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BY THE U.S. GENERAL ACCOUNTING OFFICE

Report To The Subcommittee On International Trade, Finance, And Security Economics Of The Joint Economic Committee

Assessing Production Capabilities And Constraints In the Defense Industrial Base

The prospect of defense spending totaling some \$1.9 trillion over the next five years has greatly increased concern about the ability of the defense industrial base (DIB) to meet defense requirements. The DIB must not only meet peacetime requirements, but also be prepared for "surge" conditions (rapid expansion of capacity) and the more rigorous production requirements of wartime mobilization. The Subcommittee on International Trade, Finance, and Security Economics of the Joint Economic Committee of the Congress asked GAO to explore problems encountered by the DIB in meeting those requirements. To do so, GAO examined data from DOD and weapon system contractors on six weapon systems.

For the study, GAO developed an approach for screening the many components and materials of a given weapon system so as to focus rapidly on specific items likely to cause production problems. This effort provided information often unavailable in the past, particularly on production problems at the subcontractor level. The study documented problems of foreign dependence, shortage of production machinery and test equipment, and a large number of processes proprietary to the contractors, among others. In addition, GAO found that DOD did not always take the necessary steps to resolve serious production problems that were well known.



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C o n t e n t s

		<u>Page</u>
DIGEST		i
CHAPTER		
1	CONCERN ABOUT THE DEFENSE INDUSTRIAL BASE	1
	Production constraints	2
	A shift in the U.S. war-fighting scenario	3
	Increased defense spending	3
	Objectives, scope, and methodology	4
2	METHODS OF ASSESSING THE DEFENSE INDUSTRIAL BASE	9
	Current methods	9
	Agency comments and GAO response	11
	Assessment method developed by GAO	11
	Vertical analysis	11
	Horizontal analysis	16
	Future-production analysis	18
	Applying GAO's method to cases	18
3	FINDINGS FROM SIX CASE STUDIES	21
	Critical items	21
	Phoenix missile	21
	The other weapon systems	23
	Production constraints	27
	Shortage of production machinery	27
	Shortage of testing equipment	28
	Shortage of raw materials and components	29
	Shortage of skilled labor	31
	Reliance on foreign contractors	32
	Extensive "queue time"	33
	Proprietary processes	34
	Agency comments and GAO response	34
	Future production	34
	Phoenix missile	35
	TOW2 missile	35
	M1 tank	35
	Harpoon missile	36
	F100 engine	36
	Global positioning system	36
	Summary	37

		<u>Page</u>
CHAPTER		
4	RECENT INITIATIVES, CONCLUDING OBSERVATIONS, AND MATTERS FOR CONSIDERATION	38
	Recent initiatives	38
	Task force to improve industrial responsiveness	38
	Blueprint for Tomorrow	41
	Integrated industrial data management system	41
	Army system for automation of preparedness planning	42
	Concluding observations	42
	Selecting critical items	42
	Obtaining better data	42
	Establishing baseline data	43
	Improving accuracy and verification	43
	Focusing on cooperative efforts	44
	DOD's response to problems	44
	Agency comments and GAO response	45
	Minimizing cost of industrial preparedness information	46
	Matters for consideration	46
	Agency comments and GAO response	47
APPENDIX		
I	Glossary	49
II	Bibliography	51
III	Congressional request letter	57
IV	Improving the ability of the DIB to meet defense needs: possible approaches	59
V	Groups and individuals interviewed by GAO	74
VI	Development of GAO's method	77
VII	Contractors and subcontractors visited	88
VIII	Sample GAO data collection instrument	89
IX	Information systems	97
X	General information about GAO's case- study weapon systems	100
XI	Agency comments	109

		<u>Page</u>
FIGURE		
1	Quarterly indicators of the condition of the U.S. economy (1981-83)	5
2	Vertical analysis of weapon system procurement	12
3	Application of vertical analysis to Phoenix missile system	13
4	Sample matrix of competing demands	17
5	General approach for assessing DIB capability	78

TABLE		
1	Total requested DOD budget authority 1985-89	4
2	Second-tier critical-item candidates for the Phoenix missile	22
3	Third-tier critical-item candidates for the Phoenix missile servomechanism	23
4	Second-tier critical-item candidates for the TOW2 missile	24
5	Second-tier critical-item candidates for the M1 tank	25
6	Second-tier critical-item candidates for the Harpoon missile	26
7	Production constraints at tiers 1, 2, and 3 for five weapon systems	27
8	Imported materials for five U.S. weapon systems	32
9	Industrial preparedness program funding for fiscal years 1984-88	38
10	Example of competing demands: Pratt & Whitney production of F100 aircraft engine, 1984-88	84
11	Selected growth information on cost and quantity of five weapon systems	101

TABLE

12	TOW missile production estimates	103
13	M1 production levels and estimates	105

ABBREVIATIONS

BEA	Bureau of Economic Analysis
BLS	Bureau of Labor Statistics
CBO	Congressional Budget Office
CMSEP	Contractor Management System Evaluation Program
DEIMS	Defense Economic Impact Modeling System
DIB	Defense Industrial Base
DLSC	Defense Logistics Service Center
DOD	Department of Defense
DSARC	Defense Systems Acquisition Review Council
EMD	F100 Engine Model Derivative
EPR	Economic production rate
FMS	Foreign Military Sales
FYDP	Five-Year Defense Program
GAO	General Accounting Office
GDLS	General Dynamics Land Systems
GIDEP	Government Information Data Exchange Program
GNP	Gross national product
GPS	Global Positioning System
IIDMS	Integrated industrial data-management system
IMIP	Industrial Modernization Incentives Program
JAMAC	Joint Aeronautical Material Activity
MANTECH	Manufacturing Technology Program
MDAC	McDonnell Douglas Astronautics Company
MYP	Multiyear procurement
N	Nonproprietary
NAVSHIPSO	Navy Shipbuilding Support Office
P	Proprietary
PBA	Production-base analysis
PPBS	Planning, Programming, and Budgeting System
PPI	Producer Price Index
SARS	Selected Acquisition Reports
TECHMOD	Technology Modernization Program
TSARCOM	Troop Support and Aviation Readiness Command

GENERAL ACCOUNTING OFFICE
REPORT TO THE SUBCOMMITTEE
ON INTERNATIONAL TRADE,
FINANCE, AND SECURITY
ECONOMICS OF THE
JOINT ECONOMIC COMMITTEE

ASSESSING PRODUCTION CAPABILITIES
AND CONSTRAINTS IN THE DEFENSE
INDUSTRIAL BASE

D I G E S T

The defense industrial base (DIB) consists of the private firms and government facilities that produce weapon systems and other items for the U.S. Department of Defense (DOD). Concern about the ability of the industrial base to meet defense requirements is not new but has been exacerbated by the prospects of defense-spending increases totaling some \$1.9 trillion over the next 5 years and possible perturbations caused by an improving economy. Adding to the concern is the transition from short-duration scenarios of war to those in which probable conflicts are of indefinite duration, anywhere in the world (pp. 1-4).

