items (or items representative of production) to demonstrate a system's operational effectiveness and suitability in the field. The latter uses more mature production items to validate achievement of program objectives.[4] FOT&E does not begin until after production has started. Consequently, the IOT&E phase provides a better measure of the overlap between development and production.

The limited availability of IOT&E data, however, places a constraint on the analysis. In theory, the proportion of total IOT&E tests completed after production begins is the preferred measure of the development variable in calculating concurrency. But complete data on the number of IOT&E tests for the programs examined were not available. As an alternative, the indicator used in this analysis is the percentage of all time spent in IOT&E that is to be completed after production is approved. Thus a percentage equaling zero indicates that no IOT&E testing is to take place after production is approved, in which case, by this study's definition, no concurrency is planned. A percentage equal to one hundred indicates that all IOT&E testing is to take place after production is approved, meaning that complete concurrency is planned.

Finally, in measuring concurrency, it is also necessary to identify the point at which production begins. Experts differ on how to define the start of production. Some consider that the allocation of funds for advance procurement of materials or long-lead items constitutes the initial commitment to production. For many programs, however, this advance procurement precedes authorization by DoD management to begin production by a year or more. Moreover, even if the Congress provides funds for advance procurement, there is no guarantee that production will actually begin. In a subsequent budget review, the Congress could conceivably choose not to fund actual production.

The DoD management decision to begin production seems a more appropriate measure of its actual beginning. Every weapons system goes through a series of phases, from initiation of the program through completion of production. Each major phase is preceded by a milestone denoting a decision that must be made by DoD managers. (The

4. Defense Sciences Management College, *Systems Engineering Management Guide* (October 1986), p. 6-5.

accompanying box defines the key phases and the numbered milestones that precède them.) Under present policy, an initial decision to begin production at a low rate can occur at Milestone II, the beginning of the full-scale development phase. Alternatively, Milestone III may be separated into low-rate (IIIa) and full-rate (IIIb) production milestones. Some consider the full-rate decision to be the actual beginning of production since it constitutes a "full" commitment to a program. On the other hand, few programs are canceled once production has initially been approved at a low rate. Thus, since initial production was planned to begin at Milestone IIIa for the systems being analyzed, this study uses Milestone IIIa as its measure of the start of production. (Figure 2 illustrates the relationship between phases and milestones.)

The formula used for measuring concurrency is:

$$C = \frac{t_2 - III_a}{t_2 - t_1} \times 100$$

where

t_1 = beginning of IOT&E,
t_2 = end of IOT&E, and
IIIa = date of production approval (Milestone IIIa).

Figure 2 shows the definition schematically.

Cost Growth. Defining a valid measure of the growth in cost of a weapons system is also problematic. In examining the relationship between concurrency and unit cost growth for a weapons system, it is desirable to restrict cost growth to increases associated with the basic production model and to exclude growth caused by model changes or improvements. Program cost information contained in the quarterly Selected Acquisition Reports (SARs) to the Congress on major weapons systems is satisfactory for this purpose. The SARs contain a baseline cost estimate consistent with initial plans plus current cost estimates for each major weapons system. The differences between the current and baseline cost estimates are categorized according to various sources of cost growth, including changes in the economy and in production quantities. By eliminating cost growth in these two

BOX
INITIAL ACQUISITION MILESTONES AND PHASES

Weapons systems go through a series of phases, from program initiation to completion of production. Each major phase is preceded by a managerial decision called a milestone. This box summarizes the milestones and phases that precede full-rate production.

Milestone 0--Program Initiation/Mission Need Decision

The Defense Resources Board reviews the need for a new major weapons system.

Concept Exploration Phase

Follows Milestone 0. Program office explores alternative approaches to fulfilling mission need. It draws up initial technical specifications and cost and schedule estimates. It also develops test and evaluation plan and identifies critical technical issues.

Milestone I--Concept Demonstration/Validation Decision

Defense Acquisition Board reviews and validates conceptual approach proposed by service to meet requirement. It establishes planning baseline cost, schedule, and performance thresholds to be met at Milestone II. It also reviews and validates test and evaluation and logistics and support plans and acquisition strategy.

Demonstration and Validation Phase

Follows Milestone I. Program office directs preliminary engineering and design work and analyzes cost, performance, and schedule trade-off options. Contractor develops prototypes to demonstrate feasibility of system, subsystems, components, and test and support equipment. Principal areas of risk and alternative solutions are identified. Initial designs are reviewed and development testing conducted.

Milestone II--Full-Scale Development

Defense Acquisition Board reviews results of the Demonstration and Validation Phase and recommends that program go ahead when system feasibility has been demonstrated. As appropriate, low-rate initial production of selected components or end items may be approved to verify production capability and to provide operational test resources. Program cost, schedule, and performance thresholds are updated and serve as development baseline for reports to the Congress. Test and Evaluation Master Plan, acquisition business strategy, and support and logistics plans are reviewed and updated.

