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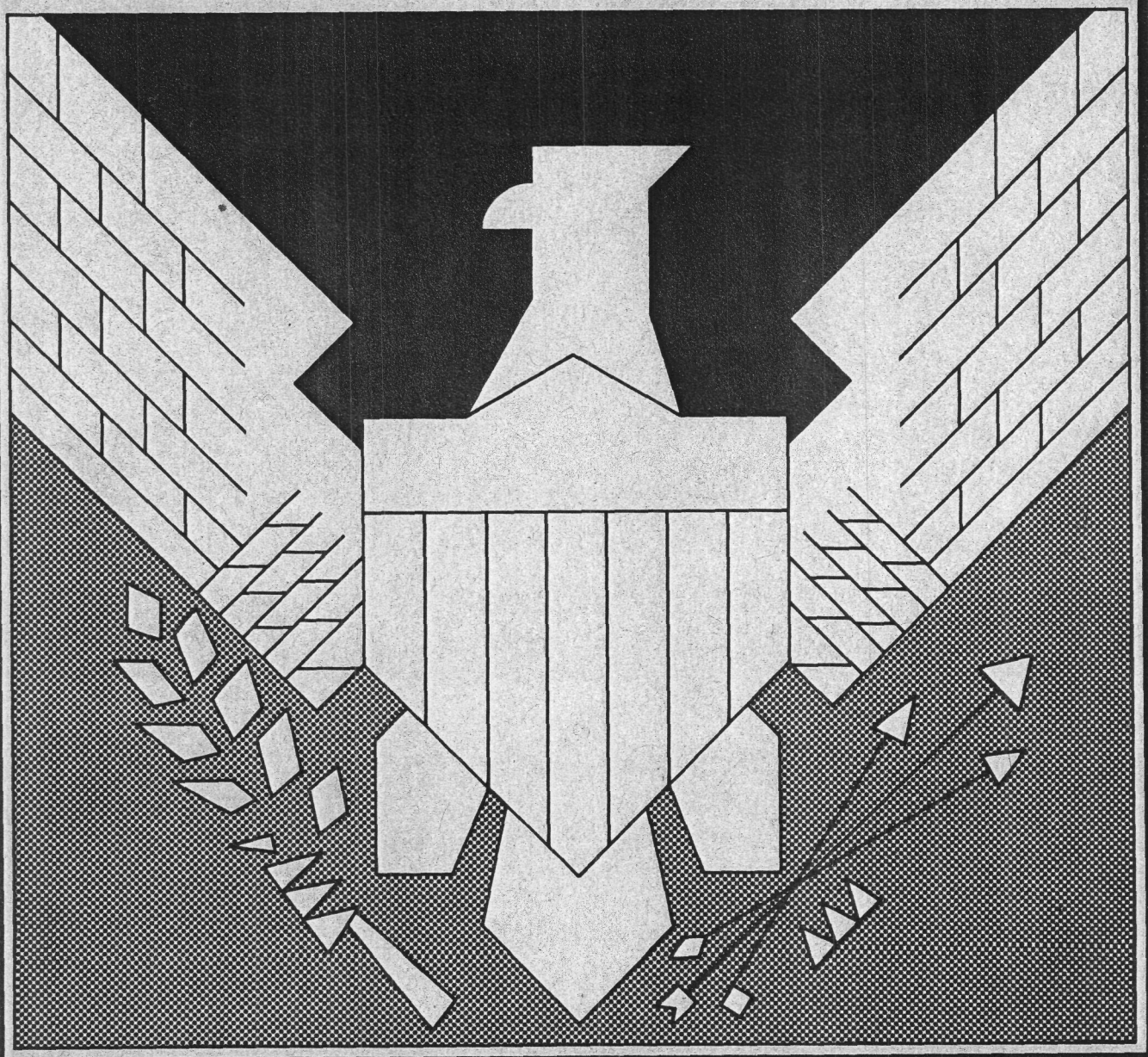
Effects of Weapons Procurement Stretch-Outs on Costs and Schedules



CBO STUDY

EFFECTS OF WEAPONS PROCUREMENT STRETCH-OUTS ON COSTS AND SCHEDULES

Congress of the United States
Congresssional Budget Office

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NOTES

Unless otherwise indicated, all years referred to in this report are fiscal years.

Details in the text and tables of this report may not add to totals because of rounding.

Unless otherwise indicated, all costs and budgetary detail are expressed in billions of constant fiscal year 1988 budget authority dollars. Calculations of additional costs or savings from altering specific procurement programs are expressed relative to the costs of those programs presented in the President's Department of Defense budget request for fiscal years 1988 and 1989 and supporting documents that accompany the budget request.

PREFACE

Despite significant efforts to reform the acquisition process, problems with buying weapons systems continue. This report, prepared by the Congressional Budget Office (CBO) at the request of the Senate Committee on Armed Services, focuses specifically on the pace of weapons production. Stretching out the process of acquiring new weapons not only adds to program costs but also limits efforts to equip U.S. forces with modern weapons. The report examines alternative procurement policies that would permit higher production rates while recognizing overall fiscal constraints on the defense budget. In accordance with CBO's mandate to provide objective analysis, the report makes no recommendations.

R. William Thomas of CBO's National Security Division prepared the report under the supervision of Robert F. Hale and John D. Mayer, Jr. The extensive cost analyses were performed by William P. Myers of CBO's Budget Analysis Division, assisted by Diane Griffith. The author wishes to express his appreciation to Jacques S. Gansler, vice president of The Analytic Sciences Corporation, for his comments on an earlier draft. (External reviewers bear no responsibility for the final product, which rests solely with CBO.) He also gratefully acknowledges the contributions of Daniel Koretz of CBO's Human Resources and Community Development Division, Frances M. Lussier and William Kostak of the National Security Division, and Tasha Wallis (formerly with CBO). Francis S. Pierce edited the manuscript, and Rebecca Kees and Kathryn Quattrone prepared it for publication.

Edward M. Gramlich
Acting Director

November 1987

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SUMMARY

The Department of Defense (DoD) buys many weapons in annual quantities that are quite low, relative to total requirements. Buying proven weapons at low rates of production makes poor use of available industrial resources; it also adds to weapons costs, discourages potential suppliers, and delays the flow of new technology to the military forces. This long-standing tendency to stretch out procurement has persisted in the face of criticism from numerous authorities--including many in the higher echelons of the Department of Defense.

As long ago as 1981, DoD set a goal of increasing weapons procurement rates to economic levels. The Congress not only supported this, but in some cases increased procurement quantities for weapons when it felt the Administration's requests were inadequate. In recent defense budgets, however, new examples are appearing of procurement programs that have been stretched out because of budgetary limitations.

RECENT PRODUCTION-RATE TRENDS

So far, the Administration has achieved mixed results in its effort to speed weapons acquisition. In the 1983-1987 period, it succeeded in buying some classes of weapons systems--such as helicopters, tactical missiles, and transport and tanker aircraft--at higher rates than in the earlier five-year period from 1976 through 1980. Other classes of weapons, however--including strategic missiles and fixed-wing combat aircraft--were bought at lower rates than before.

By the standard of economic efficiency, the record has been uneven. This study uses DoD's own measure of economic efficiency, the minimum economic rate of production--defined as the lowest rate of production that offers an acceptable return on the investment in production facilities--to appraise DoD's success. Of the 40 weapons programs--including aircraft, missiles, and combat vehicles--reviewed in this study, exactly one-half were purchased at or above their minimum economic rate (on average) during the 1983-1987 period.

For the remaining 20 systems, average annual procurement rates were below--sometimes well below--the minimum economic level. Summary Table 1 shows selected examples of both groups of weapons.

The Army was more successful than the other services, according to this measure. Seventy percent of the Army systems that were reviewed had been purchased at or above the minimum economic rate. The comparable percentages for the other military departments were much lower: 44 percent for Air Force programs and 43 percent for those of the Navy.

The above comparisons might be misleading, since the services have not always been consistent in their definition of the minimum economic rate. But similar results were obtained using as a standard the maximum economic rate--the highest level of production that current facilities can support. Overall, 18 of the 40 systems were bought at 50 percent or more of their reported maximum rate. Again, the Army did best--9 out of 10 systems meeting this test--while only 33 percent of Navy programs and 22 percent of Air Force programs in the sample were bought at rates equal to or greater than 50 percent of the maximum economic rate.

Fiscal Year 1988 Procurement Cuts

Recent developments suggest that the problem of stretch-outs may worsen. Quantities requested in the fiscal year 1988 budget for 11 of the 20 largest weapons programs (excluding shipbuilding programs, which were not considered in this study) were reduced from those planned for 1988 in last year's budget. Only 2 of these 20 programs showed an increase in quantity from last year's estimate.

Congressional Changes in the 1988 Request

Concerned by these trends, both the Senate and House Armed Services Committees recommended increasing quantities of many weapons systems--including tanks, Army helicopters, and certain air-to-air missiles--to higher levels when they reported out their respective versions of the fiscal year 1988/1989 National Defense Autho-

SUMMARY TABLE 1. PRODUCTION RATES OF SELECTED WEAPONS

System	1983-1987 Procurement Rate a/ b/	Minimum Economic Rate	Maximum Economic Rate
Systems Bought at Higher than Minimum Economic Rate			
AH-64 Apache Helicopter	117	72	144
M1 Abrams Tank	825	720	1,080
Bradley Fighting Vehicle	647	540	792
Patriot Missile	485	240	840
Stinger Missile	3,539	1,800	11,520
F/A-18 Aircraft	84	84	145
Standard Missile 2 c/	848	840	1,324
Sparrow Missile d/	2,015	1,200	3,804
B-1B Bomber	31	24	48
C-5B Transport	15	4	24
F-16 Aircraft	155	108	324
Hellfire Missile d/	6,131	1,500	6,720
Multiple Launch Rocket System	50,822	36,000	72,000
F-14A Aircraft	21	12	96
KC-10 Tanker/Cargo Aircraft	9	8	24
Systems Bought Below Minimum Economic Rate			
AV-8B Aircraft	34	36	72
A-6E Aircraft	8	12	72
F-15 Aircraft	41	120	144
Ground Launched Cruise Missile	99	120	600
Harpoon Missile	284	360	660
MX Missile	17	21	48
P-3C Aircraft	8	16	24
Phoenix Missile	222	240	420
SH-60B LAMPS Helicopter	23 e/	24	60
Tomahawk Missile	186	300	540

SOURCE: Compiled by the Congressional Budget Office from Department of Defense, *Procurement Programs (P-1)*, various years.

a. Excludes initial two years of production.

b. Average over years within the 1983-1987 period when the system was actually procured.

c. Combined procurement of medium-range and extended-range versions.

d. Combined procurement of all services.

e. Includes seven SH-60F helicopters in 1987.

rization Act. To meet the overall defense spending limit imposed by the budget resolution, however, many of these increases were limited when the House bill reached the floor. In addition, production rates for other weapons systems--including the AH-1W helicopter for the Marine Corps, the AMRAAM (Advanced Medium Range Air-to-Air Missile), and the Imaging Infrared (IIR) Maverick missile--were reduced below the Administration's request by the House. The Senate bill passed without major changes in the Committee's recommended quantities. The conference agreement on the National Defense Authorization Act recommends increases for tanks, Army helicopters, EA-6B jammer aircraft, and Sidewinder and Sparrow missiles.

IMPLICATIONS OF STRETCH-OUTS

The major reason for stretching out acquisition programs is to meet fiscal limitations imposed by the annual budget cycle. The amount of total funding required in a given year takes precedence over economic considerations, even though buying larger quantities would reduce unit costs. Limitations on funding mean that unless a program is stretched out it may be necessary to cancel or defer other weapons programs.

Another consideration is that, in the past, increasing production of a state-of-the-art weapon to high rates too early has proved costly. DoD normally keeps production rates low until systems have been tested in the field, in order to identify and remedy defects before too many units are produced. In some cases where significant production began before all development work and operational testing had been completed, DoD has needed to spend considerable sums to remedy problems in weapons already delivered to field units. The B-1B bomber is a recent example.

Low production rates are sometimes chosen in preference to shutting down production altogether when a weapons acquisition program is nearly complete. This policy keeps the production facility in being as a hedge against the need to expand production to meet wartime requirements. It also facilitates the transition from one weapons system to its successor, when the same manufacturer produces both.

Nevertheless, there are important reasons to avoid stretching out weapons procurement. As noted above, producing weapons at rates consistent with the manufacturer's capacity tends to lower unit and total program costs. Estimates made by the military services suggest that a 50 percent decrease in the annual rate of production increases real unit costs of aircraft by 7 percent to 35 percent. Tactical missile programs are even more sensitive to production-rate reductions; their unit costs rise by 8 percent to 60 percent with a 50 percent decrease in the output rate. CBO's own statistical analysis found roughly comparable effects on unit cost for many, but not all, of these systems.

There are other compelling reasons to avoid stretch-outs. At current rates of acquisition, many weapons could become technically obsolete by the time significant numbers of them are deployed. For 26 major weapons it would take an average of 16 years from the time production began to fulfill DoD's acquisition objectives--assuming that production continued at currently planned rates. For 6 of these 26 systems, it would take 20 years or more to complete the programs. Of course, many of these systems have already been considerably modified, but there is a limit to the extent to which a design that is more than two decades old can be altered to keep up with changing requirements.

Higher production rates could also meet concerns expressed by theater commanders that their forces are short of the modern weapons needed to cope with an increasingly sophisticated Soviet capability. The commanders have repeatedly emphasized the need for more modern missiles and other precision-guided munitions. Yet the current Five-Year Defense Plan fails to meet DoD's goals for many of these items, partly because of production stretch-outs.

INCREASING PRODUCTION RATES FOR SELECTED PROGRAMS

Nearly 10 years ago, DoD's Defense Science Board--an advisory panel of civilian scientists and technical experts--identified the basic problem in weapons purchasing: the military services seek to develop and acquire too many different weapons simultaneously. When defense budgets are limited, the services too often choose to underfund

all of their programs rather than making the difficult decision to cancel or defer some of them.

