate Authorization and Appropriations Committees. Further, the Congress, out of concern that even after increasing the levels of funds readiness would remain unsatisfactory, included in section 812 of Public Law 95-79 (the fiscal year 1978 Defense Appropriation Act), a directive that DOD include in future budget submissions data which would relate requests for funds to readiness levels. The Congress required the Secretary of Defense to submit by February 15, 1978, a report setting forth quantifiable and measureable material readiness requirements for the armed services and reserve components. In subsequent years, DOD was to notify the committees of any changes in material readiness requirements and what effect requested appropriations will have on the material readiness posture.

In the previously cited August 20, 1979, report on our concerns with the readiness of U.S. forces, we reported that, as required by section 812, DOD has made material readiness projections for a limited number of weapon systems through fiscal year 1982. However, DOD has not yet developed a systematic and consistent method for making readiness projections. In DOD's words it does not have, as yet,

> "* * * any reliable functional relationships that relate resources applied to materiel conditions status. Quantitative equipment condition projections have, therefore, been made using specific analytical functional relationships when available, but with a heavy reliance on historical trends and the application of experienced judgement."

DOD acknowledged that it lacks basic capabilities needed to make quantitative materiel readiness projections based on funds. Further, DOD officials indicated that significant improvements are several years away.

We concluded that maintaining desired readiness levels is a multifaceted problem, and it has no simple solutions. However, we expressed a belief that DOD can provide the Congress data related to funding and readiness levels so that the Congress can make informed decisions on where funds should be spent. Further, as indicated in a number of our reports, we believe that DOD can achieve greater efficiency in its logistics operations and thus improve readiness levels.

EFFECT OF HIGH PERFORMANCE SYSTEMS ON FORCE READINESS AND OPERATIONAL EFFECTIVENESS

As indicated in previous sections, there has been a growing concern with the readiness of U.S. forces as set forth by the Congress, DOD officials, GAO, and others. We have believed that one of the reasons for these problems was that sufficient consideration is not given to developing weapons that can be maintained at high levels of readiness by the using commands. These type weapons would be somewhat less sophisticated, less complex, and performance expectations would be reduced.

There is no precise way to define sophistication, complexity, or high performance. As indicated earlier, a good indicator is development and procurement cost. Operating cost is also a good indicator. High performance systems usually cost more to develop, test, produce, and operate. Spares, special support, and test equipment cost more and usually higher skilled operators and maintenance personnel are required. In effect, there is a close correlation between procurement cost and annual operating cost, and the primary contributing factor is the drive for high performance. In some combat categories, the more complex or sophisticated the equipment is, the more frequent it fails, requiring more maintenance actions.

Therefore, we believe that, while high performance systems usually possess unique or a combination of capabilities such as firepower, mobility, protection, endurance, and so forth, they also tend to

--increase operating cost,

--decrease the number of operating hours before failure, and

--increase maintenance load (for example, more maintenance actions, man-hours, and personnel).

In turn, these tend to

--lower the effectiveness and productivity of the system resulting in a reduction of mission capability.

RELATIONSHIP BETWEEN HIGH PERFORMANCE WEAPONS AND OPERATION AND MAINTENANCE FUNDING

The largest single area of cost in the life of a weapon system is its operation and maintenance (O&M), and these costs have been growing rapidly in recent years for a number of reasons. One is that O&M functions are personnel intensive, and these costs have grown significantly. Another basic reason has been that equipment has grown in complexity and sophistication, generally causing it to be more expensive to operate and maintain.

The total O&M funding has increased substantially since the Vietnam period. Some portions are related to the introduction of high performance equipment, some to the higher costs for spare parts and increases in fuel and the many other categories that make up the O&M budget, and some portion to inflation. However, there is the question as to whether O&M funding increases have been sufficient to keep up with rising costs and whether additional O&M funding at this time would improve the services' ability to employ their sophisticated weapons.

Some DOD officials stated that increasing O&M moneys would improve the ability of the services to fight with sophisticated weapons. However, we have reported, and DOD has also stated, that it is not possible to equate increases in general O&M funding with improvements in readiness of specific combat systems. It is also difficult to define and measure "readiness." Further, since the O&M funds are allocated to many categories, direct correlation does not appear possible. For example, in the Air Force numerous activities including communications, travel, and purchased equipment maintenance are supported by O&M moneys. While they all may have some impact on readiness, few of them apply directly.