Full-Scale Development Phase

Follows Milestone II. System is fully developed, engineered, and fabricated. Test items are built. Development and operational testing are conducted on the system, subsystems, and components. Engineering and design changes occur, and preparations for transition to production are made.

Milestone III--Production Approval

Defense Acquisition Board reviews results of full-scale development phase and recommends approval to enter production phase. (Decision may be delegated to service secretaries if Milestone II baseline thresholds have not been breached.) Milestone may be separated into low-rate (IIIa) and full-rate (IIIb) production milestones. Operational testing must be certified acceptable by the Director, Operational Test and Evaluation, before entering full-rate production.

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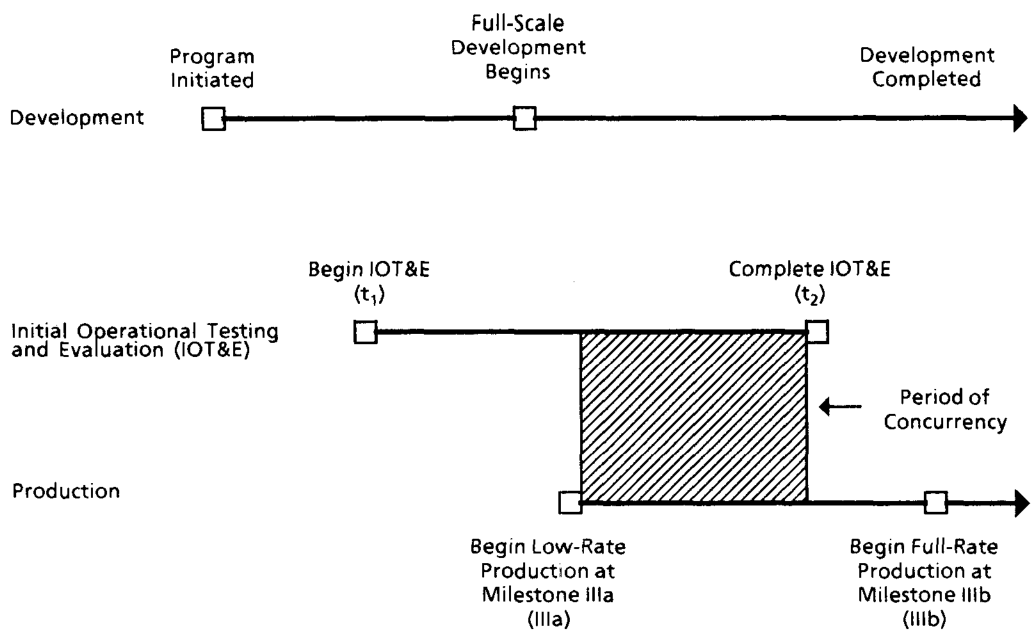
Figure 2.
Operational Schematic of Concurrency



SOURCE: Congressional Budget Office.

major categories from current estimates, it is possible to approximate the level of cost growth above the program baseline associated with only the basic production model.[5]

The formula used for measuring the cost growth variable is:

$$G = \frac{C - Q - E}{B} \times 100$$

5. The resulting indicator is only approximate since it retains all cost growth from engineering changes. Some engineering cost growth may have resulted from changes in the basic production model needed to meet program operational goals; such costs are related to concurrency and should be included in the cost growth measure. Other engineering cost growth, however, may have resulted from engineering improvements authorized subsequent to the beginning of production, and should not be included. The SAR data do not permit a distinction between these two types of engineering cost growth. Both, therefore, are included in measuring the cost growth variable.

where

C = current cost estimate,
Q = cost change due to change in quantity purchased,
E = cost change due to change in economic estimates, and
B = baseline cost estimate.

Schedule Change. The third major variable used in this study concerns program schedule changes related to concurrency. The most important schedule objective for a major weapons system is the time of its initial operational capability (IOC). An IOC is typically defined as the point at which an operating unit is trained and ready to use a new item of equipment that has been deployed. Thus, for example, the IOC for a new aircraft is achieved when a squadron begins operations. Any change in the IOC from its initially planned date is defined in this study as schedule change.[6]

A measure of schedule change should take into account not only change in the time of IOC but also the length of the program. A one-year delay in IOC for a program begun three years earlier is presumably more significant than a similar delay for a program begun ten years before. For purposes of defining schedule change, this study defines planned program length as the period from the beginning of full-scale development to the initially planned IOC. Full-scale development, beginning at Milestone II, is the period during which a prototype of the weapons system is developed. Thus, the period between full-scale development and IOC normally includes the major steps that are used to define concurrency in this study (IOT&E plus the beginning of low-rate production) and seems a reasonable basis for assessing schedule change.