An Alternative Procurement Plan

To illustrate this trade-off more concretely, the study selected 12 examples of systems for which rates could be increased without major new investment in production facilities. These examples include aircraft, missiles, and combat vehicles in procurement for all the military services. They were chosen in part by reviewing the testimony of theater commanders and focusing on those programs that seemed to have highest priority in their view.

For each of these 12 programs, an alternative procurement plan with higher production rates for the 1988-1992 period was developed and its cost estimated. Increases in production rates ranged from 19 percent to 127 percent. For 5 of the 12 systems, the alternative would buy the same total quantity already planned, but faster--completing the acquisition program for most of these systems by 1992 instead of by dates as late as 1998. For the remaining seven programs, higher rates would result in buying more weapons than the Administration currently indicates it plans to purchase, but not more than the services claim to need.

Adopting this alternative would require $24.5 billion in added funds for the five years 1988-1992 (see Summary Table 2). These additional funds would buy 1,263 more aircraft, 37,733 more guided missiles, and 3,109 more combat vehicles than the current Five-Year Defense Plan. The higher production rates would reduce unit costs of these weapons by from 2 percent to more then 20 percent, thus eventually lowering overall program costs--where quantities purchased are comparable--below those for the Administration's plan. For those five systems in which quantities would remain the same, savings in total cost were estimated at from 5 percent to 11 percent, depending on the source of the estimate.

SUMMARY TABLE 2. COSTS AND SAVINGS OF ALTERNATIVES TO THE ADMINISTRATION'S 1988-1992 PROCUREMENT PROGRAM
(In billions of fiscal year 1988 budget dollars)

Increased Budget Authority Needed to Increase Production Rates	
Five Aircraft Programs (AH-64, UH-60, SH-60, F-15, F/A-18)	15.1
Five Missile Programs (HARM, Harpoon, Maverick, STD 2, Stinger)	3.9
Two Combat Vehicle Programs (M1 Tank, Bradley Fighting Vehicle)	5.5
Total	24.5
Reductions in Budget Authority Associated with Deferring New Starts	
New R&D Programs	2.4
Eight Aircraft Programs (C-17, EX Competition, F-14D, JSTARS, P-3G, RC-12G, T-45TS, V-22)	16.9
Nine Missile Programs (Army Tactical Missile, FAADS Line of Sight-Forward-Heavy, FAADS Non Line of Sight, Penguin, Sea Lance, Tacit Rainbow, MX Rail Garrison, Small ICBM, SRAM II)	13.7
Two Ship Programs (LSD-41, SSN-21)	5.0
Three Other Programs (Fiscal Year 1989 Submarine Combat System, FAADS C^2, Sensor Fuzed Weapon)	1.2
Total	39.1
Savings in Budget Authority from Canceling Selected Programs	
Conventional Programs	
A-6F Attack Aircraft	5.1
Light Helicopter Experimental	3.1
F-15E Fighter Aircraft	8.5
V-22 Tilt-Rotor Aircraft	8.8
Subtotal	25.5
Strategic Programs	
Small Intercontinental Ballistic Missile	18.0
Rail Garrison MX Missile	8.4
Short Range Attack Missile II	1.2
Antisatellite Missile	2.5
Trident Backfit to Existing Submarines	0.8
Subtotal	30.9
Total	56.4

SOURCE: Estimated by the Congressional Budget Office from cost data reported in Department of Defense, *Selected Acquisition Report* (December 1986).

The Budgetary Trade-off

Since the alternative outlined above would impose higher near-term costs, the Congress would have to offset these additional costs through reductions elsewhere in the defense budget. Based on its responses to recent budget requests, the Congress would probably choose to reduce funding for other procurement programs rather than to cut funds that support current force operations.

It is impossible to assess the effect of such reductions without specifying what programs would be affected. Examples were chosen for the sake of illustration, using two distinctly different approaches. The first approach would defer new research and development (R&D) or production programs for two years. There are 9 new weapons programs for which R&D funds are under request and 22 for which procurement would begin in the Administration's 1988/1989 budget. Deferring all of these programs for two years would not reduce their ultimate costs but would reduce five-year budget authority by a total of $39.1 billion, much more than needed to finance the program of production-rate increases (see Summary Table 2). From these 31 programs, the Congress could select a smaller number to meet its overall fiscal constraint.

Alternatively, the Congress could choose to cancel--rather than defer--certain ongoing or newly proposed programs. Summary Table 2 lists examples of 4 conventional programs and 5 strategic programs that have previously been subjects of debate. Under Administration plans, these programs would require a total of $56.4 billion through fiscal year 1992. Again, it would not be necessary to cancel all of them in order to afford the program of production-rate increases described above. Canceling 4 conventional programs or 2 land-based ICBM systems would balance the additional costs for increasing production rates for the 12 programs.

These examples illustrate the trade-off DoD and the Congress face. With a limited total procurement budget, increased production of some weapons would probably mean postponing or forgoing procurement of others. The loss of capability from delaying future weapons or canceling some must be weighed against the advantages: getting current technology into the field more quickly and modernizing forces at a faster pace, while simultaneously reducing procurement costs.

CHAPTER I

INTRODUCTION

The Department of Defense (DoD) is the largest purchaser of military equipment in the free world. In fiscal years 1977 through 1986, the Congress authorized and appropriated a total of $248 billion for the procurement of aircraft, missiles, and combat vehicles--an average of nearly $25 billion a year. Notwithstanding these large sums, the pace of acquiring weapons systems often seems excessively slow. Acquisition schedules are routinely stretched out to fit programs into limited budgets. As a result, many weapons are being purchased at quite low annual rates. For instance, several aircraft are being produced at a rate of one or less per month, while there are instances of missiles being acquired at rates of less than one item per day.

Delaying or stretching out production of weapons by reducing annual quantities has several adverse implications for national security. Low production rates impede modernization efforts by delaying the provision of new, more capable weapons to U.S. forces in the field. They add to the total costs of weapons programs by preventing manufacturers from realizing economies of scale and introducing cost-saving manufacturing innovations. They also erode the defense industrial base because low annual purchases discourage potential suppliers of parts and components from competing for defense business.

Stretch-outs often occur because the military services seek to develop and acquire too many different weapons systems simultaneously.1/ Budget limitations then force program managers to cut their annual purchases to uneconomically low quantities. Innovations such as multiyear contracting and milestone budgeting can help to some degree to alleviate the adverse consequences of low produc-

1. Defense Science Board, *Report of the Acquisition Cycle Task Force* (Washington, D.C.: Office of the Under Secretary of Defense for Research and Engineering, 1978), p. 83.

tion rates, by allowing parts and components to be ordered in economical quantities.2/ But they cannot undo the basic inefficiency imposed on the prime contractor by an uneconomically low rate of annual production.

The United States produces far fewer weapons than its principal potential adversary, the Soviet Union. In the 10-year period from 1977 through 1986, for example, the U.S. military acquired 16,200 surface-to-air missiles as compared with 140,000 produced by the USSR. Over the same period, U.S. manu- facturers produced 3,450 fighter aircraft against 7,150 for the USSR, and 7,100 tanks as compared with 24,400 Soviet tanks.3/ While including production by the allies of the two powers would make these comparisons less one-sided, it would not reverse the Soviet bloc's superiority.

From a national security viewpoint, the United States may not be able to afford to continue producing fewer, more expensive weapons every year. As Lenin put it, "Quantity has a quality all its own." DoD and the Congress have a mutual interest in avoiding procurement program stretch-outs and low production rates for important items of military equipment needed to equip U.S. forces.

DoD'S ACQUISITION IMPROVEMENT PROGRAM

Upon assuming office in 1981, the leadership of the Department of Defense initiated a 32-point program to improve the way DoD buys weapons.4/ Among those 32 initiatives, several were designed to discourage stretch-outs and avoid uneconomically low production rates:

- Program stability--maintaining acquisition programs at planned schedules, quantities, and funding;

2. See Congressional Budget Office, *Assessing the Effectiveness of Milestone Budgeting* (July 1987), for an extensive discussion of these approaches.

3. Department of Defense, *Soviet Military Power 1987*, p. 21.

4. A thirty-third point--strengthening the defense industrial base--was added in 1984.

- Multiyear procurement--contracting for more than one year's deliveries at a time;
- Budgeting to most likely cost; and
- Buying weapons systems at economic production rates.

The Defense Acquisition Improvement Program (DAIP) has improved the acquisition process, but has not met all its goals, according to the General Accounting Office (GAO).5/ In its report, GAO noted that implementation of 23 of the 33 initiatives was less than complete. Furthermore, program managers surveyed by the GAO characterized their programs as unstable more often in 1985 than at the beginning of fiscal year 1983.

Nevertheless, the four initiatives listed above were among those targeted for high-level management attention in 1983. Thus, it is reasonable to expect that positive results might now be visible. Chapter II assesses production rate trends in more detail.

CONGRESSIONAL ACTIONS TO DISCOURAGE STRETCH-OUTS

Members of the Senate and House Armed Services Committees, concerned with low production rates, have taken steps to encourage the services to maintain their planned rates of production. These steps have included reversing DoD decisions to reduce rates during budget reviews. Often, however, these efforts have given way to pressure to reduce total defense spending. The Congress has even originated stretch-outs in some programs.

Reporting Requirements

One way for the Congress to focus attention on the production-rate issue is to require regular reporting to identify production-rate

5. General Accounting Office, *DoD's Defense Acquisition Program: A Status Report*, NSIAD-86-148 (July 1986), p. 13.

reductions. The Department of Defense Authorization Act for fiscal year 1986 required that information on actual and planned production rates be submitted in DoD's key reports on major weapons programs--the Selected Acquisition Reports (SARs). Major systems acquisition programs that are subject to the SAR requirements must report four sets of rates:

- The production rates assumed in the cost-effectiveness analysis used to support the decision to begin full-scale development;
- The rates incorporated in the production baseline estimate--defined as the rates assumed when the decision was made to proceed with production;
- The rates currently planned; and
- The maximum production rate(s) with current facilities and tooling.

In addition, the program office must estimate and report the cost impact of producing according to the current plan instead of the original production estimate, as well as the change in program completion date because of altered rates. These data provide the basis for much of the analysis in this report.

Congressional Revisions of the Budget

On several occasions, the authorizing committees have also acted to increase production rates for major weapons. The House Armed Services Committee recommended several such changes in the Administration's budget request for fiscal year 1988. Among the more significant of these House Committee changes were the addition of 120 M1 tanks (raising the annual quantity to 720), 18 Apache attack helicopters (leading to an annual buy of 85), 23 UH-60 Black Hawk helicopters (for a total of 84), and 6 EA-6B aircraft (raising procurement to 12). The rate of KC-135R tanker conversions was

returned to 50 from the planned level of 36, and higher purchases were slated for various air-to-air missiles.6/

Some of these increases were reduced when the authorization bill was approved by the House, to meet the defense target in the fiscal year 1988 budget resolution. The Apache quantity was reduced to 77 (still an increase of 10 over the Administration's request), and the Black Hawk quantity was set at 72 (versus 61 in the request). Other changes reduced production rates below those requested by the Administration. Procurement of AH-1W Sea Cobra helicopters was reduced from 22 units to 12 units; 2 E-6A aircraft were approved versus the 3 requested by the Administration; Rolling Airframe Missile procurement was halved (from 240 to 120); Navy purchases of IIR Maverick missiles were cut from 601 to 425; and Air Force AMRAAM purchases were reduced from 630 to 500 units.

The Senate Committee on Armed Services also noted with concern the premature terminations and stretch-outs of conventional weapons programs.7/ It recommended and the full Senate approved increases in purchases of attack and utility helicopters, M1 tanks, and Sparrow missiles, and a higher rate of KC-135R conversions. The conference agreement set these increases at or near the lower levels passed by the House.

Clearly, despite severe budget pressures, both authorizing committees feel that the benefits of higher production rates would outweigh their disadvantages. It seems unlikely, however, that the Congress will be willing to increase the dollars available for military procurement by substantial amounts. Can higher production rates be achieved without additional funding?

This study presents one approach. Chapter II reviews recent production programs to assess the severity of the low production-rate problem. Chapter III looks at the costs of stretch-outs, as well as reasons why stretch-outs occur. The final chapter presents specific options for maintaining higher rates for some systems, as well as ways to finance the near-term budget increases necessary to do so.

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6. *National Defense Authorization Act for Fiscal Year 1988/1989*, Report No. 100-58, House Committee on Armed Services, 100:1 (1987), p. 9.

7. *National Defense Authorization Act for Fiscal Years 1988 and 1989*, Report No. 100-57, Senate Committee on Armed Services, 100:1 (1987), pp. 8-9.

CHAPTER II

EVALUATION OF WEAPONS PRODUCTION-RATE TRENDS

Are current weapons production rates too low? The question can be answered in several ways. One approach focuses on DoD's goal of buying weapons in sufficient quantities to bring their costs down to reasonable levels. The difficulty with this approach is that most weapons are unique products, so that norms for "reasonable" costs are difficult to establish. Ultimately, such measures must rely on educated judgments, in the absence of more formal criteria.

A second, simpler approach is to look at the direction of production-rate trends. Are production quantities lower today than they were 10 or 20 years ago? If so, this may indicate that the problem of stretch-outs and inadequately funded programs is getting worse and that DoD's efforts to reverse these trends have not been successful.

CURRENT PRODUCTION RATES COMPARED WITH DoD'S NORMS

As noted previously, the Administration initially set a number of goals for improving the acquisition process. One of these was to acquire weapons systems at economic production rates. To aid in the planning and review of service acquisition requests, DoD managers in 1983 defined three measures that would be used to characterize the range of possible rates of production: the maximum and minimum economic production rates, and the minimum sustaining rate.