The Subcommittee on International Trade, Finance, and Security Economics of the Joint Economic Committee asked the General Accounting Office (GAO) to examine data on production delays, inferior quality, and cost increases and, if necessary, develop an evaluation methodology for understanding the origin and incidence of such problems (p. 4).

CURRENT METHODS OF
ASSESSING THE DIB

The Subcommittee asked GAO for information to help it understand various problems the defense industrial base is said to be having in meeting national needs. In terms of preparedness planning, the DIB must meet peacetime "business as usual" requirements of national defense production but must also be responsive to what planners call "surge" conditions--rapid peacetime expansion of the DIB--and the more rigorous production requirements of war-time mobilization.

Against the backdrop of those requirements, the last 5 years have seen increasing reports of production and quality-control problems in the DIB, along with questions of how capably that base can meet U.S. defense needs, especially those of surge and mobilization (p. 6).

Assessing a system with so many parts--the DIB comprises some 25,000 to 30,000 prime contractors and some 50,000 subcontractors--would be difficult in any case. But it is made more so by such peculiarities as mixed ownership (private and federal) of facilities and equipment and the fact that some items (e.g., warheads) are government furnished. Constant internal flux increases the confusion; firms enter and leave the DIB continually and move freely up and down between the prime-contractor and subcontractor "tiers" (p. 1).

Current methods of assessing the DIB use either aggregated data for industrial sectors or system-specific data collected on DD form 1519 ("Industrial Preparedness Program Production Planning Schedule"). The form attempts to identify components and materials likely to be associated with delays, inferior quality, or cost increases. However, it has become clear that the DD 1519 apparatus is inadequate. In studying procurement for the TOW2 missile, for example, GAO found that the Army had no DD 1519 information on four major warhead items (pp. 9-10).

From evidence of this kind, GAO concludes that current methods used by the Department of Defense do not produce the consistent, complete, and accurate data needed by industrial preparedness planners and weapon-system program managers. Gaining knowledge about the DIB requires an alternative methodology (p. 11).

THE GAO METHOD

The methodology GAO developed reflects the form of the system it is intended to probe--namely, a system of supply arranged in cascading levels of procurement through primary and subsidiary contractors, with each level subject to production constraints affecting critical items. At the same time, competition for existing resources tends to create tensions in each tier and within individual contractors' plants. Thus, GAO's method of assessment applies a vertical analysis that identifies and follows critical items for an individual weapon system down through the tiers of suppliers, evaluating possible production constraints at each level; a horizontal analysis that evaluates the competition for production resources within each firm; and a future-production analysis that compares the results of these evaluations to estimates of DOD out-year

requirements. GAO believes that this combination of analyses provides a more comprehensive view of the state and capabilities of the DIB than has been available thus far (pp. 11-18).

GAO defines critical items as those with long or growing intervals between procurement and delivery, high or increasing unit costs, few suppliers, foreign sources, or a history of production problems. To identify critical items, GAO traced subsystems, components, and raw materials of each of six weapon systems vertically from the prime contractor through lower tiers of subcontractors. The analysis continued until all critical items were uncovered, or until further downward analysis seemed unwarranted. Throughout this process, critical items were evaluated against the potential for constraining production of the weapon system. If no potential constraint was encountered, there was no immediate reason for concern (pp. 11-16).

Among the production constraints identified in the literature and in recent experiences were shortages of production machinery, raw materials, testing equipment, and skilled labor; extensive "queue time" (the interval between ordering and first production); reliance on foreign sources; and reliance on a large number of processes proprietary to the contractors (p. 2).

Through horizontal analysis, GAO looked at other products from the same contractor that could pull production resources away from the critical items identified earlier. The production of similar materials by the same contractor is not a problem in itself. But such spreading of production resources is part of an equilibrium that can be disturbed by sudden increases in defense demand or when a reviving economy creates greater commercial demand and competes with defense for limited resources (pp. 16-17).

Future-production analysis permits assessment of the DIB's likely ability to produce weapons in the future. This is done by comparing results of vertical and horizontal analyses against DOD's estimates of requirements for the next 5 years. Information on past, present, and foreseen production problems is combined with projections of future demand to forecast a given contractor's ability to meet DOD's needs during peacetime and during a surge in production or mobilization for

war. If a broad sample of items is studied, the analysis yields aggregate data and a more comprehensive view of the DIB than is presently available (p. 18).

APPLICATION OF THE METHOD

GAO applied its assessment method to that portion of the DIB involved in the production of six different weapon systems, listed below with their prime contractors:

- the AIM54 Phoenix missile, operational with the Navy since 1974 as the primary fleet-defense, long-range armament for the F14 Tomcat (Hughes Aircraft Company) (pp. 21-23 and 100-02);
- the M1 Abrams tank, the Army's main battle tank for the 1980's and 1990's and its most expensive weapon system acquisition (General Dynamics Land Systems) (pp. 24 and 103-05);
- the TOW2 missile, the tube-launched, optically tracked, and wire-guided missile that is the Army's heavy assault weapon against armor and fortifications (Hughes Aircraft Company) pp. 24-25 and 102-03);
- the Harpoon missile, the Navy's main antiship missile through the 1990's (McDonnell Douglas) (pp. 25-26 and 105-06);
- the F100 turbofan engine, used by the Air Force in the F15 Eagle and F16 Falcon fighters (Pratt & Whitney Aircraft Group of United Technologies Corporation) (pp. 26 and 106-07); and
- the Global Positioning System, an Air Force, satellite-based system designed to provide accurate and continuous positioning information worldwide, in any weather and despite countermeasures, as well as information on nuclear detonations (Rockwell International) (pp. 107-08).

GAO'S PRINCIPAL FINDINGS

The GAO method provided information often unavailable before this study. These findings underscore the inadequacy of the current DOD industrial preparedness information systems. The GAO method also illuminated examples of incidents in which the Department of Defense was aware of serious problems in the DIB but did less than it could have to resolve them. GAO analyses showed that

● Shortages of production machinery have curtailed production on four of the six case-study weapon systems, although they caused no late deliveries; however, increased demand would have resulted in significant time delays. (Seven subcontractors told GAO this would be a major constraint, if demand increased.) In the TOW2 case study, to meet surge production levels would require two Japanese-built machines costing a total of \$1 million, each with 22-month production lead times (pp. 27-28).

● Shortages of testing equipment were surprisingly widespread. Many of the contractors visited by GAO were running their testing equipment 24 hours a day to support one or two production shifts (pp. 28-29).

● Shortages of components and raw materials have constrained production, especially on the M1 tank, where final assembly requires "slaving," an expensive practice in which new tanks are built around components borrowed from finished tanks to avoid a total halt of production (pp. 29-31).

● Shortages of skilled labor did not appear to be a major problem, especially for subcontractors in areas of relatively high unemployment. There was, however, a problem of aging personnel. Most skilled machinists, for example, are 50 or more years old, so that training time will ultimately become a problem in providing younger replacements. This would apply especially in a stronger economy, where increased commercial production draws from the same skilled labor pool (p. 31).