6. For some weapons systems, the definition of an IOC may change during the course of development from its initial criteria established at the program baseline. In such cases, a delay or acceleration may not accurately express the degree of schedule change associated with a program's concurrency, since the definition of the IOC goal has been altered. Program data contained in the SARs and other program budget documentation do not define IOCs in sufficient detail to determine whether the cases selected for this analysis are affected. DoD officials indicate,however, that adjustments in IOC definitions are the exception to the rule. This analysis assumes, therefore, that no significant change in definition of IOC occurred for the subject programs.

The formula for the schedule change variable is:

$$S = \frac{I_a - I_p}{I_p - MII} \times 100$$

where

I_a = actual IOC,
I_p = planned IOC, and
MII = date of full-scale development approval.

Results of the Analysis

The analysis examined 14 major weapons systems that entered full-scale development during the 1970s and were subsequently produced and deployed.[7] The systems selected for analysis included a variety of types from each of the military services. The concurrency, cost, and schedule variables were measured for each system according to the criteria and formulas presented in the preceding section. The data are displayed in Table 1.

Ideally, an analysis of concurrency would include more than 14 programs in order to reveal details such as a preponderance of problems in one type of weapons system. Unfortunately, the historical data needed to assess concurrency for other programs that have reached deployment are either incomplete or do not exist, and an examination of programs currently in development would be premature from the standpoint of assessing the effects of concurrency.

For clarity, the systems in Table 1 are categorized according to three levels of concurrency. High-concurrency programs are defined as having 66 percent or more of the IOT&E program remaining at the time initial production is approved (Group I). Programs with a medium degree of concurrency (Group II) are those for which 33 percent to

7. These systems represent the total number of major weapons programs reviewed by the Defense Systems Acquisition Review Council that have been recently deployed, and for which all the necessary data were available.

TABLE 1. CONCURRENCY, COST GROWTH, AND SCHEDULE CHANGE FOR 14 MAJOR PROGRAMS

	Concurrency (Percentage of IOT&E testing to complete after production) a/	Cost Growth (Current/ baseline unit cost in percent) b/	Schedule Change (Change in IOC as percentage of program length) c/
	Group I (High concurrency)		
Harpoon Missile	100	228	69
Patriot Missile	83	256	24
CH-47 Helicopter	67	141	22
Copperhead Shell	67	527	84
Average	79.3	288.0	49.0
	Group II (Medium concurrency)		
Bradley Fighting Vehicle	55	389	120
I2R Maverick Missile	50	249	100
UH-60 Helicopter	50	232	1
M1 Tank	39	176	6
Phalanx Gun System	33	118	126
Average	45.4	232.8	70.6
	Group III (Low concurrency)		
Hellfire Missile	32	172	47
Stinger Missile	25	300	69
SH-60 LAMPS Helicopter	19	174	0
CH-53 Helicopter	0	133	139
F/A-18 Aircraft	0	185	38
Average	15.2	192.8	58.6

SOURCE: Congressional Budget Office based on Department of Defense program data and budget and schedule information.

NOTE: Concurrency was defined as the percentage of initial operational testing and evaluation (IOT&E) planned for completion after initial production was authorized. Zero concurrency means that all testing was to be completed before production began, while a concurrency value of 100 percent means that all testing was to take place after the beginning of production. The study defined high concurrency as 66 percent or above, medium concurrency as 33 percent to 66 percent and low concurrency as below 33 percent.

a. IOT&E = Initial Operational Testing and Evaluation.

b. Calculated using current dollars.

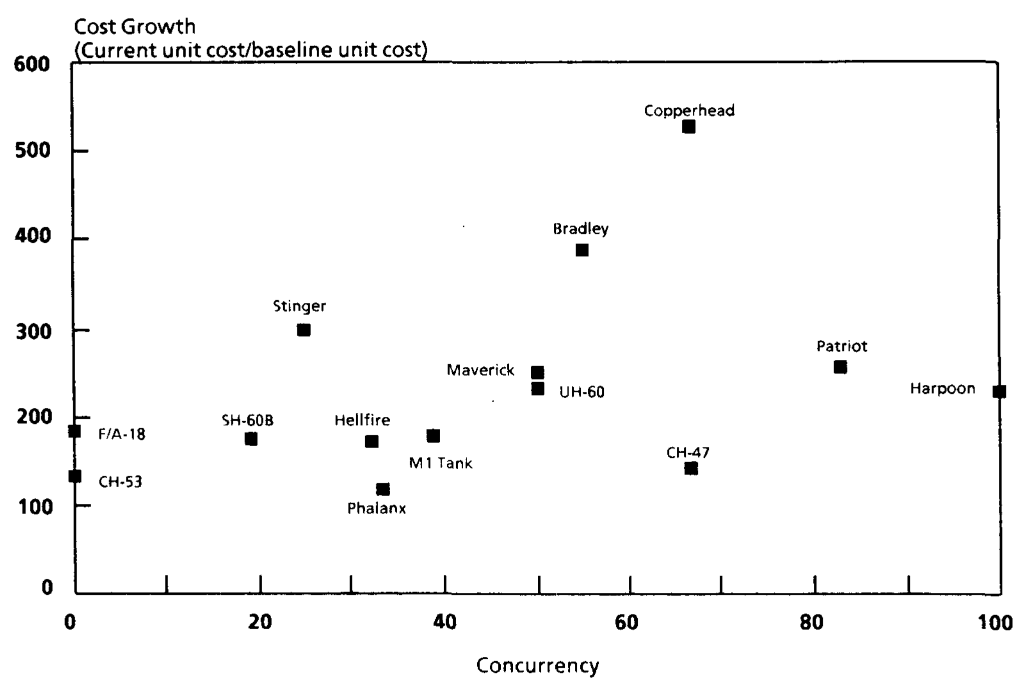
c. IOC = Initial Operational Capability.