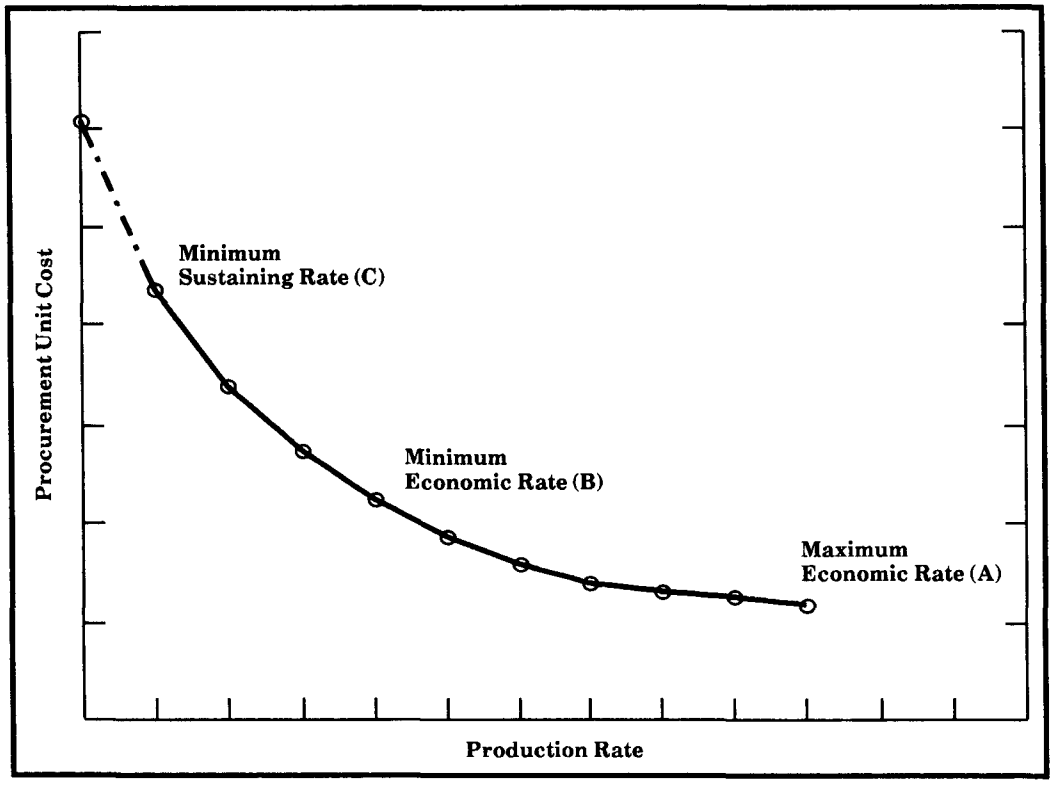
Definitions of Norms

The maximum economic production rate (point A in Figure 1) was defined by DoD as the highest rate of production permitted by existing plant capacity, tooling, or test equipment (or that currently planned, in the case of new systems). As the definition above indicates, the

limiting factor is normally capital equipment, specifically the tools and dies used to form the parts needed to manufacture the item, or the special test equipment used to verify that the components of the system (particularly electronics) function properly.

Because of its expense, producers will often plan to use this capital intensively--sometimes even 24 hours a day, seven days a week--even though the other plant activities are run on a more limited schedule of one or two shifts, five days a week. These capital equipment items, which often take two or more years to acquire, are usually bought by the manufacturer in the early years of the program. Thus, once they are in place, plant capacity is essentially limited to the throughput they permit.

FIGURE 1. RELATIONSHIPS BETWEEN ECONOMIC PRODUCTION RATES



SOURCE: Congressional Budget Office.

The minimum economic rate (point B in Figure 1) lies somewhere below the maximum production rate. DoD defined it as the lowest rate of production that still offers an acceptable rate of return on the investment in production facilities. Alternatively, it may be selected as the point on the cost schedule below which unit costs rise at an excessive rate. Unfortunately, there is no mathematical formula to indicate when the rate of production becomes uneconomic. Service program managers and contractors have their own ideas, which do not always agree. Nevertheless, the services have previously reported minimum economic rates for a number of major systems.1/

The minimum sustaining rate (MSR--point C in Figure 1) is defined as the lowest production rate that, in the judgment of program managers, can reasonably sustain an active production base. In some cases, this is set according to the minimum feasible rate of production for one shift of workers employed five days a week. In other cases, it may be determined by the minimum level of activity of a key supplier or subcontractor rather than by that of the prime contractor, who may have other military or commercial work to fill his plant. Like the other two rate concepts, the MSR is also a matter of judgment; on occasion, DoD will buy systems in smaller quantities than would be indicated by their reported MSR. This may occur early in the program, while testing of the system is still under way, or in a late stage when maintaining an active base ceases to be of concern to DoD.

Production Rates, 1983-1987

Using these three standards, the study examined the rate of procurement for 40 major weapons systems--including aircraft, missiles, and combat vehicles, but not ships--produced in the five-year period from 1983 through 1987.2/ These systems were among the acquisition programs that received the most funding during the period. They are listed in Tables 1 and 2, together with their highest, lowest, and average annual procurement rates over the five-year period; the tables

1. DoD no longer requires managers to define the minimum economic rate as such; instead, they are to report unit costs for a range of rates.

2. Production-rate economies for ships tend to be small because of their method of construction and the small quantities in which they are produced.

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TABLE 1. SYSTEMS BOUGHT AT OR ABOVE MINIMUM ECONOMIC RATES

Weapons System	1983-1987 Annual Procurement Rates			Minimum Sustaining Rate	Minimum Economic Rate	Maximum Economic Rate
	Minimum a/	Maximum	Average a/ b/			
AH-64 Apache Helicopter	112	138	117	24	72	144
M1 Abrams Tank	790	855	825	360	720	1,080
Bradley Fighting Vehicle	600	716	647	336	540	792
Patriot Missile	287	700	485	240	240	840
Stinger Missile	1,956	6,250	3,539	1,200	1,800	11,520
F/A-18 Aircraft	84	84	84	36	84	145
Standard Missile 2 (Medium-Range)	150	846	552	n.a.	480	844
Sparrow Missile c/	1,700	2,445	2,015	600	1,200	3,804
B-1B Bomber	10	48	31	12	24	48
C-5B Transport	8	21	15	4	4	24
F-16 Aircraft	120	180	155	72	108	324
Hellfire Missile c/	4,870	7,304	6,131	1,200	1,500	6,720
Multiple Launch Rocket System	23,640	72,000	50,822	24,000	36,000	72,000
F-14A Aircraft	15	24	21	12	12	96
KC-10 Tanker/ Cargo Aircraft	8	12	9	8	8	24
C-2 Greyhound Aircraft	6	9	8	4	8	9
CH-53 Super Stallion Helicopter	10	14	12	11	12	24
EA-6B Prowler Aircraft	6	12	9	6	6	24
E-2C Hawkeye Aircraft	6	10	7	4	6	18
SH-2F Seasprite Helicopter	6	18	8	6	6	48

SOURCE: Compiled by the Congressional Budget Office from Department of Defense, *Procurement Programs (P-1)*, various years (for annual procurement rates) and from service responses to Congressional inquiries (for sustaining and economic rates).

NOTE: n.a. = not available.

a. Excludes initial two years of production.

b. Average over years within the 1983-1987 period when the system was actually procured.

c. Combined procurement of all services.

TABLE 2. SYSTEMS BOUGHT BELOW MINIMUM ECONOMIC RATES

Weapons System	1983-1987 Annual Procurement Rates Minimum a/	Maximum	Average a/ b/	Minimum Sustaining Rate	Minimum Economic Rate	Maximum Economic Rate
AV-8B Aircraft	21	46	34	30	36	72
A-6E Aircraft	6	11	8	6	12	72
F-15 Aircraft	36	48	41	48	120	144
Ground-Launched Cruise Missile	76	120	99	120	120	600
Harpoon Missile	96	439	284	180	360	660
MX Missile	12	21	17	12	21	48
P-3C Aircraft	5	9	8	6	16	24
Phoenix Missile	108	265	222	108	240	420
SH-60B LAMPS Helicopter c/	18	27	23	21	24	60
Tomahawk Missile	51	324	186	120	300	540
AMRAAM Missile d/	0	180	a/	960	960	3,600
E-6A TACAMO	2	3	a/	n.a.	4	12
HARM Missile e/	289	2,462	1,460	2,256	3,240	6,480
IIR Maverick Missile	900	2,600	2,205	4,200	6,000	10,800
Laser Maverick	90	1,800	1,300	600	1,800	3,600
EH-60 Quickfix Helicopter	12	18	17	12	24	48
Sidewinder Missile e/	1,000	3,770	2,122	1,200	2,400	8,400
Standard Missile 2 (Extended Range)	100	425	296	n.a.	360	480
TOW 2 Missile e/	12,600	20,200	15,482	12,000	21,600	30,000
UH-60 Black Hawk Helicopter	78	96	85	72	96	144

SOURCE: Compiled by the Congressional Budget Office from Department of Defense, *Procurement Programs (P-1)*, various years (for annual procurement rates) and from service responses to Congressional inquiries (for sustaining and economic rates).

NOTE: n.a. = not available.

a. Excludes initial two years of production.

b. Average over years within the 1983-1987 period when the system was actually procured.

c. Includes seven SH-60F helicopters in 1987.

d. Still in low-rate initial production phase.

e. Combined procurement of all services.

also show each program's reported minimum sustaining rate and minimum and maximum economic rates.

Table 1 lists the 20 systems (of the 40 examined) for which average annual procurement quantities over 1983-1987 matched or exceeded the minimum economic rates. (None was above its reported maximum economic rate.) Many of these may have benefited from a DoD initiative to maintain procurement at or above this minimum standard. While these data seem positive, the numbers of systems qualifying for Table 1 may have been inflated. For some aircraft, the Navy reported minimum economic rates as only six aircraft per year, a doubtfully low standard. Also, the minimum economic rate for the Air Force's C-5B was reported as only four per year.

The remaining 20 (of the 40) systems were bought at average rates below their minimum economic rate (see Table 2). For a few systems (the TOW 2, Harpoon, and Sidewinder missiles), production for foreign military sales--not reflected in these data--raised total production quantities above the minimum economic rate during this period. For the remaining systems, however, rates were below--and sometimes well below--the minimum economic levels. The F-15, for example, has a minimum economic rate of 10 aircraft per month (120 per year), but was bought at an average of 41 aircraft per year.

Production below the minimum economic rate deviates from DoD's policy of keeping production rates for major systems at or above their minimum economic rates. The Army was most successful in reaching this goal: 70 percent of the Army systems reviewed were procured at average rates over the 1983-1987 period that met or exceeded their minimum economic rates. The comparable percentages for the other services were much lower: 44 percent for the Air Force and 43 percent for the Navy.

Since the services have not always defined the minimum economic rate consistently, another approach is to examine the percentage of systems bought at 50 percent or more of their maximum economic rates. While arbitrary, this choice of 50 percent seems like a reasonable lower bound; in the private sector, production below 70 percent of capacity is often considered very low. Again, the Army did best by this measure, with nine of ten systems meeting the test. The Navy was a distant second, with only 33 percent of its systems exceed-ing 50

percent of their maximum, while the Air Force produced only two of nine systems--the C-5B transport and the B-1B bomber--at 50 percent or more of their maximum economic rates.

Indeed, substantial numbers of these systems were produced at only small fractions of their maximum economic rates. Nine of the 40 systems had average rates of production in 1983 through 1987 that were one-quarter or less of their maximum economic rates.

Perhaps the minimum test of production efficiency is whether a system is produced at its minimum sustaining rate. DoD generally attempts to maintain production of all weapons at or above this rate. Only six of the 40 systems had average rates of procurement in 1983 through 1987 that were below their minimum sustaining rates. However, for 15 of the systems, production dipped below the minimum sustaining rates for at least one year during this period. And this situation seems likely to continue. In the fiscal year 1988 budget, production of four systems was planned at lower than minimum sustaining rates: the Black Hawk helicopter (61 in 1988 versus a reported MSR of 72); the AMRAAM missile (630 versus 960); the IIR Maverick (2,701 versus 4,200); and the F-15E fighter (42 versus 48). While the AMRAAM missile's production lines are still gearing up for full-rate production, low rates for the other three programs are more difficult to justify.

Since most systems undergo an initial period of low-rate production before building to their maximum planned rates, the above analysis has ignored the first two years of procurement in evaluating production rates. In certain cases, however, because of development or production problems, the low-rate period extended well beyond two years. This accounts for a few of the observed low rates--notably those for the AMRAAM, Phoenix, and IIR Maverick programs.

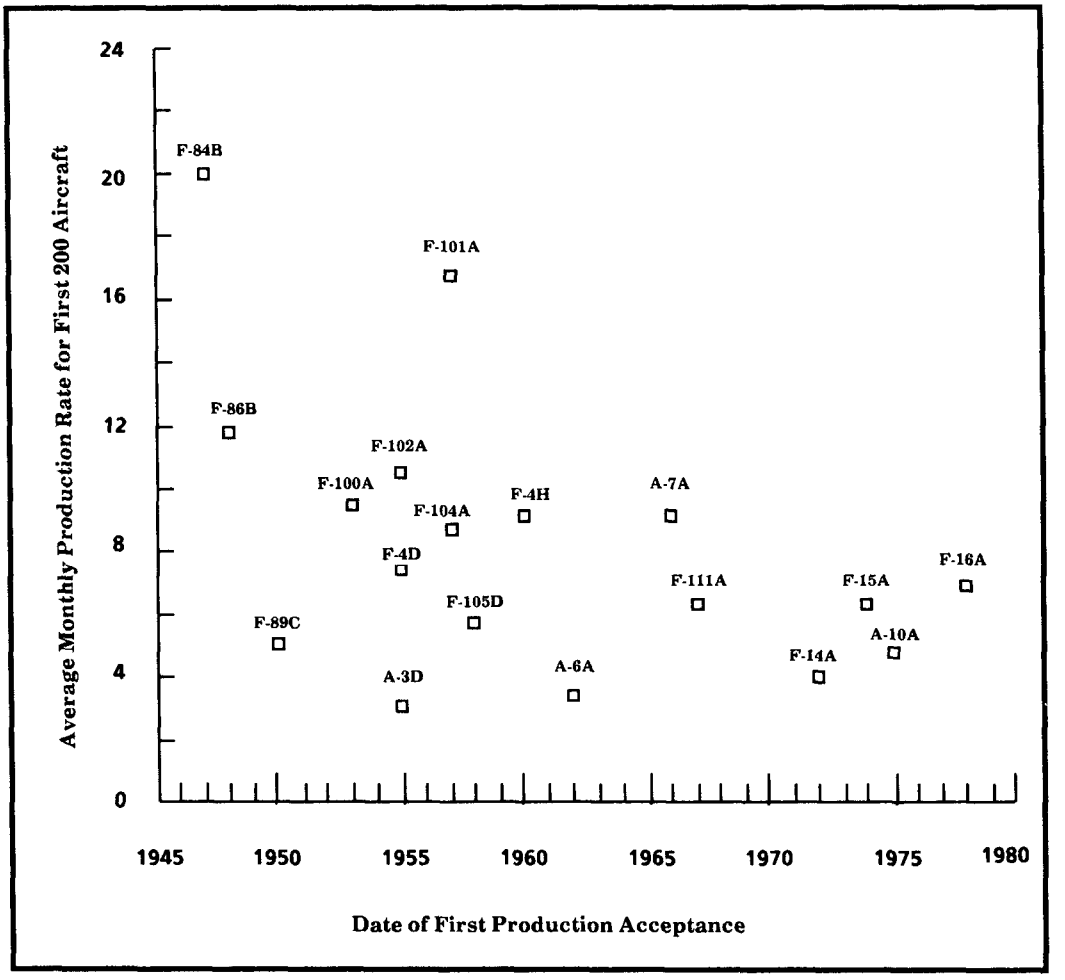
TRENDS IN WEAPONS PRODUCTION

Procurement of military aircraft has shown a distinct downward trend since the 1950s (see Figure 2). This trend is evident whether measured by annual procurement rates or by total program quantities.The primary reason for this decline is the increased real cost of aircraft,

even after adjustment for inflation. Procurement budgets have not grown proportionately to the price of aircraft; reductions in annual quantities are the inevitable result.