● Reliance on foreign sources is potentially a serious production constraint in the DIB, with many components using materials of which 50 percent or more of the national requirement must be imported. While stockpiling somewhat eased the raw-material problem, there was also large dependency upon components built abroad. For example, one TOW2 subcontractor depended wholly on foreign sources for its quartz optics, some M1 tank circuit boards were assembled in Mexico, some tank hybrid circuits came from Taiwan, and Harpoon's radar seeker used German and British parts. In particular, foreign dependency for semiconductor and microelectronic parts was high, but no one knows how high (pp. 32-33).

● Extensive queue time appeared not to be a significant constraint at the time of the GAO review

but was used at some contractor plants as a way of smoothing peaks and valleys in demand (pp. 33-34).

- The widespread use of proprietary processes to produce defense components had the effect of limiting the number of manufacturers available to produce a given item and drove up component costs. Of 39 contractors visited by GAO, 25 used processes they owned (p. 34).

Combining the information from vertical and horizontal analyses with projected defense requirements, GAO assessed the overall ability of the DIB to produce the six case-study weapon systems. In general, prime contractors experienced relatively few production constraints, but "sub-tier" contractors faced many. For example, for the Phoenix missile, GAO analysis revealed 12 production constraints, 2 at the prime contractor level, 8 at the second tier, and 2 at the third tier. Most of the current and potential production constraints were found at a level below that of prime contractor (p. 15).

Most contractors interviewed believed that competing demands were not much of a problem but that lack of orders was, a predictable response in an economy just turning toward recovery after a slump. When the economy was more robust, however, competing resource demands caused problems in the DIB so that recovery can be expected to produce constraints in the future.

GAO believes that the portion of the DIB involved in producing the six case-study weapon systems will be able to maintain present production levels but, noting that increased demand could induce problems, suggests a close watch on some programs. Specifically:

- Phoenix, after early design and testing problems, has increasing orders; this increase may cause competition between Phoenix and other Hughes-built missiles. A projected doubling of production over the next 5 years will require subcontractor support that some vendors do not now think they will be able to meet. GAO advises monitoring this situation closely (p. 35).
- TOW2 should be able to meet projected demand, although subcontractors that build components for Hellfire missiles and commercial

semiconductor markets could begin to feel the constraint of competing demands (p. 35).

- M1 tank production now meets current defense requirements; these levels can be maintained. There is, however, concern about the M1's foreign-source dependence, the continued practice of parts' slaving, and the possibility that competing demands in a recovering economy could siphon away skilled labor and material. GAO recommends a close watch on this system (pp. 35-36).
- Harpoon is maintaining present demand, and GAO sees no problem if demand does not increase. The situation might be affected, however, by competing foreign sales of the missile (p. 36).
- F100 engine production is meeting present requirements, but the ability of the DIB to produce it in increased numbers is unpredictable now, with a second prime contractor (General Electric) scheduled to begin production (p. 36).
- The Global Positioning System could not be evaluated, because of a lack of production data at the time of this study (pp. 36-37).

RECENT DOD INITIATIVES

Concerned about the DIB's ability to meet national defense needs, DOD is paying greater attention to industrial preparedness planning. The Army, Air Force, and Navy have increased their funding for it and plan further increases. Other initiatives include DOD's Task Force to Improve Industrial Responsiveness, the Integrated Industrial Data Management System, Blueprint for Tomorrow (a mutual effort of the Air Force and industry representatives) and the Army System for Automation of Preparedness Planning (pp. 38-42).

Progress has been slow, however, and some important areas merit additional attention. GAO does not believe that the current DOD initiatives adequately address the problems of identifying or removing constraints in the DIB. For example, better methods of data collection and analysis of subcontractors' abilities are required. DOD needs a method for screening the very large number of weapon system components and materials so as to focus rapidly on the specific items likely to cause production problems (pp. 42-46).

MATTERS FOR CONSIDERATION

GAO's review has identified several important matters that should be considered by defense industrial preparedness planners. They include

- the extent to which information and production problems occur at the subcontractor level, below that of prime contractor (p. 46);
- the actions that can be taken to improve the armed services' understanding of and response to problems in the defense industrial base (p. 46);
- the extent to which the services can improve their monitoring and verification of contractor data (p. 46);
- the feasibility and cost of implementing an assessment method, such as the one presented in this report, consistently across all of the armed services to insure continuous, accurate, and generalizable information on the state of the defense industrial base (p. 46); and
- the desirability of further expanding cooperative, tri-service efforts, such as naming a central unit in the Department of Defense for collecting, computerizing, and analyzing DIB data or a DOD-wide composite production-base analysis, such as that recommended by the Task Force to Improve Industrial Responsiveness (pp. 46-47).

AGENCY COMMENTS AND GAO RESPONSE

The Department of Defense provided comments on a draft of this report. DOD, while noting that GAO recognized initiatives it has already taken to address DIB problems, believes that certain recently revised DOD regulations express the spirit and intent of this report. Where problems have persisted, DOD believes they tend to be those of resource commitment and allocation rather than management approach (p. 47).

Using DOD comments, GAO updated its presentation on recent DOD initiatives from GAO's draft report. While commending these initiatives as a start on such issues as cooperative efforts among the services, GAO is concerned over the extent of their implementation. To make systematic improvements to the defense production system, DOD must give

greater attention to certain measures. These include consistent application of criteria to identify critical items, improved verification and accuracy checks, increased collection of data from subcontractors, and use of horizontal analyses that consider production demands from all the services. GAO believes, for example, that horizontal analyses would be enhanced by implementing a recommendation of the Task Force to Improve Industrial Responsiveness that DOD develop a composite, production-base analysis. Such a composite analysis could identify industrial-base shortfalls and help determine priorities for allocating resources. DOD does not, however, plan to carry out this recommendation (p. 40).

Bearing in mind resource constraints, GAO describes ways to efficiently implement its data collection and analysis method. While recognizing that not all production constraints can be remedied, GAO believes that DOD can improve its methods for identifying and analyzing problems by using procedures such as those demonstrated by GAO. With sounder information, DOD should be in a better position to assign priorities to problems and decide which to address first.





UNITED STATES GENERAL ACCOUNTING OFFICE

WASHINGTON, D. C. 20548

PROGRAM EVALUATION
AND
METHODOLOGY DIVISION

B-217381

The Honorable William Proxmire
Vice Chairman, Subcommittee on
International Trade, Finance,
and Security Economics
Joint Economic Committee
Congress of the United States

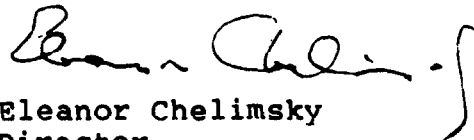
Dear Mr. Chairman:

This report was prepared by the General Accounting Office in response to your request that GAO examine data on production delays, inferior quality, and cost increases in the defense industrial base and, if necessary, develop an evaluation methodology for understanding the origin and incidence of such problems. As agreed in discussions with your staff, we restricted our evaluation to six weapon system case studies.

We received comments from the Department of Defense and incorporated them in the report where appropriate.