66 percent of IOT&E remains. Low-concurrency programs (Group III) have less than 33 percent of IOT&E remaining.

The data show a modest relationship between concurrency and cost growth. For example, the most concurrent group of programs experienced a higher average cost growth (288 percent of the initial baseline estimates) than those in the medium (233 percent) and low (193 percent) concurrency groups.

Figure 3 corroborates this finding, but illustrates that less concurrent programs may also experience relatively high degrees of cost growth. Although several highly concurrent programs (Patriot, Harpoon, Copperhead) experienced a high degree of cost growth (current unit-cost estimates of more than 200 percent of the baseline), so did

Figure 3.
Concurrency and Unit Cost Growth



SOURCE: Congressional Budget Office based on Department of Defense program data and budget and schedule information.

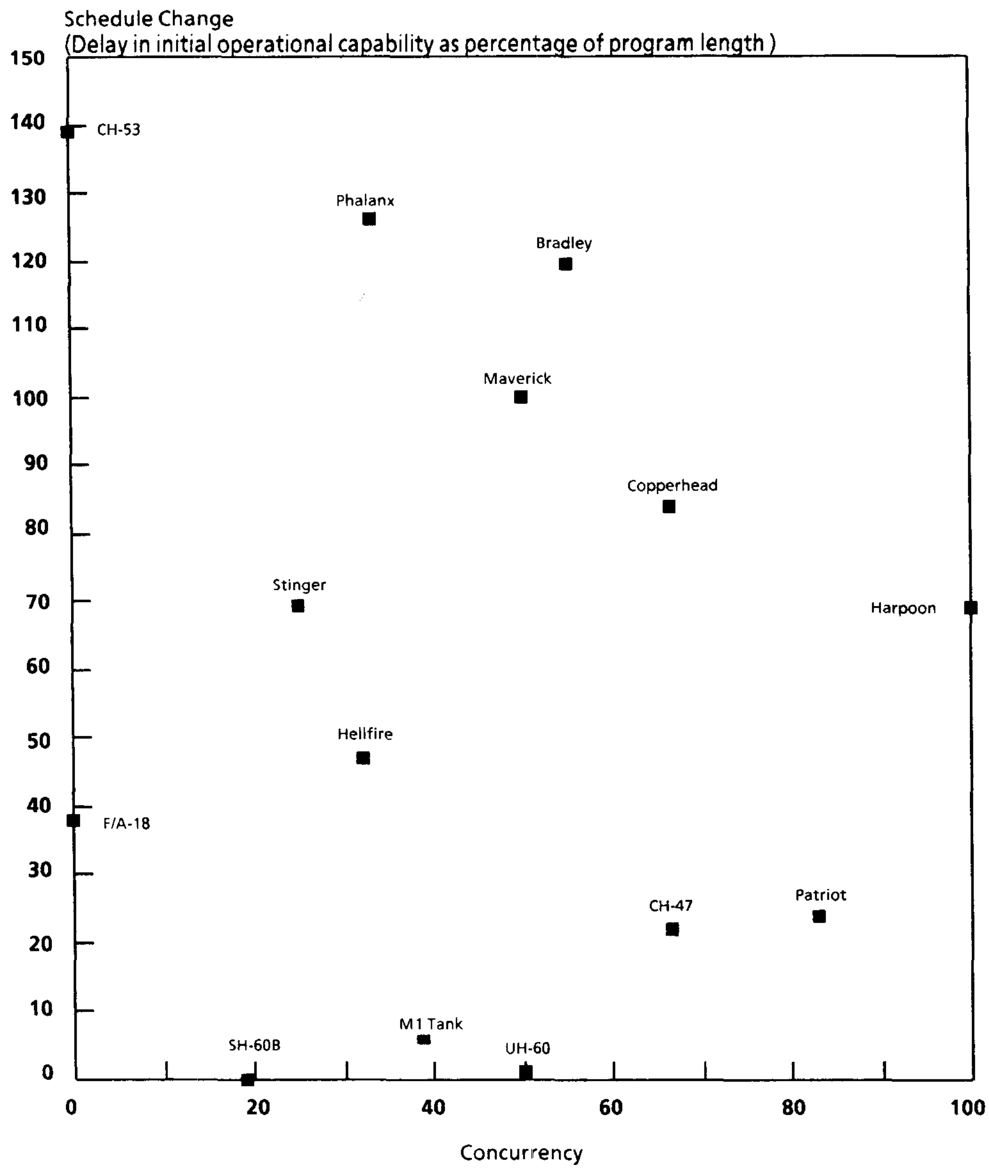
programs in the medium- and low-concurrency groups (Bradley, I2R Maverick, UH-60, Stinger). On the other hand, the CH-47 helicopter, a highly concurrent program, experienced significantly lower cost growth than most programs in less concurrent groups.