During the 1950s and 1960s, most fighter aircraft were bought at rates of six to ten per month (see Figure 2). In the past five years, only two fixed-wing aircraft--the Air Force's F-16 and the Navy's F/A-18--

FIGURE 2. PRODUCTION RATES FOR TACTICAL AIRCRAFT



SOURCE: Congressional Budget Office using data from G.K. Smith and E.T. Friedmann, *An Analysis of Weapon System Acquisition Intervals, Past and Present*, R-2605 (Santa Monica: The RAND Corporation, November 1980).

were bought at a rate of five or more units per month. Some recent Navy programs, by contrast, plan to buy aircraft at a rate of one or less per month in 1988.3/

The effects of increasing cost on production rates are also manifested in total program quantities for aircraft. Consider the A-6 attack aircraft's production history. Some 479 of the A-6A model were delivered in the nine-year period from 1961 through 1969--an average of 53 a year. Although the improved A-6E model has been in production since 1970, only 195 aircraft have been ordered in 18 years--less than 11 a year. Now, the Navy plans to acquire the upgraded A-6F model, starting with the fiscal year 1988 program, but to buy only 150 over the next six years. If history is any guide, these plans too are likely to be altered downward, stretching procurement of these 150 aircraft over 10 to 12 years.

Impact of the Defense Buildup on Production Rates

Nor has the recent expansion in defense spending always reversed this trend toward lower numbers. Procurement budget authority in fiscal years 1983-1987 was 92 percent higher than in the earlier five-year period from 1976 through 1980, after adjusting for inflation. But this large increase in funds did not result in uniformly higher procurement rates, as is apparent from a comparison of the annual average rates for the identical or comparable systems in the earlier period (see Table B-2 of Appendix B).

For some tactical missiles, procurement rates did increase in the more recent period. Procurement of the Army's TOW antitank missile averaged 15,500 per year over the 1983-1987 period, an increase of 1,000 missiles per year over the 1976-1980 rates. The Standard Missile's order rate nearly doubled, increasing from 449 to 848 per year. Procurement of the Sparrow air-to-air missile increased by about one-third, but procurement of the Sidewinder (another air-to-air missile) decreased slightly.

3. These programs include the EA-6B and E-2C aircraft and the F-14D fighter.

Helicopter procurement rates also increased. The AH-64 Apache attack helicopter was bought at an average of 117 per year over the period 1983 to 1987, versus 61 for its predecessor, the AH-1 Cobra. Procurement of the UH-60 Black Hawk, a transport helicopter, increased to 85 per year, as compared with an average of 64 over the 1977-1980 period. Procurement of the CH-53 Super Stallion, a transport helicopter, increased modestly from 9 to 12 per year.

On the other hand, production rates for strategic weapons were not significantly higher even though strategic modernization was one of the Administration's highest priorities. Procurement of the MX missile was limited by the Congress to an average of 16.5 units per year. But even the Administration's planned MX production rate of 48 per year was less than the 78 Trident missiles produced annually in 1976 through 1980.

Finally, production rates for fixed-wing aircraft introduced before 1976 were sharply lower in the more recent period, despite larger budgets. Average annual procurement of the F-14 fighter/interceptor aircraft decreased from 38 to 21, annual procurement of the P-3 anti-submarine warfare aircraft fell to 8 from 13, and the F-15 fighter aircraft experienced the largest decrease of all, declining from 95 per year to an average of 41.

Production Rates in the Fiscal Year 1988 Budget Request

If past results are mixed, more recent trends seem clearer. Production rates for 11 of the 20 largest programs (excluding ships) in the budget for fiscal year 1988 were reduced from last year's estimate (see Table B-3 in Appendix B). Only 2 of these 20 programs--the Tomahawk missile and the AH-64 helicopter--show a rate increase from last year's estimate. The direction in which many rates are headed seems evident.

CHAPTER III

IMPLICATIONS OF STRETCH-OUTS FOR COSTS AND SCHEDULES

Stretch-outs generally impose a cost penalty on procurement programs, as well as delaying deliveries of weapons to the military forces. Sometimes, however, good reasons exist to slow or defer production in specific cases. These considerations need to be balanced against the cost penalties and deployment delays that stretch-outs impose.

INCREASED PROGRAM COSTS

Stretching out the production of weapons tends to increase both unit and total program costs. Decreasing the basic rate of production for major weapons by 50 percent would increase real unit costs by from 7 percent to more than 50 percent, according to data supplied by the military departments and weapons producers (see Table 3). In the extreme case, according to the Army, procurement unit costs for the TOW 2 missile would increase by 60 percent if Army procurement of this missile were reduced to 6,000 missiles per year. Decreasing MX purchases to a rate of 13 per year would increase costs by 50 percent. Other tactical missiles, such as the IIR Maverick and Phoenix, would experience cost increases of from 8 percent to 43 percent if their production rates were cut in half.

The costs of ongoing aircraft programs, such as the A-6 and the AH-64, appear somewhat less sensitive to production-rate declines. Even for these programs, however, a 50 percent cut in production rates would increase unit costs by 7 percent to 35 percent. Unit cost increases for the two Army vehicles examined--the M1 tank and the Bradley Fighting Vehicle--were estimated at 27 percent and 37 percent, respectively, if annual quantities purchased were reduced by 50 percent.

TABLE 3. SENSITIVITY OF UNIT COSTS TO CHANGES IN PRODUCTION RATES
(Rates in units per year; cost changes in percent)

	Service Estimates					Regression Model
		50 Percent Decrease		50 Percent Increase		50 Percent Increase
System	Basic Rate a/	New Rate	Cost Change	New Rate	Cost Change	Cost Change
Aircraft						
A-6F Intruder	12	6	16	18	-7	-7
AH-64 Apache	78	39	21	117	n.a.	-6
AV-8B Harrier II	32	16	19	48	-5	-14
CH-47D Chinook	48	24	28	72	-7	b/
E-2C Hawkeye	6	3	24	9	-9	b/
EA-6B Prowler	6	3	17	9	-7	b/
F-14D Tomcat	7	3	13	10	c/	c/
F-15D/E Eagle	48	24	35	72	-13	-1
F/A-18 Hornet	84	42	10	126	-4	-5
KC-135R Tanker	50	25	7	75	-3	-4
SH-60F CV Helicopter	18	9	8	27	-3	-6
Missiles						
AMRAAM	833	417	30	1,250	c/	c/
Harpoon	124	62	40	186	-15	b/
IIR Maverick	6,000	3,000	27	9,000	-13	b/
MX	26	13	50	39	-18	-26
Patriot	884	442	16	1,326	c/	c/
Phoenix	430	215	14	645	-10	-12
Stinger	4,200	2,100	43	6,300	-14 c/	-7 c/
Tomahawk	475	238	8	713	-3	-1
TOW 2	12,000	6,000	60	18,000	-13	-15
Vehicles						
M1 Tank	720	360	27	1,080	-15	-8
Bradley Fighting Vehicle	720	360	37	1,080	c/	c/

SOURCES: Congressional Budget Office estimates (for regression model results), U.S. Air Force, U.S. Army, and U.S. Navy.

NOTE: n.a. = not available.

a. The basic rate is the service's proposed quantity for fiscal year 1988 in the case of Army and Air Force systems, and the quantity requested in the fiscal year 1988 budget for Navy systems.

b. Regression model estimate was insignificant.

c. A 50 percent increase in production is not feasible for 1988, according to the service.

On the other hand, increasing quantities above the current rate of production would lower unit costs. A 50 percent increase would decrease unit costs by from 3 percent to 18 percent, depending on the system (see Table 3). Missiles such as the MX, IIR Maverick, and Phoenix appear to offer potential savings of from 10 percent to 18 percent, were production rates boosted by 50 percent. The M1 tank's unit cost would decrease by 15 percent, according to the Army, were its production increased 50 percent to 1,080 units per year. Cost decreases for aircraft programs would be smaller--generally 10 percent or less for a 50 percent rate increase. But 10 percent of a $30 billion aircraft program is $3 billion--not an insignificant sum.

The cost savings obtainable from higher production rates would be smaller--system by system--than the comparable percentage cost increases from reducing rates. This asymmetric pattern results from the observed relationship between costs and production rates (displayed in Figure 1 in Chapter II). At low rates of production, unit cost is very sensitive to changes in the rates, but as one moves along the curve toward higher production rates the relative savings from further increases diminish.

Regression Estimates of the Rate-Cost Relationship

A schedule of increases and decreases in unit cost does not provide a basis for accurate budget estimates over five years; these estimates depend on factors other than the production rate, such as the effect of learning. In order to facilitate making cost estimates for other quantities and budget years, the study used regression models to relate costs to changes in production rates and other factors for a number of programs. These models are based on the previous work of other researchers.1/

1. See John C. Bemis, "A Model for Examining the Cost Implications of Production Rate," *CONCEPTS--The Journal of Defense Systems Acquisition Management*, vol. 4, no. 2 (1981), and Michal Bohn and Louis A. Kratz, *Development of an AFSC Production Rate Variations Model*, Report No. TR-4612-2-2 (Arlington, Va.: The Analytic Sciences Corporation, 1984).

These estimates--like others previously reported--were not always successful in capturing the relationship between cost and production rates. Significant rate effects were found for only about half the programs for which models were fitted. These successful estimates were sometimes higher and sometimes lower than those made by the services, but were comparable overall (see the final column of Table 3 for examples).

In cases where a regression model failed, it was usually because the estimated coefficients were statistically insignificant or had an implausible sign (implying, for example, that unit costs increased as rates increased). In these cases a simpler model was employed, relating unit costs solely to total numbers of weapons bought. The simpler model captured the effects of the "learning curve"--that is, the decline in unit costs as the contractor builds more weapons and learns how to be more efficient--but did not separately capture the effect of buying weapons faster. Although the simpler models still show that speeding up the rate of buy decreases annual unit costs, this is because learning-curve savings are realized more quickly.2/ The estimated effects on costs are usually much smaller than estimates using models that explicitly capture the effects of buy rates. This accounts for the wide range of cost estimates that appear in parts of this study.

Reasons Why Higher Rates Offer Savings

The reductions in unit cost that come through higher production rates stem from many sources. Labor savings are achieved by assigning a larger crew of workers more specific tasks, allowing them to become more proficient, and avoiding delays associated with shifting them from one job to another. Similar savings are possible in the use of

2. An example will clarify this statement. Assume that 100 articles are to be bought. If one uses a simple model that does not capture production-rate effects explicitly, but does capture the effects of the learning curve, total costs in real terms to buy all 100 weapons will be the same regardless of the rate at which they are bought. Average unit costs in, say, the first five years could differ, however. For example, the average unit cost over five years if 20 units are bought each year will be lower than the average unit cost if only 10 are bought a year, because the more rapid rate of production realizes learning-curve savings more quickly. Thus, when analysts compare costs of buying weapons at varying rates over a fixed period of time, unit costs can vary even with a simple learning-curve model.

machinery, since a larger number of units can be run off once a machine is set up to perform a given task. If the rate of production warrants, it may be economical to build special-purpose machines to perform tasks more efficiently than is possible with general-purpose tools. Economies also result when quantity discounts are obtained on purchases of parts and components. Other reductions in unit costs come from spreading fixed production costs (such as for tooling and test equipment) over a larger number of units.

Dollar Savings from Higher Rates

Higher production rates clearly have the potential to reduce the unit costs of weapons. What do lower unit costs mean in terms of potential budget savings? The range of these savings can be illustrated by looking at production rates for two aircraft--the F-15E and F/A-18.

TABLE 4. ESTIMATED SAVINGS UNDER HIGHER PRODUCTION RATES
(Costs in billions of 1988 dollars)

System	Average Annual Production Rates		Added Near-Term Costs of Alternative Plan	Net Long-Term Savings	Discounted Present Value of Savings	
	Administration Plan	Alternative Plan			2 Percent	10 Percent
F-15E Aircraft (Lower Estimate)	38	86	5.2 a/	0.5	0.1	-0.9
F-15E Aircraft (Higher Estimate)	38	86	1.3 a/	2.9	2.3	0.9
F/A-18 Aircraft	73	116	4.5 b/	0.5	0.2	-0.7

SOURCE: Congressional Budget Office estimates of savings, based on program costs reported in Department of Defense, *Selected Acquisition Reports* (December 1986).

a. Through 1991.

b. Through 1990.