Due to the proprietary nature of the data provided by some of the contractors, a separate restricted document was published. In the report forwarded to you under this cover letter, all proprietary information has been removed.

Sincerely,


Eleanor Chelimsky
Director

CHAPTER 1

CONCERN ABOUT THE DEFENSE INDUSTRIAL BASE

Traditionally, the United States has relied heavily on the private sector to produce weapon systems. The term "defense industrial base"¹ generally refers to the business firms and government facilities that produce the weapons and allied services purchased by the U.S. Department of Defense. The firms that make up the DIB include large corporations and small family-owned companies. Some manufacture both defense and nondefense products. Activities of the firms range from assembling major weapon systems (such as tanks and missiles) to supplying small parts (such as washers, screws, and clamps) to machining already manufactured parts.

In this arrangement, companies that supply the armed services directly are called "prime contractors." They are at the top, or first, tier of the many-layered DIB. Below them, other firms--called "subcontractors," "subtier contractors," or "second-tier contractors"--supply components and materials to the prime contractors. A third tier is made up of companies that supply items directly to the second tier. Currently, 25,000 to 30,000 prime contractors supply DOD with weapon systems and most of the systems' major components. As many as 50,000 firms in the lower tiers provide other components and materials in support of the DIB.

The DIB is complex and often changing. Many contractors own their plants and equipment. The government owns some production facilities, however, and supplies equipment for them, while contractors operate them. Government-owned facilities tend to involve specialized products or processes, such as the manufacturing of munitions and missiles for which there are no commercial applications. DIB contractors usually supply defense items as only part of their product lines. The amounts and proportions of resources they devote to defense change frequently. Firms continually leave and enter the DIB. Further, only in relation to a particular weapon system is a company identified as a first-tier contractor or a contractor at a lower tier. A firm that supplies one weapon directly to DOD as a prime contractor may also be supplying other items to another firm as a subcontractor.

During the last 5 years, concern has increased about the DIB's ability to meet national defense requirements. Problems have been reported in productive capacity, including specific instances of shortages in materials and components. There has been a major shift in the U.S. war-fighting scenario. The administration has proposed substantial increases in defense spending, while the general economy has improved. Given these

¹This and other terms used in this report are defined and expanded upon in the glossary (appendix I).

conditions, questions have been raised about how well the DIB can produce the weapon systems already on order and those being planned.

PRODUCTION CONSTRAINTS

The literature cites direct and indirect constraints on the DIB's productive capacity. Reviewing this literature, we identified a number that seem to be of greatest concern. They include the following:

- shortages of capital equipment necessary to produce defense items, as evidenced by instances of antiquated and nonproductive machinery (Hintz, Sullivan, and Van Parys, 1978; U.S. Congress, 1980a);²
- difficulties in obtaining necessary items from subcontractors, resulting at least in part from a shortage of smaller, lower-tier suppliers (Gansler, 1981; U.S. Congress, 1980);
- reliance on foreign producers for components and almost total dependence on imports of raw materials, such as cobalt, chromium, columbium, manganese, mica, titanium, and others necessary to support a modern DIB. The sources of some of these are in politically unstable regions (Office of Secretary of Defense, 1981; U.S. Congress, 1980);
- inordinately long time between placement of purchase orders for defense items and their production and delivery, partly because civilian goods sometimes take precedence for production resources over defense items (U.S. Congress, 1980; Office of Secretary of Defense, 1981);
- shortages of skilled labor for producing defense materials, given an aging labor force and few employees being trained to replace retiring skilled laborers (Gansler, 1981; Hintz, Sullivan, and Van Parys, 1978); and
- many defense contractors' proprietary processes, which limit DOD's ability to address production problems by qualifying additional suppliers.

The major studies on this topic were based on data from the 1970's, although some were published in the 1980's. A decade ago, the economy was quite different from what it is today, and the structure of the DIB, DOD's demand for defense materials, and conditions in the civilian marketplace have changed. Thus, earlier discussions of production constraints can address only that

²Abbreviated bibliographic citations are expanded in appendix II.

time period and do not necessarily show that the constraints still hold.

A SHIFT IN THE U.S. WAR-FIGHTING SCENARIO

Another reason for increased interest in the DIB is the change in the U.S. war-fighting scenario. Prior to 1976, DOD based its plans and programs on the concept of a potentially long conflict. The services stocked enough items to support combat consumption from the day on which military operations might commence until the rate of production could equal combat consumption. Under this concept, industrial preparedness planning was extremely important, as the services and contractors were expected to be responsive to potentially major increases in requirements, while continuing to meet current production requirements.

In July 1976, this concept was superseded by an emphasis on a short-warning, short-war scenario. Improving the responsiveness of the industrial base was no longer called for, since conflict would be ended before the effects of industrial mobilization could be realized. Industrial preparedness planning deteriorated to differing degrees among the services. Unlike the Navy and the Air Force, however, the Army retained much of its industrial planning capabilities. It did so probably because of its need to manage items that have large, increased demands in time of war. Ammunition planning is a good example of this.

In 1981, DOD modified the war-fighting scenario again, to emphasize preparation for conflict of indefinite duration anywhere on the globe. This made the DIB's ability to respond to long-term needs again significant. DOD's policy statement of March 6, 1982, on industrial preparedness described past DIB problems and stressed the importance of meeting "surge" or mobilization crises while supplying products efficiently during peacetime. As a result, industrial preparedness planning has taken on a new importance.

INCREASED DEFENSE SPENDING

Since 1980, the administration's budgets have called for substantial increases in defense expenditures. The defense budget authority for fiscal year 1983 was \$239 billion, up 12 percent from the \$213.8 billion requested for the preceding fiscal year. The budget approved for fiscal year 1984 authorized \$258 billion in defense expenditures, an 8 percent increase over 1983. In table 1, on the following page, we show that budget projections through 1989 indicate a 5-year total of about \$1.9 trillion.

In view of the large increase proposed in defense spending and the possibility of a general economy that continues to improve, there is some doubt that the DIB can produce what the national defense requires without bottlenecks and pressure on

Table 1

Total Requested DOD Budget Authority 1985-89

	<u>Fiscal year</u>					<u>Total</u>
	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	
Current dollars requested ^a	305.0	349.6	379.2	411.5	446.1	1,891.4
Constant (1985) dollars requested ^a	305.0	333.0	344.7	357.9	371.1	1,715.3
Percentage change	13.0	9.2	3.5	3.8	3.9	

SOURCE: U.S. Secretary of Defense, Annual Report to the Congress, Fiscal Year 1985. Washington, D.C.: January 30, 1984.

^aDollars in billions.

prices. As the economy improves, civilian competition for productive resources increases. Any given firm may be producing both military items and commercial goods simultaneously. Three important indications that the U.S. economy has become more robust in the last few years appear in figure 1. The unemployment rate dropped from 10.6 to 8.47 percent between the fourth quarters of 1982 and 1983. In the same period, the capacity utilization rate for all manufacturing grew from 69 to 78.9 percent. Also, the gross national product, which had been headed generally downward in 1982, rose sharply from \$1,480 billion (in 1972 constant dollars) to \$1,572 billion.