Parts and maintenance are a problem. In the case of aircraft, while the initial spare parts are procured through the procurement budget, some replenishment spare parts are provided with O&M funds. One option is to buy more of the part which is failing, but another is to fix the cause of the failure. In both cases, it takes time to analyze the problem to determine the best solution and then to procure the proper new part(s). Deliveries can be slow, as for turbine blades. Also, for new weapon systems, especially complex ones, there is a lag before the real problems are corrected so that large increases in O&M funds might not necessarily be the best procedure to correct a specific problem.

The cause and extent of any funding deficiencies in O&M are not totally clear. Some DOD officials say O&M has been constrained by inflation. Moreover, they do not feel that sophisticated equipment and increased funding for its procurement are major factors in solving readiness problems. We believe that OSD and the services are primarily responsible for any imbalance between procurement and readiness. We believe that the services, by electing to develop and support so great a variety of high performance weapon systems, have been forced to consciously trade off solving problems for currently deployed systems for what appears to be a better future force. In peacetime there is a limit on funds available for defense. The practical effect of such a limit on the total defense funding is that all procurement and all O&M activities cannot be funded completely. The more one program is accommodated, the less can be spent on the other. The services should plan to achieve the best balance possible. If it requires developing less sophisticated equipment, the services should move in that direction.

SUMMARY

The readiness of U.S. forces and many high performance systems is lower than desired due to supply, maintenance, logistics management, and other factors. Also, the drive for high performance, sophistication, and complexity in weapon systems has had an adverse effect on the readiness of many combat systems. When coupled with the generally low quantities of systems acquired or scheduled for acquisition, the result can be a serious equipment availability situation. In this review we did not attempt to determine how serious the situation is overall.

No matter what the reason for the readiness problems with certain systems, the United States has few alternatives other than to improve the reliability and availability of the fielded systems. This is being done, and the services are predicting somewhat better readiness status on many systems during the next few years. In some instances, however, indications are that the lack of personnel will inhibit the rate of improvement.

Overall, the O&M budget has been increasing and it is expected to continue to increase in fiscal year 1981. O&M funds, however, support many activities, and it is difficult to determine whether or not the increase will significantly improve readiness.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

We believe that the sophistication of many weapon systems deployed today is one of the contributing factors that has led to budget problems, inventory shortfalls, and a low state of readiness for certain combat categories. High technology, sophisticated, complex, weapon systems by themselves do not automatically create readiness problems. They do, however, set the stage. Other influences include high performance demands, inadequate testing of systems, design deficiencies, supply issues, maintenance issues, logistics concepts, management, and training. Those responsible for developing and acquiring new weapon systems must be just as concerned with the capability of the equipment when it is deployed as they were with the acquisition.

Although some yet-to-be deployed systems designed in the mid-1970s are likely to exhibit many of the same problems occurring in the high performance weapons deployed today, recently developed systems should benefit from emphasis on reliability, availability, and maintainability, therefore presenting a brighter future. However, a reappraisal of some may be in order. (See pp. 11 and 12.)

Defense's emphasis on lower cost weapon systems and greater reliability, although well placed, does not appear to have been sufficient. While established inventory objectives for new weapons are high, rapidly rising unit costs make it unlikely that they can be achieved without major increases in or realinement of the defense budget. (See p. 5 to 10.)

RECOMMENDATIONS TO THE CONGRESS

As recommended in a previous report, 1/ the Congress should carefully examine lower cost alternative programs before approving new weapon systems. In particular, the committees should explore with senior military officials the pros and cons of larger quantities of alternative weapons versus smaller numbers of highly sophisticated and expensive systems.

1/"Impediments to Reducing the Costs of Weapon Systems," PSAD-80-6, Nov. 8, 1979.

In accordance with the wishes of the chairman of the Senate Committee on Foreign Relations, we did not solicit comments on this report from DOD. This was because he wanted to have this report in the hands of the Congress before completing congressional actions on the fiscal year 1981 Defense authorizations and appropriations.

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