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F-15E Eagle Fighter Aircraft. The Air Force plans to buy 342 F-15E fighter aircraft from the McDonnell Douglas Corporation over the period 1988-1996 at an estimated total cost of $12.4 billion. The rate of production under the Air Force's plan averages 38 aircraft per year. It could instead buy these aircraft at a rate of about 7 per month (86 per year), still well below McDonnell Douglas's maximum economic production rate of 12 a month. This approach would save from $0.5 billion (assuming little rate effect) to as much as $2.9 billion (using the higher service estimate for the rate effect) over the life of the program (see Table 4).

F/A-18 Hornet Fighter/Attack Aircraft. The Navy recently chose to reduce the annual rate of procurement of F/A-18s to an average of 73 aircraft per year. In contrast, the acquisition plan presented with the fiscal year 1987 budget called for an increase to the maximum economic production rate of 132 aircraft per year.

The present Navy plan is estimated to cost $15.3 billion for the 580 aircraft needed to complete the F/A-18 program. If these aircraft were bought instead at an average of 116 aircraft per year, a net savings of $0.5 billion could be realized. This plan, however, would require that $4.5 billion in additional budget authority be granted to the Navy over the 1988-1992 period.

Discounted Net Savings

As these examples suggest, more rapid acquisition programs entail higher near-term budgets but lead to net savings over the life of the program. For a proper assessment of the cost-effectiveness of increasing production rates, the savings have to be discounted to reflect the reality that future budget dollars are worth less than current ones.3/ If the net discounted present value of long-term savings exceeds the near-term costs, then the higher rates more than pay for themselves in the long run.

At CBO's preferred real discount rate of 2 percent, the net present value of savings for the three estimates described above is positive--

3. The effects of inflation have already been removed by expressing all system costs in constant dollars.

suggesting that higher production rates reduce costs even after discounting (see Table 4). The services sometimes use higher real discount rates of as much as 10 percent in their program analyses.4/ At a rate of 10 percent, two of the three cases have negative discounted present values, suggesting that higher rates do not achieve savings. A discount rate of 10 percent is extremely high given current economic conditions. A rate of 2 percent better reflects more recent experience.

OTHER REASONS TO AVOID STRETCH-OUTS

Debate over the rate of production of weapons systems tends to focus on the economic issue, particularly the negative impact of lower rates on unit and total program cost. But avoiding stretch-outs by maintaining high production rates would offer other benefits as well.

Completing acquisition programs faster could limit the effects of technological obsolescence. Table 5 shows the number of years that would be required to meet DoD objectives for acquiring 26 selected weapons systems at the procurement rates planned for 1989. (The 1989 rates were chosen over those for 1988, because in most cases they were more typical of planned rates.) The table also shows the number of years these systems have already been in production. If planned 1989 rates were to continue, it would take an average of 16 years from the start of production to meet DoD's objectives; for 6 of the 26 systems, it would take 20 years or more. While many of these systems have been modified during these long production periods, there are limits to what these modifications can do to meet increasing foreign threats.

Completing the acquisition of weapons systems sooner would also make room in future budgets for new weapons. For example, 35

4. The Office of Management and Budget, in its Circular A-94 (published in 1972), directed all federal agencies to use a discount rate of 10 percent, after expressing costs and benefits in constant dollars, for all program analyses submitted to OMB for approval. It also suggested, but did not mandate, the use of this rate in internal agency analyses. Since then other circulars, oriented toward more specific cases, have specified other discounting rules, some of which use lower discount rates. But Circular A-94 has been neither revised nor rescinded, and still reflects Administration policy for selecting the discount rate in the absence of more specific instructions.

TABLE 5. YEARS TO ACQUIRE SELECTED MAJOR WEAPONS SYSTEMS

System	Total Program Quantity	Needed to Complete	Years in Production	Procurement Rates 1988	Procurement Rates 1989	Years to Complete a/	Total Years
AMRAAM Missile b/	24,320	24,140	1	630	1,800	14	15
AV-8B Aircraft	328	148	6	32	32	5	11
A-6E/F Aircraft	345	150	18	12	18	9	27
Bradley Fighting Vehicle	6,882	2,549	8	616	618	5	13
CH/MH-53E Helicopter	153	32	11	14	14	3	14
E-2C Aircraft	141	30	17	6	6	5	22
EA-6B Aircraft	80	42	4	6	9	5	9
F-14A/D Aircraft	710	132	17	12	12	11	28
F-15A/D/E Aircraft	1,266	342	15	42	42	9	24
F-16A/B/C/D Aircraft	2,729	1,230	10	180	180	7	17
F/A-18 Aircraft	1,157	580	9	84	72	8	17
HARM Missile b/	14,619	7,098	7	2,514	2,659	3	10
Harpoon Missile	3,971	886	13	124	138	7	20
Hellfire Missile c/	48,696	27,614	6	5,000	4,000	7	13
IIR Maverick Missile d/	60,664	50,744	6	2,100	1,900	27	33
M1 Tank	7,844	2,086	9	600	534	4	13
Multiple Launch Rocket System	440,322	180,000	8	72,000	36,000	5	13
MX Missile	235	169	4	21	21	8	12
Patriot Missile	6,452	3,602	8	715	815	5	13
Phoenix Missile	7,204	5,904	8	430	560	11	19
SH-60F Helicopter	175	168	1	18	18	10	11
Standard Missile 2	14,677	9,375	12	1,150	1,635	6	18
Stinger Missile c/	50,370	31,631	10	4,200	5,000	7	17
Tomahawk Missile	3,994	2,958	8	475	510	6	14
TOW 2 Missile c/	125,856	48,623	7	9,416	8,719	6	13
UH-60 Helicopter c/	1,111	252	11	61	72	4	15

SOURCE: Congressional Budget Office computations based on DoD data contained in Congressional Data Sheets, *Selected Acquisition Reports*, and *Procurement Programs (P-1)*.

a. Based on 1989 rate.

b. Combined Air Force-Navy procurement.

c. Army procurement only.

d. Air Force (AGM-65D/G) version only.

percent of the Navy's 1987 combat aircraft procurement budget request was for aircraft models that entered production more than 10 years ago. Had production of these been completed more rapidly, the budgeted funds would be available for other, newer systems.

Avoiding stretch-outs, and buying at high rates, may not always be the best way to deal with obsolescence. For example, suppose the military buys a new missile very quickly, but it is rendered largely obsolete by a change in potential battlefield conditions. Under a slower rate of procurement, the system could have been canceled before too many units were produced. Still, given the average of 16 years to complete production of the typical systems examined above, it does not seem likely that policy changes to avoid stretch-outs would result in overly rapid procurement.

Finally, higher production rates would also mean that more systems could be deployed sooner. In their testimony before Congressional committees, theater commanders emphasize that they are short of critical "war stoppers"--modern munitions capable of blunting an enemy attack.5/ They explicitly mention missiles such as the Sparrow, Sidewinder, High Speed Antiradiation Missile (HARM), Maverick, and MLRS--missiles for which production rates could be increased without investing in new facilities.

WHY STRETCH-OUTS OCCUR

Given the advantages of higher rates, why are program stretch-outs so common? The easy answer is "fiscal limitations." Certainly, both DoD, in preparing its budget for submission, and the Congress, in acting on the request, must meet overall constraints on the level of defense spending through cuts in specific programs. The more relevant question is why stretch-outs are chosen in preference to other ways of reducing the budget.

5. See *Department of Defense Authorization for Appropriations for Fiscal Year 1986*, Hearings before the Senate Committee on Armed Services, 99:1 (1985), p. 3, pp. 1241-1249.

Keeping production rates high for some weapons would mean that other weapons programs would almost certainly be delayed or canceled. Higher production rates often lower the cost per unit of a weapon, but producing 100 items rather than 50 in a particular year will always increase the total funding required in that year. Even if unit costs were lower, the higher numbers would more than offset reduced costs per weapon. Within a fixed budget, these higher program costs would have to be offset by reductions elsewhere. It would probably be considered unwise to reduce numbers of forces or readiness. More likely, higher costs for ongoing programs would have to be offset by canceling or deferring new weapons. This approach would delay the acquisition of new weapons, which are always technologically more advanced and thus often more highly prized by the military. Chapter IV illustrates this trade-off explicitly.

Low production rates are justifiable in the case of weapons that are still undergoing developmental or operational testing, since DoD is naturally loath to sink large sums into an unproved system. A common approach is to produce at low rates for a few years and then increase production to more economic levels. This allows major deficiencies that emerge in testing to be corrected before many units have been delivered.

Most weapons systems undergo many modifications over their lifetimes, and keeping production rates low may reduce the costs of such modifications. It is usually cheaper to incorporate modifications into new units as they are produced; with high production rates, more systems might have to be recalled, a costly procedure.

Finally, stretching out production by keeping rates low makes it easier to maintain an active production base. Higher production rates mean shorter production periods, if total acquisitions are fixed. Shorter periods would increase the likelihood of a production gap, because procurement of one generation of weapons might be finished before development of the next generation was completed. In order to facilitate transition to the new products, it is important to keep together the accumulated knowledge and skills of engineers and key production managers. One solution, of course, would be to buy existing systems quickly and efficiently and then move on to new ones. Short of this, sales to foreign customers might help to fill production gaps without sacrificing productive efficiency.

CHAPTER IV

PRODUCTION-RATE INCREASES FOR SELECTED PROGRAMS

What impact would more rapid acquisition schedules have on equipment modernization objectives and weapons stocks? What would be the long-run savings from the increase in production rates implied by these faster schedules? Most importantly, could annual procurement quantities be kept at these higher rates without an overall increase in procurement budget authority? To assist the Congress in answering the first two of these questions, this study estimates the budget impact of higher procurement rates for selected weapons systems. To illustrate possible solutions to the third question--how to fit higher procurement rates into a fixed budget--the study examines possible budgeting offsets, such as canceling or deferring other weapons programs.

EFFECTS OF PRODUCTION-RATE INCREASES

The 12 systems chosen to illustrate the effects of higher production rates include missile, combat vehicle, and aircraft programs drawn from the procurement plans of all four military services. The higher rates that characterize the alternative schedules for these weapons were based on a review of previous service acquisition plans. Their feasibility is demonstrated by the fact that they are lower than or the same as rates contained in those previously submitted plans--which were later revised downward--and they are often lower than peak production rates actually achieved in the past. An additional criterion was that sufficient manufacturing capability be available to increase the production of a weapon without significant new investment. Table 6 lists the changes in quantities and costs for each program; Appendix A describes the programs' baselines and alternative schedules and costs in more detail.

TABLE 6. EFFECTS OF ACCELERATING PRODUCTION OF SELECTED WEAPONS SYSTEMS
(Costs in billions of 1988 budget dollars)

System	Number of Units Acquired through 1992: Administration's Plan	Number of Units Acquired through 1992: Alternative Plan	Additions under Alternative Plan: Number	Additions under Alternative Plan: Percent	Increase in Budget Authority Needed: 1988	Increase in Budget Authority Needed: 1988-1992
Aircraft						
AH-64 Apache	593	1,102	509	86	0.3	4.5
F-15E Eagle	260	392	132	51	0.4	3.7
F/A-18 Hornet	949	1,157	208	22	0.1	4.5
SH-60F CV Helicopter	85	175	90	106	a/	1.0
UH-60A Black Hawk	1,111	1,435	324	29	0.2	1.4
Total, Aircraft	2,998	4,261	1,263	42	1.0	15.1
Missiles						
HARM	14,619	20,481	5,862	40	0.2	1.3
Harpoon	3,971	4,697	726	18	a/	0.6
IIR Maverick	25,820	49,864	24,044	93	0.2 b/	1.5 b/
Standard Missile 2 ER	3,973	4,643	670	17	a/	0.2
Stinger	43,939	50,370	6,431	15	0.1	0.3
Total, Missiles	92,322	130,055	37,733	41	0.5	3.9
Combat Vehicles						
M1 Tank	7,844	9,718	1,874	24	0.1	4.3
Bradley Fighting Vehicle	6,882	8,117	1,235	18	a/	1.2
Total, Combat Vehicles	14,726	17,835	3,109	21	0.1	5.5
Increase in budget authority for all systems					1.6	24.5

SOURCES: Congressional Budget Office estimates (for increase in budget authority); Department of Defense (for quantities).

a. Less than $50 million.

b. Based on the difference between the 1987 budget, adjusted for Congressional action and inflation, and the 1988/1989 budget.

The missile systems selected were among those nominated for faster acquisition by senior military leaders. The heads of Unified Commands in the European, Pacific, and Central areas have testified before the Congress concerning deficiencies in stocks of guided missiles.1/ The weapons examined in the following discussion are among the critical "war-stoppers" they believe are in short supply. Other weapons systems were included to illustrate the effects of higher production on a wide variety of systems.

For several programs, higher procurement rates simply buy the planned program more quickly. In other cases, they buy more weapons than planned currently, but a requirement has previously been established by the service or services concerned for additional numbers of systems--a requirement not met by the Administration's current plan. (Details of these requirements are not reported here, since they are generally classified data.) DoD may choose not to meet an established requirement because of budgetary limitations or because it expects some later-generation weapon to fill the need.

Near-Term Impact of Faster Acquisition

The increasing numbers of weapons acquired over the 1988-1992 period as a result of these production-rate increases would, in some cases, reduce the current deficiencies noted by military commanders. The five missile programs would add 37,733 more missiles than the Administration plans for these systems, an increase of 41 percent. This increase would significantly enhance U.S. war reserve stocks of these items.

For other weapons, higher production rates would allow requirements to be met more quickly. Accelerated purchases of the F/A-18 aircraft, as the 1987 defense plan called for, would mean the program would be completed by 1992 rather than 1995 as targeted in the current budget plan. Earlier deliveries would allow aging A-7 aircraft to be retired more quickly, avoiding operational problems and enhancing the Navy's and Marine Corps' attack capabilities. Simi-

1. See *Department of Defense Authorization for Appropriations for Fiscal Year 1986*, Hearings before the Senate Committee on Armed Services , 99:1 (1985), pt. 3, pp. 1241-1449.

larly, completing the SH-60F helicopter program by 1992 would provide improved submarine protection to the carrier battle group.