The relationship between concurrency and schedule change appears to be weaker than between concurrency and cost growth. The programs in the medium-concurrent Group II, for example, experienced a higher average rate of schedule delay than those in the high-concurrent Group I. For the programs in Group II, the average delay approached 71 percent of the time initially planned between Milestone II and the IOC. The average delay for programs in Group I was less: about 50 percent of the planned period between Milestone II and the IOC. Figure 4 illustrates this point graphically.

Simple regression analyses also corroborate the findings described above. Statistical indicators of correlation and determination demonstrate that concurrency is only modestly related to cost growth for the programs being examined. The correlation coefficient between concurrency and cost growth is only 0.38. This suggests that about 14 percent of the variation in cost growth from average levels is explained by concurrency. The correlation between concurrency and schedule delay is 0.12. This means that almost none of the variance in schedule delay from the average for this set of programs is explained by concurrency.

These findings appear consistent with at least some of the findings of an earlier study by the Defense Science Board (DSB)--an independent, high-level advisory group to the Secretary of Defense. In 1977 the DSB reviewed 62 acquisition programs that occurred between 1940 and 1977. It concluded that no correlation existed between concurrency and the meeting of cost, schedule, and performance goals. Since the DSB study did not present detailed data and definitions, this study has been unable to use the DSB data for comparison. In general, the statistical relationship of concurrency to cost growth and schedule delay for the programs examined is not compelling. Some highly concurrent programs experience major cost growth and schedule delays, however, and this suggests that closer Congressional review of such programs might be desirable.

Figure 4.
Concurrency and Schedule Slippage



SOURCE: Congressional Budget Office based on Department of Defense program data and budget and schedule information.

HISTORY OF CONCURRENCY

The use of concurrency has varied since World War I and has been the subject of continuing debate. During wars or periods of national emergency, the need for weapons has put a premium on the accelerated development and production of weapons. During peacetime, however, the use of concurrency has often been debated. During the past decade, some have argued that the Soviet military threat justifies concurrent scheduling, while others consider the threat to be less immediate and therefore favor a measured acquisition approach. Some believe in holding weapons acquisition costs to a minimum during peacetime, while others are willing to risk higher costs in the pursuit of national security. The following discussion summarizes the historical use of concurrency, and traces the policy debate since the 1960s.

The Use of Concurrency During Wartime and National Emergency

The development and production of weapons have customarily been accelerated in wartime or national emergencies. During World War I, for example, the Navy developed and produced depth charges within four months in order to meet the German submarine threat to allied shipping.[8]

After the delayed entry of the United States into World War II, urgent military requirements led to widespread use of concurrency. Many examples can be cited. A crash program to develop and produce radars, for instance, was undertaken in November 1940. By the end of the war, scientists at the Massachusetts Institute of Technology Radiation Laboratory had designed, developed, and produced 150 different radar systems for use on land, ships, and aircraft.[9] Research on the proximity fuse--a technological advance enabling destruction of enemy aircraft without a direct hit--was initiated in 1942, and the fuse

8. Wayne C. Foote, "History of Concurrency: The Controversy of Military Acquisition Program Schedule Compression" (Thesis, Air Force Institute of Technology, Wright Patterson Air Force Base, Ohio, 1986), p. 31.

9. Bernard Brodie and Fawn Brodie, *From Crossbows to H-Bomb* (Bloomington: Indiana University Press, 1973), p. 209.

entered production in 1943.[10] Numerous aircraft programs were also accelerated; in some cases, such as the P-47, aircraft entered production within a matter of months after beginning development.[11] Perhaps the most famous concurrent program during World War II was the Manhattan Project, in which the design, development, and production of the world's first atomic bomb were telescoped into three years.