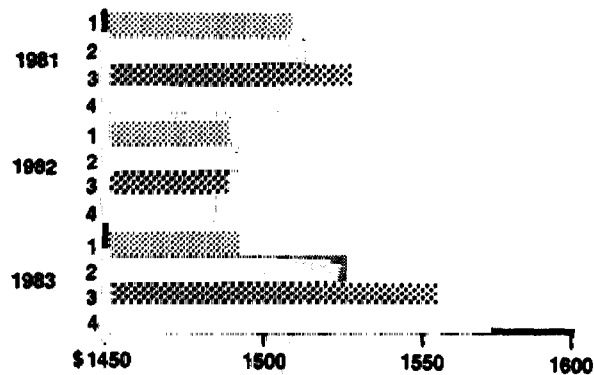
OBJECTIVES, SCOPE, AND
METHODOLOGY

The Subcommittee on International Trade, Finance, and Security Economics of the Joint Economic Committee asked us to explore the reasons for DIB production delays, problems of quality, and cost or price increases, and to develop a methodology, if necessary, for examining DIB issues. (Appendix III contains the congressional request letter.)

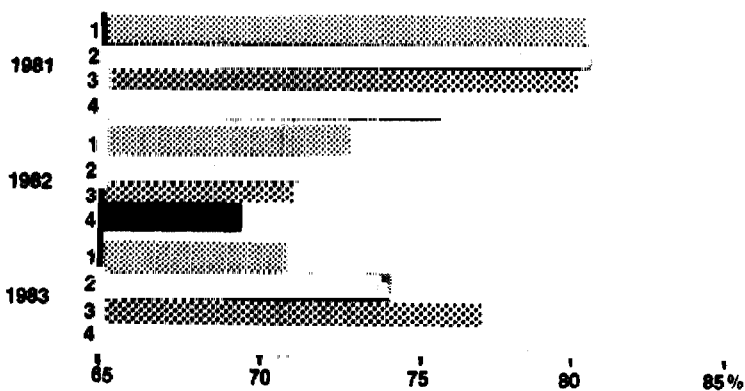
Many studies suggested that major constraints exist in the lower contracting tiers of the DIB structure; however, there was insufficient information available on the DIB substructure to allow a comprehensive or detailed assessment of the ability of the DIB to meet production requirements. Therefore, our objectives included finding and applying an improved method for assessing DIB capability and clarifying subtier problems. We did develop such a method and applied it to six case studies.

Figure 1
Quarterly indicators of the Condition
of the U.S. Economy (1981-83)

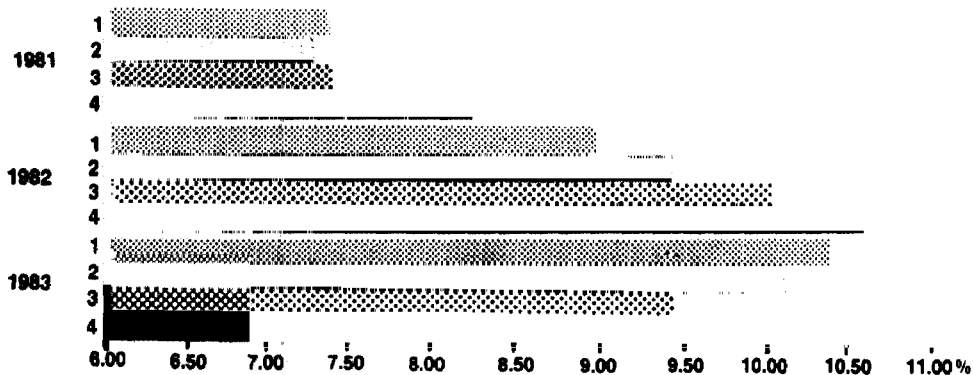
Calendar year **Gross national product (billions in 1972 constant dollars)**



Manufacturing capacity utilization rate



Civilian unemployment rate



Source: Data Resources, Inc.

DOD's industrial preparedness planning includes a full range of possibilities for peacetime, surge, and mobilization. Peacetime DIB production tries to meet planned requirements as currently specified and as if there were to be no major unexpected interruptions. Surge production occurs when there is a rapid expansion of the industrial base within the limits of a peacetime environment, without the declaration of a national emergency. Mobilization production implies a war situation, requiring a higher level of industrial support for the armed forces.

Therefore, we looked at DOD's current data and systems for analyzing these aspects of industrial preparedness planning. Given that few data were available on the lower tiers, we spent most of our effort examining subcontractors.

It was necessary to analyze peacetime conditions before attempting to deal with surge and mobilization issues. Developing a data base for peacetime production, with its current constraints, makes it possible to identify what the constraints during surge and mobilization might be, given current laws and regulations, and where expansion would be needed.

To analyze future production needs, we began with Army, Navy, and Air Force peacetime needs. We did not examine the productivity or efficiency of defense contractors, nor did we focus on or analyze DOD's approaches or those of defense contractors to improving productivity or output. For completeness, however, we briefly describe several such approaches in appendix IV.

Since the congressional request asked for a way to study problems for which data were not available, we decided on a project design that would allow us to determine what kind of method was needed, develop such a method, and examine its feasibility and usefulness. First we made an extensive literature search and reviewed the primary sources of data used to support industrial preparedness planning. We supplemented what we found with information gathered in interviews with DOD officials, personnel in the services, and outside experts (appendix V lists them).

This first step confirmed our expectation that we needed a new method to assess the capabilities of the DIB in a way that would account for the lower tiers, where many production problems appeared to be located. After considering several ways to examine the DIB capabilities, we settled on a method that had three elements: a vertical analysis involving careful examination of the DIB's lower tiers, as well as horizontal and future-production analyses. We incorporated these elements in our design, whose development we discuss in detail in chapter 2 and appendix VI.

In weapon systems, production problems can be traced to individual components or materials, called critical items. A method to assess DIB capabilities must identify critical items that currently cause or could cause production problems; it also should determine, as well as possible, production constraints that cause

the problems. There is now no sure way to identify critical items or establish the cause of a production problem. Moreover, development of a perfectly accurate method is not possible. We could only strive to develop methods that were better than the current ones.

To examine the feasibility and usefulness of our evaluative method, we applied it to six high-priority weapon systems in production, looking at two cases from each of the three services. Central to this work was collecting information from prime contractors and subcontractors. To do this, we visited 5 prime contractors (2 of our case study weapon systems were produced by Hughes in Air Force plant no. 44) and 34 subcontractors (listed in appendix VII), utilizing a questionnaire (appendix VIII) and conducting semistructured interviews on strengths and weaknesses in production capability. From our six case studies, we drew conclusions about our evaluation method as a workable and useful means for assessing the DIB. The review was performed in accordance with generally accepted government auditing standards.