The Army's attack helicopter requirement would be fully met through the increase envisioned here for the AH-64 Apache helicopter, whereas it would not be met under current Administration plans until a new helicopter--the LHX--is purchased in the 1990s. And the increase in UH-60 Black Hawk helicopters would reduce the UH-60 helicopter shortfall to about 20 percent as against 37 percent under the Administration's five-year plan.

Accelerated purchases of the F-15E Strike Eagle would complete the acquisition of these new deep-attack aircraft by 1991, a gain of five years over the Administration's schedule. Overall, the aircraft procurement rate adjustments would add 1,263 aircraft in 1988-1992 above those in the Administration's plan.

The Army recently stretched out the M1 tank and Bradley Fighting Vehicle programs, responding to Congressional direction to conduct an analysis of future tank production and the impact of closing the only U.S. tank production line.2/ The alternative examined here would be to continue buying tanks at economic rates. The Bradley Fighting Vehicle production rate is also increased, though more modestly than last year's production plan anticipated. Overall, these increases would add 3,109 combat vehicles to those the Administration plans to buy in the next five years.

Unit Cost Decreases

These alternative procurement programs at higher production rates would result in lower unit costs for the weapons purchased. Estimates based on data gathered from the services suggest that, for the 12 systems analyzed here, unit costs could go down by as much as 25 percent (see Table 7).

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2. *National Defense Authorization Act for Fiscal Year 1987*, Report No. 99-718, House Committee on Armed Services, 99:2 (1986), p. 29.

These estimates were derived from schedules relating production rates to unit costs. The method ignores factors such as learning curves and product changes that also affect cost. Nevertheless, it usually yielded results that were within four to five percentage points of those obtained using a statistical cost model estimated from budget data (see Chapter III for further discussion). There were exceptions, however, where the two estimates deviated more significantly, as illustrated by the range of estimates in Table 7 for the F-15E aircraft,

TABLE 7. REDUCTIONS IN UNIT COST THROUGH HIGHER PROCUREMENT RATES

System	Average Production Rate: Administration's Plan	Average Production Rate: Alternative Plan	Average Production Rate: Percent Increase	Percent Decrease in Unit Cost
Aircraft				
AH-64 Apache Helicopter	67	115	72	16
F-15E Eagle Aircraft	38	86	126	4-18
F/A-18 Hornet Aircraft	73	116	59	3
SH-60F CV Helicopter	15	34	127	6-9
UH-60 Black Hawk Helicopter	63	115	83	4-13
Missiles				
HARM Missile	2,366	3,240	37	4-8
Harpoon Missile	177	322	82	22-24 a/
IIR Maverick Missile	5,074	8,457	67	11-20
Standard Missile 2 (ER)	330	464	41	9-10
Stinger Missile	5,272	6,326	20	2-7
Combat Vehicles				
M1 Tank	417	792	90	13-25
Bradley Fighting Vehicle	637	757	19	5-8

SOURCE: Estimates by the Congressional Budget Office based on cost data from the armed services and defense contractors.

the IIR Maverick missile, and the M1 tank. In these cases, the service estimate of savings was likely to be larger than that derived from regression analysis. On the basis of the latter, unit cost decreases would range from 2 percent to 16 percent.3/

Estimates of Long-Run Savings from Higher Production Rates

In most of the cases studied, completing an acquisition program earlier by choosing a higher rate of production would save money. This is seen most clearly in the five cases that would not require any change in total program quantity from that planned by the Administration. Costs to complete those five systems, under the Administration's plan, total $36.1 billion. To produce these five systems at higher rates would require that the Congress add $11 billion in budget authority for 1988-1992. But over the long term, this move would save money. Using the more conservative regression estimates of rate effects on cost, long-run net savings from higher production rates were estimated at $1.7 billion or 5 percent of the cost (see Table 8). This estimate ignores inflation savings from buying weapons sooner; if included, those inflation savings would nearly double total savings.

Indeed, if the higher estimates of the effect of higher production rates on unit cost were substituted for the more conservative figures, savings for the five systems would total $3.9 billion in constant dollars, or about 11 percent of total costs, compared with 5 percent using the lower estimates. This range illustrates the degree of uncertainty as to the magnitude of potential savings from higher-rate production. But even the lower estimates demonstrate that the potential savings from higher-rate acquisition programs are large enough to merit the attention of DoD and the Congress.

3. The higher figures appearing in Table 7 were not derived from CBO's regression estimates.

TABLE 8. ESTIMATES OF SAVINGS FROM HIGHER PRODUCTION RATES (In billions of 1988 budget dollars)

System	Administration's Plan		Alternative Plan		Savings	
	Average Annual Rate	Total Cost	Average Annual Rate	Total Cost	Undis-counted	Discounted at 2 Percent
F-15E Aircraft	38	12.4	86	10.2-11.9	0.5-2.2	0.1-1.7
F/A-18 Aircraft	73	15.3	116	14.8	0.5	0.2
IIR Maverick	5,074	4.4	8,457	3.6-3.9	0.5-0.9	0.3-0.6
SH-60F Helicopter	15	2.6	34	2.3	0.2	0.1
Stinger Missile	5,272	1.5	6,326	1.4-1.5	0.0-0.1	a/
Total		36.1		32.3-34.4	1.7-3.9	0.7-2.6

SOURCE: Savings estimated by the Congressional Budget Office, based on models relating costs to production rates and on service estimates of rate effects.

a. Less than $50 million.

PAYING FOR HIGHER PRODUCTION RATES

Long-run savings notwithstanding, higher production rates are not feasible unless some way is found to offset the higher near-term funding needed to support them. The fiscal year 1988 Congressional budget resolution set a cap on national defense budget authority of no more than $296 billion, a reduction of at least $16 billion from the President's budget request and a slight reduction in real terms below the 1987 level.4/ Thus, decisions to fund higher production rates for some systems would have to be accompanied by actions to reduce budget authority elsewhere. This study assumed that cuts would be made in other procurement or research and development programs. The Congress seems unlikely to support large reductions in money for operations and support, since this might result in reduced readiness.

4. Should the President not accept the higher taxes assumed in the budget resolution, this figure would be cut still further to $289 billion.

Indeed, recent Congressional cuts in DoD's budget have come disproportionately from the investment accounts that pay for procurement and research.

Reducing the production rate on one system in order to increase it for another would be self-defeating. The other savings options available to the Congress are either (1) to defer starting new procurement or research and development efforts until current programs are completed, or (2) to cancel certain ongoing or planned weapons programs in order to fund production increases in others with higher priority. Examples were developed of each approach in order to illustrate the savings and possible impacts on the defense program.

If the Congress chose to support the specific increases for all 12 programs detailed in Table 6, it would add $24.5 billion to defense budget authority for fiscal years 1988 through 1992.5/ The larger part of this funding--$15.1 billion--would be needed for the five aircraft programs; in contrast, accelerating the missile programs would require less than $4 billion in added budget authority. Near-term costs for the additional combat vehicles would be $5.5 billion.

Funding Production-Rate Increases by Deferring New Starts

The study analyzed the savings that would result from deferring development or production by two years. Twenty-two systems scheduled to start production in fiscal years 1988 through 1990 are listed in Table 9; they include the Navy Department's V-22 Osprey aircraft and SSN-21 attack submarine, the Air Force's C-17 transport aircraft and small strategic missile (SICBM), and elements of the Army's air defense system and tactical missile system. Development funds for these programs were either continued at fiscal year 1987 real levels through the two-year delay period--when development spending was scheduled to rise--or continued as planned.

5. This is an upper-bound estimate based on regression costing methods. Were service estimates of higher savings used instead, the additional budget authority required would be less.

TABLE 9. ESTIMATED SAVINGS FROM DEFERRING NEW STARTS (In billions of 1988 budget dollars)

Program	Savings from a Two-Year Deferral 1988	Savings from a Two-Year Deferral 1988-1992	Reduction in Units Purchased through 1992
Research and Development Programs			
Army R&D Programs	a/	1.8	N.A.
Navy R&D Programs	0.1	0.3	N.A.
Air Force R&D Programs	a/	0.2	N.A.
Procurement Programs b/			
Aircraft			
V-22 Osprey c/	0.1	5.3	120
RC-12 Reconnaissance	0.1	0.4	19
F-14D	0.6	1.8	24
P-3G	a/	2.0	50
EX Competition	0.2	0.1	0
T-45TS	0.4	1.1	96
JSTARS (Air Force)	a/	0.3	2
C-17	1.3	5.8	30
Missiles			
FAADS Line of Sight-Forward-Heavy	0.1	0.8	2,724
FAADS Non Line of Sight	0.1	0.6	n.a.
Army Tactical Missile	a/	0.3	658
Penguin	a/	a/	65
Sea Lance	0.0	0.4	d/
Rail Garrison	0.5	4.2	45
Tacit Rainbow	0.2	0.8	d/
SRAM II	0.2	0.3	100
Small ICBM	1.1	6.4	96
Ships			
LSD-41 Cargo Variant	0.3	0.8	3
SSN-21 Submarine	0.3	3.7	4
Other			
FAADS C^2I	0.2	0.4	n.a.
FY 1989 Submarine Combat System e/	0.2	0.7	4
Sensor Fuzed Weapon	0.0	0.5	2,325
Total All Programs	5.7	39.1	

SOURCE: Congressional Budget Office estimates based on Department of Defense, *Selected Acquisition Reports* (December 1986 and June 1987).

NOTE: N.A. = not applicable. n.a. = not available.

a. Less than $50 million.

b. Procurement programs include costs for RDT&E, Procurement, and Military Construction associated with the program.

c. Joint service program.

d. Number is classified.

e. Excludes costs included in the SSN-21 program.

Nine other new programs scheduled to start development in 1988 or 1989 would be similarly delayed. These include the Army's effort to develop a new armored family of vehicles, the Navy's Advanced Air-to-Air Missile, and the Air Force's Air Defense Battle Management Technology program.

Together these deferrals would free a total of $39.1 billion in funds for fiscal years 1988 through 1992 (see Table 9). Deferrals, of course, are not permanent savings. The study assumed that these programs would commence after two years according to the schedule set out in the Administration's defense plan, and that the ultimate real cost of the programs would not be increased.6/

Deferral of all these new starts would free up more funds than are necessary. Increasing production rates for the 12 programs listed in Table 7 would require less than $25 billion in additional funds over the 1988-1992 period, as compared with $39.1 billion in near-term savings from the deferrals listed in Table 9. Thus, the Congress could choose to proceed with some new programs and still afford to increase production rates for current-generation weapons. Alternatively, it could increase rates for a selection of such programs while deferring only a few new starts.

A combination of new-system deferrals and increases in production rates would emphasize near-term capability at the expense of delaying future force modernization. Over the next five years, assuming all the aircraft program changes detailed above--both production increases and deferrals of new starts--were approved by the Congress, the services would gain 1,263 additional modern aircraft, while losing 341 others because of deferrals, a net gain of 922 aircraft. Similarly, approval of the missile program changes would add 37,733

6. This assumption is based on the fact that, for most programs, considerable development effort is planned even after production is started. For example, $3.7 billion of an eventual total of $4.9 billion in research and development funds for the C-17 aircraft remains to be appropriated over fiscal years 1988 through 1993. Thus, deferring production of systems for delivery to operational units while building and testing prototypes is possible. This approach was, in fact, a recommendation of the President's Commission on Defense Acquisition (the Packard Commission). Although not included in these cost estimates, eventual reductions in the program costs are possible if such testing reveals unanticipated defects that can be remedied before production begins.

missiles, and result in the loss through deferrals of at most one-fifth this amount.7/

The two-year delay in producing new weapons would delay the benefits of the new technology incorporated in such systems as the SSN-21 attack submarine, V-22 tilt-rotor aircraft, C-17 transport, and new air defense systems for the Army. It could also introduce inefficiencies of its own by slowing the R&D effort for these and other new systems.

On the other hand, rapid production of a weapons system, requiring a tight schedule for developing certain components while at the same time producing others, may also be expensive. Concurrency is thought to have been a major factor in the problems that emerged with the B-1B bomber. In such cases, deferring production while continuing R&D might ultimately result in lower, not higher, costs.

Funding Production-Rate Increases by Terminating Programs

Rather than deferring new program starts, the Congress might instead choose to terminate some of them in order to fund others at efficient rates. It is beyond the scope of this study to discuss in detail the pros and cons of terminating specific weapons programs. But in order to illustrate concretely what might be required to pay for higher production rates in the near term, the study lists nine programs that might be considered as candidates for termination (see Table 10).

These nine programs include examples from each of the military services. Four of them buy aircraft that serve to augment conventional force capability, while five are strategic programs. The notes to Table 10 identify sources of further information about each program; the sources either advocate termination or present pros and cons for such an action.

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7. It is impossible to calculate this figure with precision, since quantities for the five-year defense plan have not been established for all new program starts. Deferred missiles that can be counted sum to 3,688, less than one-tenth the number that would be added because of increases in production rates.

TABLE 10. ILLUSTRATIVE SAVINGS FROM CANCELING PROGRAMS, 1988-1992 (In billions of 1988 budget dollars)

System	1988	1989	1990	1991	1992	Total, 1988-1992
Conventional Forces Programs						
A-6F Aircraft	1.0	1.0	0.9	0.9	1.3	5.1
LHX Helicopter a/	0.4	0.6	0.8	0.9	0.5	3.1
F-15E Aircraft	1.8	1.8	1.8	1.7	1.5	8.5
V-22 Aircraft	0.5	0.6	2.0	2.6	3.0	8.8
Strategic Forces Programs						
Small ICBM	2.2	2.3	5.1	4.2	4.2	18.0
Rail Mobile MX Missile	0.6	1.2	2.2	2.9	1.5	8.4
Short Range Attack Missile II	0.2	0.2	0.3	0.2	0.2	1.2
Antisatellite Missile	0.4	0.7	0.5	0.5	0.4	2.5
Trident Backfit Program	b/	0.2	0.1	0.3	0.2	0.8

SOURCE: Congressional Budget Office estimates based on Department of Defense, *Selected Acquisition Reports* (December 1986).