Soviet progress in space during the 1950s led to the acceleration of U.S. ballistic missile programs. The Thor intermediate-range missile, for example, entered development in December 1955; it was designed, built, and tested within two years, and was operationally deployed in June 1959. The Atlas and Titan missiles were also accelerated during the 1950s to achieve the earliest possible production and deployment dates.[12]

Weapons programs were accelerated to meet military requirements during the Vietnam War. The history of the Cobra helicopter is a good example. In September 1965, after only six months in development, a prototype of the AH-1 Huey Cobra helicopter was flight tested in order to meet an urgent requirement for a gunship escort for CH-47 helicopter transports. The Army signed an initial production contract six months later, and began deployment of Cobras in the fall of 1967, less than three years after the program had been undertaken.[13]

Programs designed to interdict enemy logistics and support lines in Southeast Asia were also accelerated. Forward Looking Infra-Red (FLIR) detection, Moving Target Indicators (MTI), and night vision devices were concurrently developed and produced for use against the Ho Chi Minh trail. "Smart" bomb programs were accelerated to provide needed military capability against critical military targets.[14]

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10. Ibid., p. 214.

11. Foote, "History of Concurrency," p. 33.

12. Wernher Von Braun and Frederick Ordway, *History of Rocketry and Space Travel* (New York: Thomas Crowell Company, 1966), pp. 133-135.

13. Bernard Nolty, Jacob Neufeld, and George Watson, *An Illustrated Guide to the Air War Over Vietnam* (New York: Arco Publishing Inc., 1981), p. 16.

14. Raphael Littauer and Norman Uphoff, eds., *The Air War in Indochina* (Boston: Beacon Press, 1972), p. 152.

Concurrency During Peacetime--Debating the Policy

Until recent years, weapons were generally developed and produced sequentially during peacetime. This was particularly true following World War I during a time of demobilization, limited defense budgets, and broad political support for disarmament and international cooperation. No military requirement existed during the postwar period that justified accelerating the weapons acquisition process.

During the interwar period, weapons were typically built as prototypes and subjected to extensive testing. The T-4, the only tank to enter serial production before 1935, was developed, tested, and produced sequentially.[15] Indeed, even when production of a weapon was started during the interwar era, relatively small quantities were manufactured. Aircraft such as the Curtiss Goshawk, the Helldiver, and the B-17 were produced in limited quantities.[16]

Following World War II, weapons acquisition generally returned to a sequential approach with a few exceptions such as the B-47 aircraft and the missile programs of the 1950s. In some cases, weapons such as the Terrier, Sparrow, and Nike missiles were kept in development in order to incorporate the latest technological advances before initiating production. Other programs were kept in development in order to avoid the post-production problems being experienced by concurrent programs such as the B-47. Indeed, the Air Force adopted a policy during the mid-1950s that restricted production for 18 to 24 months until testing was completed.[17]

The introduction of Total Package Procurement (TPP) by Secretary of Defense Robert McNamara in the early 1960s represented a major shift in weapons acquisition policy and practice. Previously, the Department of Defense had issued separate contracts for research and development and production. Under TPP, the DoD awarded a single fixed-price contract for the entire program. This provided contractors

15. Peter Chamberlain and Chris Ellis, *British and American Tanks of World War II* (New York: Arco Publishing Company, 1969), p. 105; and Arthur Alexander, *Armor Development in the Soviet Union and the United States* (Santa Monica: The RAND Corporation, 1976), p. 79.

16. Enza Angelucci, ed., *Rand McNally Encyclopedia of Military Aircraft 1914-1980* (New York: Rand McNally and Company, 1980), pp. 153-155 and 288.

17. Foote, "History of Concurrency," pp. 41-42.

with an incentive to accelerate a program and to minimize development costs. In effect, TPP encouraged the use of concurrency.

Experience with programs such as the C-5 cargo aircraft demonstrated the risk of TPP, even for programs with only moderate technological difficulty. The C-5 entered production in 1968, after an abbreviated development phase had been compressed to meet an IOC that had been advanced from 1972 to 1969.[18] In July 1969, six months after the Air Force agreed to purchase a second lot of C-5 aircraft, the wings developed cracks. An expensive wing modification program was required.[19]

Other concurrent programs also experienced significant difficulties during the 1960s. The B-70 bomber and the Skybolt missile were canceled because of excessive costs. The MBT-70 tank, the Cheyenne helicopter, and the Condor missile were unable to meet cost, schedule, and performance objectives. The MBT-70 was replaced by a less ambitious program, the XM-803, which in turn, was terminated in 1972. The Cheyenne helicopter was canceled in favor of the AH-64 Apache helicopter program.

Early in 1969, Deputy Secretary of Defense David Packard reviewed the acquisition practices of the previous decade and concluded that "program after program was in trouble from a common fault--production had been started before engineering development was finished."[20] Packard favored the development and testing of prototypes before beginning production--a "fly before buy" approach to weapons acquisition. In 1970, the Fitzhugh Blue Ribbon Defense Panel supported Packard by recommending that the DoD adopt "a general rule against concurrent development and production efforts, with the production decision deferred until successful demonstration of developmental prototypes."[21]

18. Berkeley Rice, *The C-5A Scandal* (Boston: Houghton Mifflin Company, 1971), p. 41.

19. Ibid., p. 150.

20. Foote, "History of Concurrency," pp. 53-54.

21. Blue Ribbon Defense Panel, *Report to the President and the Secretary of Defense on the Department of Defense* (July 1970), p. 8.