We have organized this report as follows:

<u>Chapter 1</u>	<u>Chapter 2</u>	<u>Chapter 3</u>	<u>Chapter 4</u>
DIB production constraints	Current methods of assessing the DIB	Critical items	Recent developments
Change in the war-fighting scenario	Developing a new method	Production constraints	Matters for consideration
Increased defense spending	The case study approach	Future capability	
	The selection of weapon systems for study		

In chapter 2, we briefly describe current methods for assessing the DIB and the need for a better way of gathering information about it. We also introduce our method. In chapter 3, we present illustrative results from applying the method, and in chapter 4, summarize DOD's efforts to improve industrial preparedness, present our observations about the feasibility and usefulness of our evaluative method, and state some matters for further consideration.

A draft of this report was provided to the Department of Defense and each service for review and comment. Comments were received on December 7, 1984. GAO considered the comments and, where appropriate, made changes; specific comments are reflected in this report. The Department generally concurs with the overall

report. DOD officials stated that the findings of the report are consistent with the many other investigations and special studies that have taken place within the past three years.

CHAPTER 2

METHODS OF ASSESSING

THE DEFENSE INDUSTRIAL BASE

CURRENT METHODS

Current methods of assessing the ability of the defense industrial base to produce what the services need for defense are based on aggregate (macroeconomic) data or system-specific data collected by the Department of Defense on its "Industrial Preparedness Program Production Planning Schedule" (DD Form 1519). Generally, the data aggregated have been produced from models or studies of industrial sectors. For example, the Defense Economic Impact Modeling System (DEIMS) is a multisector, input-output econometric model for predicting which industrial sectors are likely to receive more defense funds and the effect of their expenditure. DEIMS reports on the economy as a whole, not on specific weapon systems.

Studies of particular industrial sectors (manufacturers of fasteners, forgings, etc.) or particular types of skilled labor (e.g., machinists) try to estimate trends in the use of plant capacity or labor shortages and to determine what kind of federal action could prevent problems. These and other information systems and methods we reviewed are described in greater detail in appendix IX.

Such methods provide data useful for identifying and tracking general trends, but industrial preparedness planners and program managers need data specific to individual weapon systems. DOD's major tool for obtaining this type of data, Form 1519, asks defense contractors and subcontractors for information about their ability to supply certain items and production data on those items. Contractors are not directly reimbursed for completing the form, which is voluntary. We found extensive criticism of the form's utility. For example, a recent report stated that

"Our analysis indicates that the current IPP program does not provide the information necessary to assess the capability of the lower tiers of the industrial base to meet crisis demand requirements." (Baumbusch, 1978)

Also typical is the more recent comment that

"The current industrial preparedness planning tool used by the Department of Defense (DD Form 1519) lacks realism in establishing the potential of the defense industrial base to expand production of major weapon systems and end items and is an ineffective planning tool" (U.S. Congress, 1980a)

The Air Force discontinued use of the form in 1979, but has been considering its reimplementa-tion; the Army and the Navy continue to use it. Only a few contractors complete it. For example, just 17 of the hundreds of Harpoon missile contractors submitted it, and only 18 submitted it for the TOW2 missile. (For a complete description of the six weapon systems chosen for our case studies, see appendix X.) Moreover, the further down the tiers of procurement a subcontractor is, the less likely that DOD will have requested the information the form is intended to provide.

For example, no DD 1519 was completed for the most expensive component of the Navy's Harpoon missile (representing almost of the missile's cost) nor for four important items for the warhead of the Army's TOW2 missile (liner, bushing, cone, and body). To point out this lack is not to criticize the subcontractors, but simply to indicate that important data can be missing.

Finally, in attempting to track down DD 1519's for the Harpoon missile, we were told by Navy officials that the Navy's major user of DD 1519 data is the Harpoon project office in the Pentagon. Officials in that office, however, had no copies of the form on file, nor were they able to refer us to the office that did.

We did not analyze the accuracy of the data collected with the form; but did identify extensive criticism of such data. Some service personnel called the data satisfactory (e.g., officials at the Army Armament Command believe strongly that data on ammunition production are sufficiently accurate); but elsewhere we found near unanimity among contractors, weapon system program managers, and authors of previous studies that the data were incomplete and unreliable.

The armed services-production planning officer for a company providing equipment for the M1 tank, for example, wrote on the DD 1519 the company submitted that the data he supplied did not meet requirements for a valid schedule. This was because, he said, he could not provide necessary added information concerning foreign sources, engineering studies, and the availability of industrial plant equipment. He noted that the company would not provide better data without compensation and that he was supplying the data, despite their insufficiency and invalidity, because the Army Tank and Automotive Command insisted on signed DD 1519's.

Reporting recently on the accuracy of the service data, we concluded that accurate information on production capacity was not available for the industrial sectors that include small, specialized aerospace subcontractors and little was known about their ability to absorb an increase in defense spending (U.S. GAO, May 1981). Production projections generally were not based on adequate analysis, we further reported, concluding that industry planning data were insufficient and unreliable.

AGENCY COMMENTS AND GAO RESPONSE

The problem with using the DD form 1519 as the singular method for industrial preparedness planning, DOD comments, has not been so much with the form, but with the availability of resources to fully exercise the system as it was designed. (See appendix XI for full DOD comments.) For example, because of higher priority requirements, the Air Force discontinued its DD 1519 type of planning in 1978. DOD states, however, that new and revised DOD policies now provide for the use of other methods of planning and data collection, such as sector analysis, data item description, mobilization/surge planning, and surge contracting. These are in addition to the DD 1519. DOD believes the program now benefits from a combination of plant- and item-specific planning activity and aggregated data by industrial sector. Planning information can now be contracted for as a line item in a production contract. According to DOD, the application of this method is highly desirable for industrial preparedness planning on the most critical items. For other items, depending on type or availability of resources, DOD thinks the voluntary DD 1519 approach may be sufficient or desirable.

We believe, however, that despite the new policy and increased emphasis on industrial planning within DOD, problems still exist in the basic structure of the system that relies on DD form 1519 data. We detail these problems further in the following chapters.