NOTES: The pros and cons of canceling many of the programs listed above are presented in Congressional Budget Office, *Reducing the Deficit: Spending and Revenue Options* (January 1987). See "Restructure the Army Helicopter Programs," pp. 38-39 (for LHX); "Cancel Procurement of the F-15," pp. 20-21; "Cancel V-22 Aircraft," pp. 36-37; "Reduce Purchases of MX Missiles," pp. 34-35; "Cancel Trident Refit Program," pp. 26-27; "Cancel the Antisatellite Missile," pp. 24-25.

Arguments for canceling the A-6F are presented in *National Defense Authorization Act for Fiscal Years 1988 and 1989*, Report No. 100-57, Senate Committee on Armed Services, to accompany S. 1174, 100:1 (1987), p. 36. For information on all strategic programs, see Congressional Budget Office, *Modernizing U.S. Strategic Offensive Forces: Costs, Effects, and Alternatives* (forthcoming).

a. Research and development costs only.

b. Less than $50 million in savings.

Taken together, canceling these nine programs would reduce five-year defense costs by a total of $56.4 billion. As with the deferrals, it seems unlikely that the Congress would choose to terminate all these programs; many are widely regarded as having high priority. But only a limited number of such terminations would be necessary to offset the additional $24.5 billion needed over the next five years to increase production rates for the 12 programs discussed above. More realistically, termination of only one or two programs would allow production rate increases for some of the 12 systems.

In some cases, terminating selected new programs while increasing production rates for others would be consistent with the priorities expressed by key defense groups in the Congress. For example, in their reports accompanying the National Defense Authorization Act for fiscal years 1988/1989, both the Senate and the House Armed Services Committees expressed their sense that budget priorities should be shifted away from strategic forces and toward building conventional forces. Though the options listed here go beyond specific committee recommendations, a combination of selected strategic program terminations with increases in conventional weapons production would be consistent with the committees' expressed priorities.

APPENDIXES

APPENDIX A

DETAILS OF PRODUCTION-RATE INCREASES FOR SELECTED WEAPONS

This appendix presents detailed estimates of the costs and savings from accelerating procurement of selected weapons. The data include annual quantities and costs for the Administration's program and for the accelerated program, near-term additional costs and long-run savings from the latter, and the discounted present value of net savings. The savings are based on regression model results; thus, they represent a conservative estimate of long-term savings in most cases. A brief description of each weapon and its production history is included as well. (All costs and savings are in billions of dollars of constant fiscal year 1988 budget authority.)

AH-64 Apache Helicopter

The Apache helicopter--the Army's primary attack helicopter--is designed primarily to destroy enemy armored vehicles with the Hellfire missile system. Its advanced targeting and pilot night vision systems allow it to operate at night and in all weather conditions. The Army has a requirement for over 1,100 new attack helicopters. Because of funding limitations, however, the Administration intends to terminate the Apache program; the fiscal year 1988 request for 67 aircraft will be the last increment to a total of 593 aircraft. The remaining requirement would not be met until the new Light Helicopter Experimental (LHX)/Scout-Attack (SCAT) weapons system becomes operational in the mid-to-late 1990s.

The accelerated plan would procure 509 additional Apaches (for a total of 1,102) to meet the Army's requirements by the end of the 1992 funded delivery period. This would add $4.5 billion to the cost of the Apache program. The annual production rate would rise to 120 per year in the 1989-1992 period.

Maximum economic production rate = 144
Minimum economic production rate = 72

Fiscal Year	Administration's Plan Quantity	Administration's Plan Cost	Accelerated Plan Quantity	Accelerated Plan Cost	Additional (Cost) or Savings
1988	67	0.7	96	1.0	(0.3)
1989		0.1	120	1.2	(1.0)
1990		a/	120	1.1	(1.0)
1991			120	1.0	(1.0)
1992	—	—	120	1.0	(1.0)
Total 1988 to Completion	67	0.9	576	5.3	(4.5)

a. Less than $50 million.

F-15E Eagle

The F-15D Eagle is currently the Air Force's most capable air superiority fighter. Armed with medium-range, radar-guided Sparrow and short-range, infrared-guided Sidewinder missiles, it can perform its counterair mission at night and in inclement weather. The new "E" model gives the F-15 a capability for deep penetration attacks against surface targets. Changes in the "E" model include the addition of the Low Altitude Navigation and Targeting Infrared for Night (LANTIRN) system, improvements in radars and in electronic warfare, communications, and identification systems, and a second crew position to operate the LANTIRN and other new electronics systems.

The Air Force intends to purchase 342 F-15Es at an average of 38 systems per year. The total cost of the F-15E program is currently estimated at $12.4 billion. The alternative plan would increase the production rate to a maximum of 108 per year, completing the program in 1991 instead of 1996 under the Administration's plan. While this higher acquisition rate would save $0.5 billion in the long run, it would require additional funding of $3.7 billion over the 1988-1992 period.

Maximum economic production rate = 144

Minimum economic production rate = 120

Fiscal Year	Administration's Plan Quantity	Administration's Plan Cost	Accelerated Plan Quantity	Accelerated Plan Cost	Additional (Cost) or Savings
1988	42	1.7	54	2.0	(0.4)
1989	42	1.7	72	2.6	(0.9)
1990	42	1.8	108	3.8	(2.0)
1991	42	1.6	108	3.5	(1.8)
1992	42	1.4	—	—	1.4
1988-1992 Subtotal	210	8.2	342	11.9	(3.7)
1993	42	1.4			1.4
1994	42	1.4			1.4
1995	42	1.2			1.2
1996	6	0.2	—	—	0.2
Total 1988 to Completion	342	12.4	342	11.9	0.5

Net savings discounted at 2 percent = 0.1

F/A-18 Hornet

The F/A-18 is a dual-mission aircraft that replaces the A-7 and F-4 as a light attack aircraft and also as a highly maneuverable and survivable fighter. A new "C" model will be acquired beginning in 1988 with improved electronic countermeasures, avionics, and air-to-air attack capabilities. In 1990, a "D" model featuring all-weather attack capabilities will be introduced to meet Marine Corps requirements.

The Navy intends to acquire 580 additional F/A-18s at a rate, beginning in 1989, of 6 a month through 1995. (The proposed 1988 rate is 7 per month, the same rate the Congress has approved for the last five years.) The accelerated plan would up this rate to a maximum of 132 aircraft per year, thus completing the program three years earlier, as well as reducing its long-term cost by $0.5 billion. This

alternative would, however, require the Congress to provide additional budget authority of $4.5 billion over the period 1988-1992.

Maximum economic production rate = 145
Minimum economic production rate = 84

Fiscal Year	Administration's Plan Quantity	Administration's Plan Cost	Accelerated Plan Quantity	Accelerated Plan Cost	Additional (Cost) or Savings
1988	84	2.6	84	2.6	(0.1)
1989	72	2.3	112	3.2	(1.0)
1990	72	2.0	120	3.0	(1.1)
1991	72	1.7	132	3.0	(1.3)
1992	72	1.8	132	2.9	(1.1)
1988-1992 Subtotal	372	10.3	580	14.7	(4.5)
1993	72	1.9			1.9
1994	72	1.7			1.7
1995	64	1.4	—	—	1.4
Total 1988 to Completion	580	15.3	580	14.7	0.5

Net savings discounted at 2 percent = 0.2

Harpoon Missile

The Harpoon missile is a medium-range (over 50 nautical miles) cruise missile designed to attack ships. It is produced in three versions--air-launched, surface-launched, and a submarine version ejected through a torpedo tube. The Harpoon is used by customers from 19 nations, in addition to the U.S. Navy.

The Navy plans to purchase 886 Harpoon missiles over the 1988-1992 period, an annual average of 177 missiles. Because of the extensive foreign military sales program for Harpoon, capacity exists to produce up to 660 missiles per year and additional Navy purchases could be made at significant savings. The accelerated plan calls for

the acquisition of 1,612 Harpoon missiles over the 1988-1992 period and would require $0.6 billion in additional funding, relative to the Administration's 1988-1992 defense plan.

Maximum economic production rate = 660
Minimum economic production rate = 360

Fiscal Year	Administration's Plan		Accelerated Plan		Additional (Cost) or Savings
	Quantity	Cost	Quantity	Cost	
1988	124	0.2	204	0.2	a/
1989	138	0.1	268	0.3	(0.1)
1990	188	0.2	380	0.3	(0.2)
1991	181	0.2	380	0.3	(0.2)
1992	255	0.2	380	0.3	(0.1)
Total 1988 to Completion	886	0.8	1,612	1.5	(0.6)

a. Less than $50 million in cost.

High-Speed Antiradiation Missile (HARM)

The HARM is an air-to-surface missile designed to home in on and destroy enemy radars. Plans call for the development of a new low-cost seeker version of HARM to be procured competitively. Both the Air Force and the Navy purchase the HARM. Combined procurement plans of the two military departments call for the purchase of 7,098 missiles over the 1988-1990 period at a total cost of $1.7 billion.

The alternative plan would increase the average rate of HARM procurement from 2,366 per year to 3,240 per year over the 1988-1991 period, resulting in total purchases of 12,960 missiles, an 83 percent increase over the Administration's plan for 1988-1992. These additional missiles would add $1.3 billion to the program's cost.

Maximum economic production rate = 6,480 (with two sources)
Minimum economic production rate = 3,240

Fiscal Year	Administration's Plan Quantity	Administration's Plan Cost	Accelerated Plan Quantity	Accelerated Plan Cost	Additional (Cost) or Savings
1988	2,514	0.6	3,240	0.8	(0.2)
1989	2,659	0.6	3,240	0.7	(0.1)
1990	1,925	0.4	3,240	0.7	(0.3)
1991	—	—	3,240	0.7	(0.7)
Total 1988 to Completion	7,098	1.7	12,960	3.0	(1.3)

Imaging Infrared (IIR) Maverick Missile

The IIR Maverick is an air-to-surface, imaging infrared guided missile for use against hard targets such as armored vehicles, fortifications, roads and railroads, and reinforced structures. The IIR version is superior to the earlier TV Maverick because it can be used both day and night. Both the Air Force and the Navy purchase the IIR Maverick. (The Navy's version--AGM-65F--uses a larger warhead and special algorithms for attacking ships.)

The Air Force plans to buy 15,900 Mavericks over the 1988-1992 period for a total cost of $1.7 billion. Procurement will average about 3,200 per year over the 1988-1992 period. This represents a significant stretch-out of production compared with plans submitted with the 1987 budget request.

The alternative acquisition program would restore Maverick production rates to the levels envisioned in last year's program. Procurement for the Air Force would total 5,500 missiles in 1988 and average about 9,000 missiles in 1989 through 1993. This alternative plan would complete the Maverick program four years earlier and would save $0.5 billion. Additional funding required over the 1988-1992 period would total $1.5 billion.

Maximum economic production rate = 10,800
Minimum economic production rate = 6,000

Fiscal Year	Administration's Plan Quantity	Administration's Plan Cost	Accelerated Plan Quantity	Accelerated Plan Cost	Additional (Cost) or Savings
1988	2,100	0.4	5,500	0.6	(0.2)
1989	1,900	0.4	7,000	0.6	(0.3)
1990	2,700	0.3	7,000	0.5	(0.2)
1991	4,400	0.3	9,644	0.7	(0.4)
1992	4,800	0.3	10,800	0.7	(0.4)
1988-1992 Subtotal	15,900	1.7	39,944	3.2	(1.5)
1993	7,000	0.7	10,800	0.7	a/
1994	7,000	0.6			0.6
1995	7,000	0.5			0.5
1996	7,000	0.5			0.5
1997	6,844	0.4			0.4
Total 1988 to Completion	50,744	4.4	50,744	3.9	0.5

Net savings discounted at 2 percent = 0.3

a. Less than $10 million in cost.

SH-60F Carrier Inner Zone Helicopter

The SH-60F helicopter will provide antisubmarine warfare protection in the inner zone of the carrier battle group. Other missions include anti-air warfare, command, communications, logistics, fleet support operations, and surveillance. The SH-60F is derived from the SH-60B helicopter that supports the Light Airborne Multipurpose System (LAMPS) Mark III. The Administration plans to buy 168 SH-60Fs at a rate of 12 to 24 a year, even though the aircraft manufacturer has the capacity to produce 60 a year.

The accelerated program would increase the production rate to a maximum of 40 per year, completing the program six years earlier and

saving $0.2 billion. Additional budget authority necessary to fund the program over 1988-1992 would total $1.0 billion.

Maximum economic production rate = 60 (for B and F models combined)
Minimum economic production rate = 24 (for B and F models combined)

Fiscal Year	Administration's Plan		Accelerated Plan		Additional (Cost) or Savings
	Quantity	Cost	Quantity	Cost	
1988	18	0.3	18	0.3	a/
1989	18	0.4	30	0.5	(0.2)
1990	18	0.3	40	0.6	(0.3)
1991	12	0.2	40	0.5	(0.3)
1992	12	0.2	40	0.4	(0.2)
1988-1992 Subtotal	78	1.4	168	2.3	(1.0)
1993	12	0.2			0.2
1994	12	0.2			0.2
1995	11	0.2			0.2
1996	24	0.3			0.3
1997	24	0.3			0.3
1998	7	0.1	—	—	0.1
Total 1988 to Completion	168	2.6	168	2.3	0.2

Net savings discounted at 2 percent = 0.1

a. Less than $50 million in cost.

Standard Missile 2 (Extended Range)

The Standard Missile is replacing the Tartar and Terrier missiles as the basic surface-to-air weapon aboard Navy ships and has been produced since 1967. The newest Standard (designated Standard Missile 2) comes in two versions: a medium-range version with a range of more than 30 kilometers and an extended-range version, using a booster stage, with a range of over 100 kilometers.

The Navy plans to purchase 1,650 extended-range Standard Missiles over 1988-1992 at a cost of $0.8 billion. The alternative plan would increase the production rate from 325 to a maximum of 480 per year, requiring additional funds of $0.2 billion.

Maximum economic production rate = 480
Minimum economic production rate = 360

Fiscal Year	Administration's Plan		Accelerated Plan		Additional (Cost) or Savings
	Quantity	Cost	Quantity	Cost	
1988	350	0.2	400	0.2	a/
1989	325	0.2	480	0.2	(0.1)
1990	325	0.2	480	0.2	(0.1)
1991	325	0.2	480	0.2	(0.1)
1992	325	0.2	480	0.2	(0.1)
Total 1988 to Completion	1,650	0.8	2,320	1.1	(0.2)

a. Less than $50 million in cost.