The DoD began to implement the "fly before buy" approach during the early 1970s. Deputy Secretary Packard established a formal management process under the Defense Systems Acquisition Review Council (DSARC) to review weapons acquisition and ensure that a weapon did not proceed from one acquisition phase to the next without successfully completing the previous phase. Under the DSARC system, a decision to begin production could not occur until the full-scale engineering phase had been completed.[22]

As a result of Packard's new approach, acquisition became more sequential during the 1970s. Flyoffs between prototypes of weapons or their components preceded production decisions for major weapons such as the A-X attack aircraft, the Lightweight Fighter, the F-15, and the AWACS aircraft. Test program results for major weapons in development during the late 1970s indicate that performance parameters were more thoroughly tested before beginning production than they had been previously.[23]

As the pendulum swung toward more sequential acquisition, however, the policy process generated another reversal. In 1977, the Defense Science Board (DSB), an independent, high-level advisory group to the Secretary of Defense, observed that the acquisition process was taking too much time and ought to be shortened. The DSB reviewed 62 acquisition programs between 1940 and 1977 and determined that no correlation existed between the use of concurrency and the ability of a program to meet cost, schedule, and performance goals. Consequently, the DSB recommended that DoD encourage the use of concurrency.

The recent difficulties with two highly concurrent programs, the B-1B bomber and the DIVAD gun, have again generated concern over the use of concurrency. In 1985 the President's Commission on Defense Management, under Chairman David Packard, reviewed the acquisition process and recommended a return to more sequential acquisition practices. For example, the Commission concluded that the most reliable approach to procuring high-technology weapons systems

22. Although the acquisition milestone system established by Packard has been modified many times, it continues to function. See Box, p. 11.

23. Edmund Dews and others, *Acquisition Policy Effectiveness: Department of Defense Experience in the 1970's* (Santa Monica: The RAND Corporation, 1979), p. 21.

was through developing and testing competitive prototypes before awarding a production contract. The Commission further recommended that prototype competitions be applied to all major weapons and critical subsystems.[24] It also recommended early operational testing in order to ensure that the design was satisfactory before beginning production.[25]

CURRENT LEGISLATION AND REGULATIONS

The outcome of these ebbs and flows of policy, together with the ambivalent evidence concerning concurrency, is a set of laws and regulations that do not prohibit concurrency, and in some cases encourage it. (Appendix A discusses the laws and regulations in more detail.) Indeed, DoD's basic acquisition regulations favor concurrency by emphasizing the need to reduce the time required to acquire weapons. One regulation explicitly states that the services can reduce weapons development or "lead" time through concurrency (DoD Directive 5000.1). In addition, a recent change in DoD Regulation 5000.2 permits authorization to begin production earlier in the acquisition process than ever before--at the start of full-scale development.

On the other hand, the Congress has enacted legislation that constrains concurrency. The 1987 Defense Authorization Act, for example, states that "a major defense acquisition program may not proceed beyond low-rate initial production until IOT&E of the program is completed." That same law requires that testing of a weapon's ability to survive enemy attack must be satisfactorily completed before the program may begin full-rate production.

Other legislation and policies seem intended to discourage concurrency. The 1987 Defense Authorization Act requires that, absent a Congressional waiver, the DoD must develop and test competitive prototypes of a major weapon before awarding a production contract. Competitive prototyping, which is also encouraged by several DoD

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24. President's Blue Ribbon Commission on Defense Management, *A Quest for Excellence: Final Report to the President* (June 1986), p.56.

25. Ibid., p. 50.

instructions, is likely to lead to sequential rather than concurrent programs because time must be allowed to complete a competition between two or more contractors before production begins.

CHAPTER III

SHOULD THE CONGRESS TAKE ACTION?

Given the ambivalent evidence on the effects of concurrency, the Congress may wish to take no further action regarding concurrent programs as a group. Limits have already been set, both in law and in DoD regulations, to the use of concurrency. The policy pendulum in DoD may be swinging back toward less concurrency if the recent Packard Commission report is an indicator, and the risk factors in specific programs for which concurrency is proposed could be evaluated against the benefits of accelerating those programs.

Since some members of the Congress have expressed concern about concurrency-related problems in specific programs, including the B-1B bomber and the DIVAD gun, this chapter discusses several possible actions, noting the pros and cons of each.

GETTING INFORMATION ON CONCURRENT PROGRAMS

The documents routinely sent to the Congress do not identify programs that DoD regards as concurrent. Nor is there a definition of how DoD measures concurrency or what criteria it uses to identify a highly concurrent program. The data to make such judgments are available, however, and the Congress may wish to ask that a measure of concurrency accompany the Selected Acquisition Report (SAR) for each program. A letter accompanying the first such SAR could define DoD's measure and indicate its criterion for classifying a program as highly concurrent or less so.