ASSESSMENT METHOD DEVELOPED BY GAO

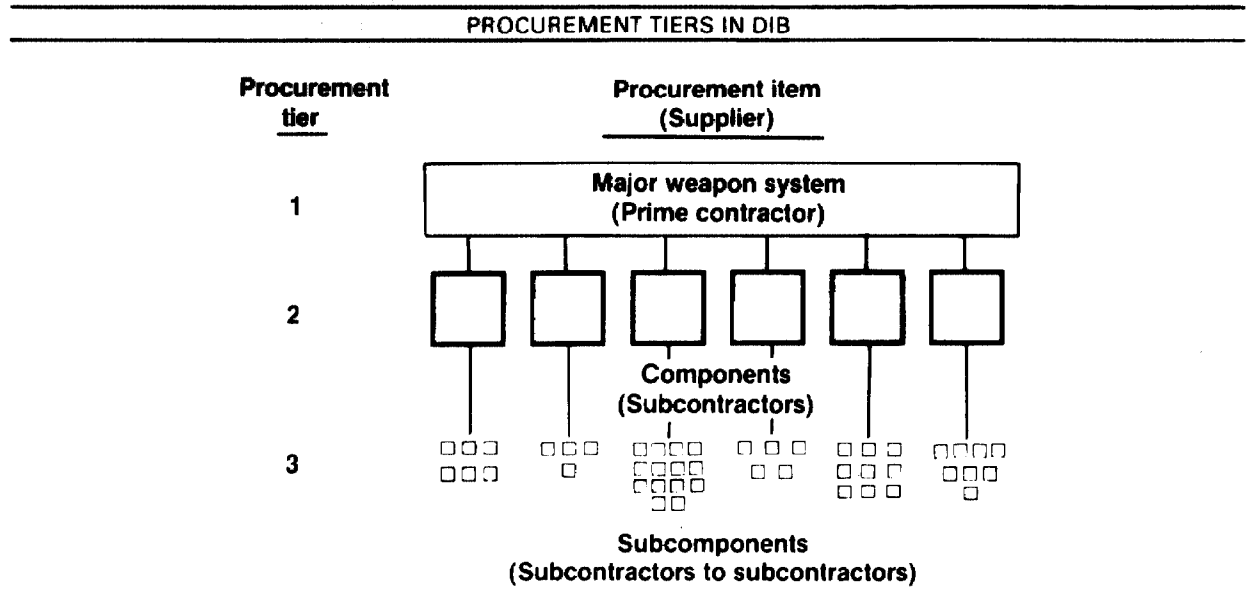
The lack of accurate information on specific weapon systems and contractors confirmed the need for an adequate method for assessing the DIB's capabilities. The method GAO developed for this report contains three key elements, described in this section: a vertical analysis, a horizontal analysis, and a future-production analysis. In the final section of this chapter, we explain our application of this method to our six case studies.

Vertical analysis

Applied to a weapon system or component, vertical analysis identifies critical items in its production, the contractors that produce them, and any production constraints. GAO defines critical items as components or materials likely to be associated with delays, inferior quality, or cost increases in the production of a weapon system. On the following two pages, steps of the vertical analysis are diagrammed in figure 2, while figure 3 shows their application by GAO to a specific missile system. The steps and their application are discussed below:

Step 1. Collect background information about the production of the weapon system from appropriate officials in DOD and the U.S. Department of Commerce (the latter for certain industrial data relevant to this study) through semistructured interviews.

Figure 2
Vertical Analysis of Weapon System Procurement



VERTICAL ANALYSIS PROCESS

At each *procurement tier*, the following process is followed for each *procurement item* (weapon system or component/subcomponent/material):

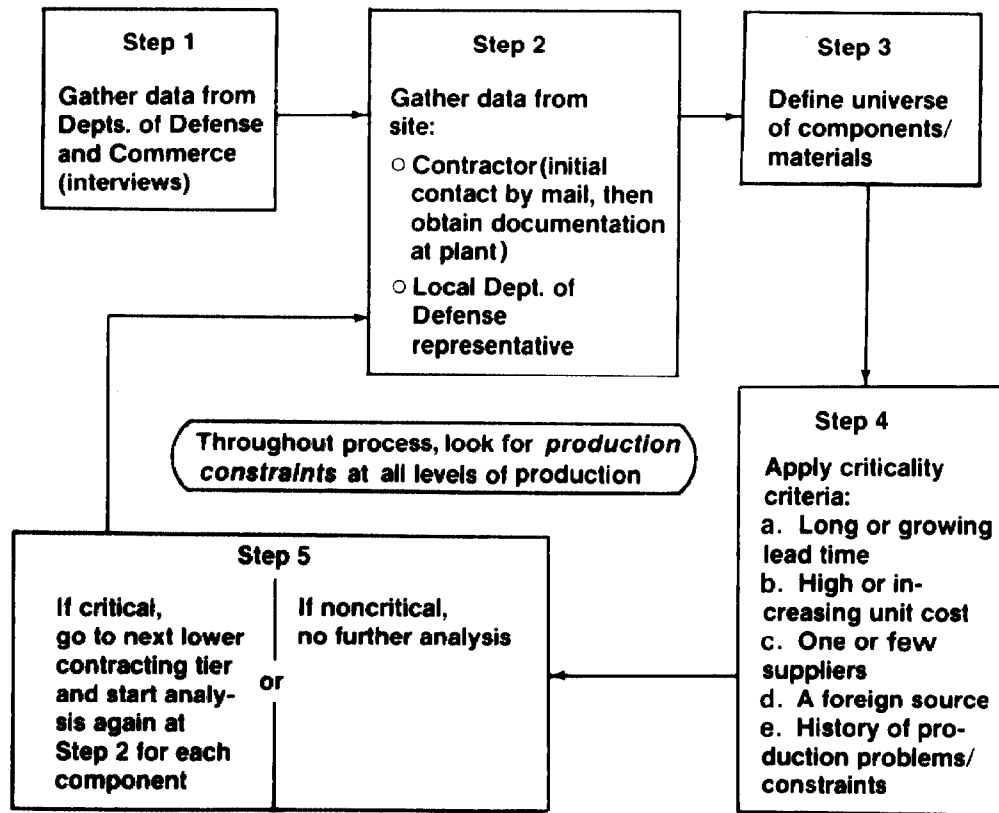
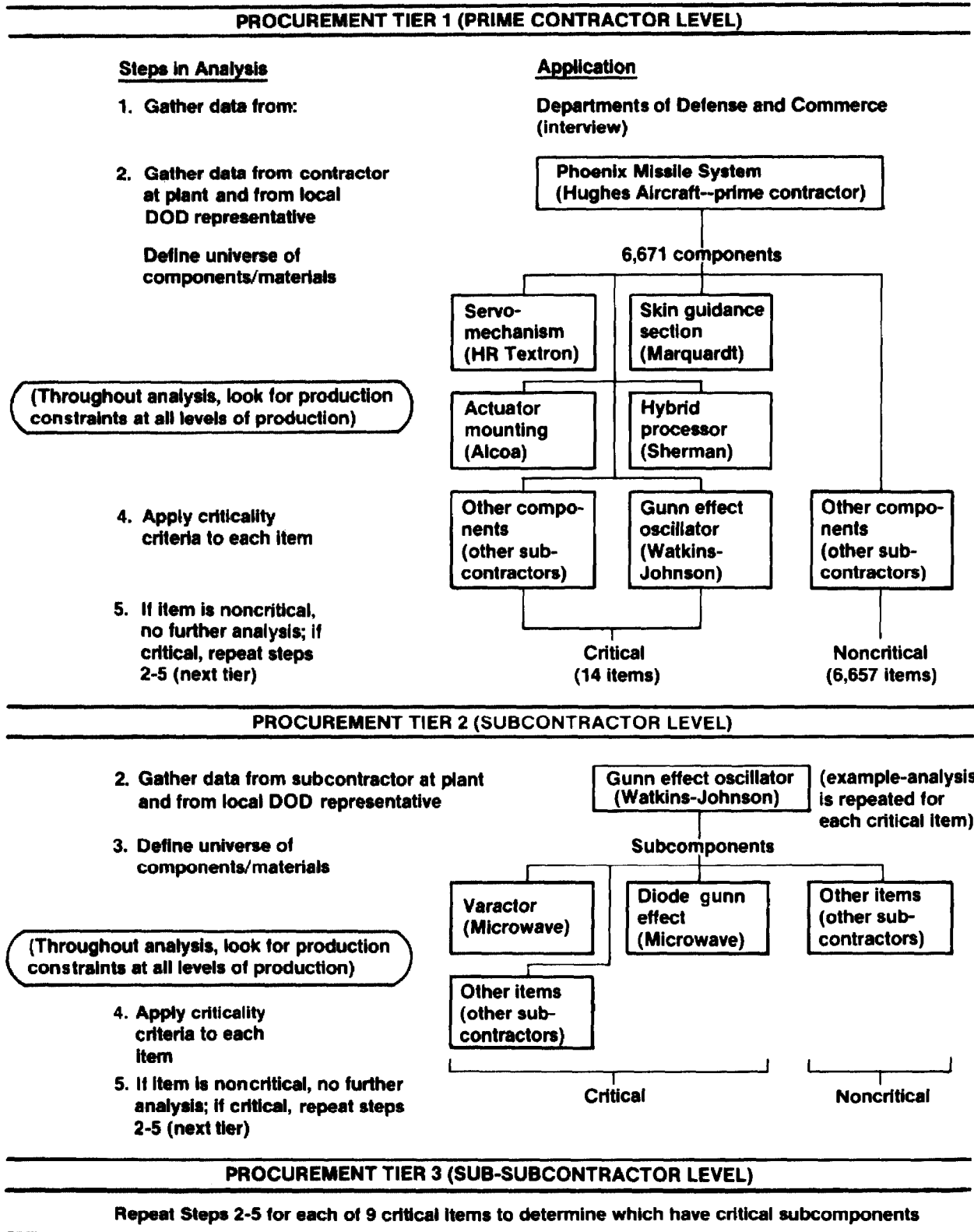