Stinger Missile

The Stinger is a shoulder-fired missile that can be used to destroy aircraft flying at low altitude. It is a short-range missile, guided to its target by heat emissions from the aircraft's engine(s), and is used to defend troops, equipment, and installations.

The Army plans to purchase 31,631 Stinger missiles over the 1988-1993 period. The total cost for these missiles is $1.5 billion. The accelerated plan would increase the average annual production rate to 6,326, a 20 percent increase, and would complete the acquisition program for Stinger in 1992.

Maximum economic production rate = 11,520
Minimum economic production rate = 1,800

Fiscal Year	Administration's Plan Quantity	Administration's Plan Cost	Accelerated Plan Quantity	Accelerated Plan Cost	Additional (Cost) or Savings
1988	4,200	0.2	6,000	0.3	(0.1)
1989	5,000	0.2	6,000	0.3	a/
1990	5,000	0.3	6,000	0.3	a/
1991	5,000	0.3	6,800	0.3	(0.1)
1992	6,000	0.3	6,831	0.3	a/
1988-1992 Subtotal	25,200	1.2	31,631	1.5	(0.3)
1993	6,431	0.3	—	—	0.3
Total 1988 to Completion	31,631	1.5	31,631	1.5	b/

Net savings discounted at 2 percent = b/

a. Less than $50 million in cost.
b. Less than $50 million in savings.

UH-60A Black Hawk Helicopter

The Black Hawk is the Army's primary utility helicopter and can be configured to carry troops, cargo, specialized electronic equipment (in its EH-60A version), or medical evacuees. The Army plans to cut the UH-60A's production rate from the recent value of about 96 per year (including derivatives) to 61 in 1988 and 72 in 1989 and 1990. The Black Hawk program would terminate after 1991, when the last 47 aircraft would be ordered. This would leave a gap between utility helicopter requirements and available units.

The alternative plan for Black Hawk procurement would increase the production rate to 120 per year and continue procurement through 1992. This would add 324 aircraft at an additional cost of $1.4 billion through 1992.

Maximum economic production rate = 144
Minimum economic production rate = 96

Fiscal Year	Administration's Plan		Accelerated Plan		Additional (Cost) or Savings
	Quantity	Cost	Quantity	Cost	
1988	61	0.4	96	0.7	(0.2)
1989	72	0.5	120	0.8	(0.3)
1990	72	0.4	120	0.6	(0.2)
1991	47	0.2	120	0.4	(0.2)
1992	—	—	120	0.4	(0.4)
Total 1988 to Completion	252	1.4	576	2.9	(1.4)

M1A1 Abrams Tank

The M1A1 is the main battle tank for the Army. It possesses special armor, compartmentalized fuel and ammunition stowage, and greater speed and mobility for improved survivability. It is capable of operating under all climate and light conditions. The M1A1 mounts a 120 mm cannon (compared with 105 mm for the M1) and possesses improved nuclear, biological, and chemical defense capabilities.

The Army plans to purchase a total of 2,086 M1A1s over the 1988-1992 period, at an average annual rate of 417 units. Additional planned purchases for the Marine Corps will still leave M1 production far below its minimum economic rate of 720 units per year. The alternative plan would increase M1 procurement to an annual rate of 840 units over 1989-1992, resulting in 1,874 additional tanks and adding $4.3 billion to procurement costs.

Maximum economic production rate = 1,080
Minimum economic production rate = 720

Fiscal Year	Administration's Plan Quantity	Administration's Plan Cost	Accelerated Plan Quantity	Accelerated Plan Cost	Additional (Cost) or Savings
1988	600	1.6	600	1.6	(0.1)
1989	534	1.4	840	2.0	(0.5)
1990	304	1.1	840	2.4	(1.2)
1991	331	1.2	840	2.4	(1.2)
1992	317	1.2	840	2.5	(1.3)
Total 1988 to Completion	2,086	6.6	3,960	10.8	(4.3)

Bradley Fighting Vehicle

The Bradley Fighting Vehicle (BFV) is a full-track, lightly armored fighting vehicle. It possesses a two-man turret that mounts a 25 mm automatic stabilized cannon, supported by the TOW antitank missile system and a 7.62 mm machine gun. The mobility of the BFV is comparable to that of the M1 tank.

The Administration plans to purchase 2,549 fighting vehicles, ending in 1991. The annual procurement rate varies from 616 to 691 units. The accelerated plan would increase BFV production to its maximum economic rate of 792 vehicles per year and continue producing the fighting vehicle through 1992. This plan would provide 1,235 more vehicles by 1992 at an added cost of $1.2 billion.

Maximum economic production rate = 792
Minimum economic production rate = 540

Fiscal Year	Administration's Plan		Accelerated Plan		Additional (Cost) or Savings
	Quantity	Cost	Quantity	Cost	
1988	616	0.7	616	0.8	a/
1989	618	0.7	792	0.8	a/
1990	624	0.7	792	0.9	(0.2)
1991	691	0.6	792	0.8	(0.2)
1992	—	—	792	0.8	(0.8)
Total 1988 to Completion	2,549	2.8	3,784	4.1	(1.2)

a. Less than $50 million in cost.

APPENDIX B

SUPPLEMENTARY TABLES

These supplementary tables provide additional detail supporting findings discussed in the main text.

Table B-1 documents the historic decline in aircraft production rates. It shows that the time required to complete production of the first 200 tactical aircraft has been rising from about 20 months to as long as 58 months (in the case of the A-6). Production rates, once as high as 20 units per month (in peacetime), declined to around four to six per month for aircraft programs that began in the 1970s.

Even these rates look favorable when compared with current procurement trends. Several Navy aircraft, including the A-6E/F, C-2A, E-6A, and P-3C, were bought at average rates of less than one per month over the 1983-1987 period (see Table B-2). Overall, weapons procurement for that period shows little improvement over the earlier five-year period from 1976 through 1980.

Recent trends show that stretch-outs are increasing. Table B-3 lists the 20 largest weapons programs in the fiscal year 1988 defense budget request. (Ships are excluded by definition.) For 11 of these 20 programs, procurement quantities were reduced in 1988 below the estimate previously reported in the 1987 budget sub-missions. Only two systems--the AH-64 helicopter and the Tomahawk cruise missile--recorded an increase.

TABLE B-1. AIRCRAFT PRODUCTION RATES

Aircraft	Date First Production Aircraft Delivered (Month/Year)	Time to Produce 200 Aircraft (In months)	Monthly Production Rate (In units)
F-84B	6/47	10	20.0
F-86B	5/48	17	11.8
F-100A	10/53	21	9.5
A-4D	8/55	28	7.1
F-102A	6/55	19	10.5
F-106A	6/58	22	9.1
F-4H	12/60	22	9.1
A-6A	4/62	58	3.5
A-7A	3/66	22	9.1
F-111A	4/67	32	6.2
F-14A	5/72	50	4.0
F-15A	11/74	32	6.3
F-16A	8/78	29	6.9

SOURCE: G.K. Smith and E.T. Friedmann, *An Analysis of Weapon System Acquisition Intervals, Past and Present*, R-2605 (Santa Monica: The RAND Corporation, November 1980), Table D-1, p. 141.

TABLE B-2. COMPARISON OF PROCUREMENT RATES, 1983-1987 VERSUS 1976-1980

System	1983-1987 Average Annual Purchases	Comparable System	1976-1980 Average	Increase (Decrease) in 1983-1987
		Army Systems		
Hellfire	6,131	Dragon a/	23,731	(17,600)
AH-64	117	AH-1T a/	61	56
M1	825	M-60 a/	694	131
Bradley	647	M113	962	(315)
Patriot	485	Hawk	472	13
Stinger a/	3,539	Stinger a/	2,366	1,173
TOW 2 a/	15,482	TOW 1 a/	14,465	1,017
Black Hawk	85	Black Hawk	64	21
		Navy Systems		
Harpoon a/	284	Harpoon a/	234	50
HARM a/	1,460	Shrike	1,092	368
Phoenix	222	Phoenix	212	10
Standard Missile 2	848	Standard Missile 1	449	399
Sparrow a/	2,015	Sparrow a/	1,511	504
Sidewinder a/	2,122	Sidewinder a/	2,270	(148)
Harrier	34	A-7E	23	11
A-6E	8	A-6E	9	(1)
Tomahawk	186	ALCM	91	95
CH-53E	12	CH-53E	9	3
C-2A	8	UC-12B	22	(14)
EA-6B	9	EA-6B	6	3
E-2C	7	E-2C	6	1
E-6A	3	E-3A	4	(1)
F-14A	21	F-14A	38	(17)
F/A-18	84	A-7E	23	61
P-3C	8	P-3C	13	(5)
		Air Force Systems		
AMRAAM a/	180	Sparrow a/	1,511	(1,331)
F-15D	41	F-15A/D	95	(54)
F-16	155	F-16A/B	152	13
GLCM	99	ALCM	91	8
KC-10A	9	KC-10A	3	6
MX	17	Trident I	78	(61)

SOURCE: Congressional Budget Office from Department of Defense data.

a. Joint service procurement.

TABLE B-3. PROCUREMENT CHANGES IN FISCAL YEAR 1988 DoD BUDGET

System	1988 Funding Request (In millions of dollars)	1988 Quantity in 1987 Budget	1988 Quantity in Current Budget	Increase (Decrease)
F-16	2,758	216	180	(36)
F/A-18	2,458	132	84	(48)
Trident II Missile	2,198	66	66	0
F-15E	1,603	48	42	(6)
M1 Tank	1,538	840	600	(240)
MX	1,260	48	21	(27)
Tomahawk	916	410	475	65
Patriot	897	715	715	0
AMRAAM	875	833	630	(203)
F-14D	802	12	12	0
A-6F	782	12	12	0
Bradley Fighting Vehicle	709	870	616	(254)
AH-64	655	0	67	67
C-17	653	2	2	0
AV-8B	640	42	32	(10)
HARM	618	3,240	2,514	(726)
Standard Missile	583	1,250	1,150	(100)
MLRS	507	72,000	72,000	0
Phoenix	418	430	430	0
UH-60	396	85	61	(24)

SOURCE: Congressional Budget Office from Department of Defense, *Procurement Programs (P-1)*, 1987 and 1988.

APPENDIX C

A NOTE ON THE COST ESTIMATES USED IN THIS STUDY

At CBO's request, the services supplied estimates of unit cost at alternative procurement rates. These estimates were made for annual quantities ranging from 50 percent to 150 percent of a basic rate (typically, the proposed fiscal year 1988 procurement rate). These estimates were prepared in many cases with support from the manufacturers of the equipment.

Data for Army and Air Force systems used the procurement unit cost concept in reporting these estimates. Comparisons based on procurement unit cost may overstate rate effects because that concept includes certain costs for support items that are not always keyed to the annual procurement quantity. These support costs can be as much as half of the total funding request, the remainder being the actual cost of the weapon itself--its "flyaway cost."1/ The need for these support items depends on the size of the total program, not on its production rate, and they are sometimes purchased on a separate schedule keyed to activating units. Naturally, when these fixed costs for support are divided by a much smaller quantity, large increases in procurement unit cost can result.

For that reason, it is preferable to use flyaway cost whenever possible in analyzing production rate effects. Total cost estimates must include these support costs, however. For the cost estimates used in this study, support costs were assumed not to change as long as

1. The term "flyaway cost"--originating in aircraft production--is often used generically to refer to any weapons system. DoD Instruction 5000.33, *Uniform Budget/Cost Terms and Definitions*, defines flyaway cost as costs directly related to the creation of a usable end item of hardware, including government-furnished equipment, system/project management, test and evaluation, warranties, and first destination transportation. Only costs paid by procurement appropriations are included. Excluded from flyaway cost, but included in the broader procurement cost definition, are costs for training, peculiar support equipment, data, site activation, industrial facilities, and initial spare and repair parts (if paid for with procurement funds).

the total program quantity remained unchanged.2/ If the total quantity varied from the Administration's plan, support costs were adjusted proportionately.

Year-to-Year Comparisons May Overstate Rate Effects on Cost

Reductions in procurement are sometimes accompanied by very large changes in unit cost.3/ Some examples from DoD's fiscal year 1988 budget request illustrate this effect (see Table C-1). Procurement of the EA-6B aircraft was cut from 12 aircraft in 1987 to 6 in 1988 (a 50 percent decrease), with a 61 percent increase in unit cost. The E-2C aircraft procurement rate was reduced from 10 to 6 a year (a 40 percent decrease), and its unit cost rose 45 percent. In these cases, reductions in quantities purchased appear to be accompanied by more than proportional increases in unit cost.

Such year-to-year changes often tend to exaggerate the actual cost penalty associated with lower rates of procurement, however. In some cases, such as the A-6 aircraft in 1988, the reason for the increase may be a change to a more expensive, improved model. Even without major technical changes, inclusion of support costs in the cost concept, as discussed above, may bias the results upward.

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2. Some support costs, especially those for spare parts, might prove sensitive to the production rate.

3. Unit cost is defined here as the budget cost of the weapons divided by their quantity. It excludes initial spares, but includes long-lead funding in prior years.

TABLE C-1. SELECTED PROGRAM CHANGES IN THE 1988 REQUEST FOR AIRCRAFT PROCUREMENT
(By fiscal year, in millions of dollars of budget authority and percent)

Aircraft	1988 Request		Percent Change from 1987	
	Quantity	Dollars	Quantity	Unit Cost
Increases				
SH-60F Helicopter	18	330	157	-21
A-6E/F Aircraft	12	853	9	110
Decreases				
EA-6B Aircraft	6	357	-50	61
F-14A/D Aircraft	12	829	-20	56
E-2C Aircraft	6	427	-40	45
SH-60B Helicopter	6	144	-65	36
AV-8B Aircraft	32	700	-24	24
UH-60 Helicopter	61	480	-26	21
AH-64 Helicopter	67	746	-34	-5

SOURCE: Compiled by the Congressional Budget Office from data supplied by the Department of Defense.