Such a measure would not only inform the Congress as to which programs are concurrent; it might also focus DoD management attention on such programs. In general, DoD managers are in the best position to judge whether the benefits that can come from concurrency are worth its risks. Having such a measure in the SARs would also allow the Congress to note when concurrency is being planned or when programs are becoming more concurrent. A sharp rise in a program's concurrency above the level initially planned might suggest a need to review that program with added care.

A preliminary examination of current and recent programs suggests that the list of concurrent programs would include a substantial number of major programs (see Table 2).

TABLE 2. PLANNED CONCURRENCY LEVELS OF SELECTED MAJOR WEAPONS PROGRAMS

High-Concurrency Programs	
Army Helicopter Improvement Program	F-15 Aircraft
Harpoon Missile	Patriot Missile
NAVSTAR Satellite	B-1B Aircraft
C-17 Aircraft	AMRAAM Missile
MK-50 Torpedo	CH-47 Helicopter
T-45 Aircraft	Copperhead Artillery Shell
	V-22 Aircraft
Medium-Concurrency Programs	
Phalanx Gun System	UH-60 Helicopter
ASW SOW (Nuclear) Missile	I2R Maverick Missile
Bradley Fighting Vehicle	SRAM II Missile
	M1 Tank
Low-Concurrency Programs	
AV-8B Aircraft	Stinger Missile
F/A-18 Aircraft	ISA-AMPE Communications System
HARM Missile	F-16 Aircraft
CH-53 Helicopter	ASW SOW (Conventional) Missile
SH-60 Helicopter (LAMPS III)	Airborne Self-Protection Jammer System
Hellfire Missile	

SOURCE: Congressional Budget Office, based on Department of Defense program data.

NOTE: For a definition of concurrency, see Chapter II.

A measure of concurrency should at most add modestly to the workload of DoD managers. If it were analogous to the measure proposed in Chapter II of this study, it would require only a few computations for each program.

NONCONCURRENT BENCHMARKS

For programs that reflect substantial concurrency, the Congress might ask the Department to propose an alternative plan that would reduce or eliminate concurrency. This would provide a benchmark for judging concurrency's effectiveness. If the nonconcurrent benchmark, updated for experience acquired as the weapon was developed and produced, showed lower costs and the same or lower time to completion, then concurrency would clearly have failed. If the opposite proved true, then concurrency would be seen to have met its key objectives. As noted earlier, without such a benchmark it is very difficult to determine whether concurrency succeeds, and at what cost.

There is precedent for requiring such a benchmark estimate. When the Congress approved DoD proposals to expand multiyear contracting, it required the Department to estimate the costs of the program in the absence of a multiyear contract. (Multiyear contracting allows DoD to commit itself to buying a weapon for more than one year and to pay contractors to buy key components in economic quantities and stockpile them for later use.) These dual cost estimates have enabled analysts to estimate the effects of multiyear contracting.[1]

Making benchmark estimates could add substantially to DoD's workload. To be useful, such estimates would require careful judgments by DoD and its contractors concerning schedules and costs. This takes time and is not routinely done at present. If it requires such estimates, the Congress may wish to restrict them to selected programs.

1. Congressional Budget Office, Staff Working Paper, "Alternative Strategies for Increasing Multiyear Procurement" (July 1986).

ENSURING ADEQUATE OPERATIONAL TESTING

Adequate operational testing is important for all weapons programs, whether or not they feature concurrency. The Congress emphasized this point in 1983 when it established the office of the Director of Operational Testing and Evaluation as an independent adviser to the Secretary of Defense and as a rapporteur to the Congress on issues regarding operational testing.

But operational testing is particularly important for concurrent programs. By definition, these programs will be producing weapons at a time when operational testing is not yet complete. Testing problems must be identified quickly in order to minimize the number of weapons that will have to be refitted with modifications. Also, delays in operational testing can disrupt a concurrent program--which by definition operates under a compressed time schedule--more than a nonconcurrent program.

For these reasons, the Congress may wish to ensure adequate operational testing by examining the testing plans for major programs that feature substantial concurrency. That could be accomplished by reviewing the testing plan during hearings or, for weapons of particular concern, by asking for staff reports on the plan.

Several guidelines would be needed to assess the adequacy of a testing plan. The plan should:

- o Establish clearly the objectives that must be met by a weapon for its operational testing to be judged successful. A recent GAO study found that, out of 63 reports concerning testing issued in the period from 1970 to 1986, test objectives and the criteria and plans for the tests were incomplete in 25 cases.[2] It is important that test personnel be involved in setting objectives since they must judge the tests' adequacy.

2. General Accounting Office, "Operational Test and Evaluation Can Contribute More to Decisionmaking" (December 1986), p. 14.