Figure 3
Application of Vertical Analysis
to Phoenix Missile System



In this way, we focused on known production problems and looked for special studies already performed that could provide useful data.

Step 2. Gather data from the production site. We first mailed our data collection instrument (a questionnaire, reproduced in appendix VIII) to the prime contractor. We held semistructured interviews with DOD representatives in the area of the plant site, then visited the prime contractor to complete the questionnaire and collect documentation on its operations. For the Phoenix missile system, the questionnaire went to officials at Hughes Aircraft, and we completed our data collection at Hughes' Air Force plant no. 44, in interviews and through direct observation of production operations. To identify critical items, unit costs, sources of raw material, and the like, we obtained generic data on products, plant capacity, labor force size, production history, etc., as well as specific data on the missile system and its components.

Step 3. Define the universe of components and materials for the weapon system as well as possible at this point. We used the data collected at steps 1 and 2, but had not yet collected data from subcontractors. For the Phoenix missile, we compiled a total list of 6,671 items.

Step 4. Apply the following "criticality" criteria to the items from which the contractor assembles the system:

- long or growing lead times,
- high or increasing unit costs,
- one or few suppliers,
- a foreign source, and
- a history of production problems or constraints.

The more criteria that apply to an individual component, the higher is the possibility that it will be selected as a critical item. We established a cutoff point for production lead time after the purchase order; items for which production time exceeded the cutoff point were classified as critical. For qualitative criteria such as dependence on foreign sources, all items in a certain class were identified as critical. At the end of this process, we had classified 14 items used in Hughes' final assembly of the Phoenix missile as most critical.

Listing critical items started the search for production constraints, which went on throughout the analyses. A constraint is any factor that limits the production rate or would limit production if the intended rate were only slightly higher. For each critical item, we attempted to identify constraints at the first tier that might lead to delay, inferior quality, or cost

increases. We determined such constraints on the basis of production rates for pieces of machinery, number and type of specially skilled employees, use of rare ores or minerals, scrap and rework rates, and the like. The search for constraints continued when we looked at the subcomponents of critical items at the next procurement tier, and went on until a constraint was found or the cost-effectiveness of the search ruled out continuation. For the Phoenix missile, we found two production constraints at the Hughes plant.

Step 5. Repeat the vertical analysis (starting at step 2) for subcontractors at the second tier producing items determined to be critical. This is done after data collection and analysis is complete at the level of the prime contractor. For noncritical items, there is no further analysis.

For the Phoenix missile, resource limitations confined our steps at the second tier to visits to 11 subcontractors producing 12 components. When, at the second tier, we found HR Textron making a servomechanism that we had classified as critical, we mailed a questionnaire to that subcontractor (step 2), following it with a visit to the site. We then defined the universe of items for the subcontractor (step 3) and applied our criteria to the list (step 4). For the Phoenix missile, for example, this gave us nine potential critical subcomponents of the servomechanism. For each critical item assembled by the subcontractor, we searched for production constraints, finding for the Phoenix missile eight constraints at the second tier.

At each successive procurement tier, the vertical analysis is repeated from step 2. In the example we have been using, we collected data from six third-tier subcontractors and found two production constraints.

This is a simplified description of vertical analysis, illustrating only the main ideas. In practice, the DIB is very complicated; some data, such as trend values for unit costs or lead times that are needed in the analysis, cannot be obtained. In such instances, and because many weapon systems contain a large number of items, it may be best to use the following screening process at steps 3 and 4 to identify critical items:

Step 3 (alternative). Collect and analyze lead-time and cost data for as many items as possible. Tentatively classify those that have the longest lead time or the highest dollar cost as critical. To this list, add items that the local DOD representatives and the contractors' officials consider critical (based on their own implicit or explicit criteria).

Step 4 (alternative). Gather histories on lead time, unit costs, foreign dependencies, and production problems for each item tentatively identified as critical. Apply this information to yield a final list of critical items.

This alternative procedure offers a relatively quick way to determine criticality for weapon systems that have a large number of components and hard-to-obtain data.

Horizontal analysis

The main purpose of horizontal analysis is to identify competing demands for production resources and thus to provide further information about production constraints. For each contractor and subcontractor identified in the vertical analysis, the products they manufacture that compete for production resources are examined.

Horizontal and vertical analyses are conceptually distinct, but the search for competing demands is embedded within both. The data collection and analysis of competing demands (step 1 of horizontal analysis) takes place at the time of the site visits that constitute step 2 of vertical analysis. Beginning with the prime contractor, and as critical items are traced down through the various procurement tiers, horizontal analyses are conducted for the contractors at each level. In the Phoenix missile example, we carried out 1 horizontal analysis at the first tier, 12 on second-tier items, and 6 on third-tier items.

Horizontal analysis, as applied to one contractor and one critical item, consists of three steps:

Step 1. Determine production levels and competing demands from DOD and private sectors for the contractor's resources that are available to produce the item under review. Do this by holding interviews and examining company records. Look for demands for similar or identical products or dissimilar products that place demands on the same contractor for resources for that item.

Also collect two additional pieces of information to be used in the future-production analysis: the proportion of the contractor's business that the critical item represents and the relationship between the contractor's defense and civilian business (e.g., what percent of the business is defense related?). These data help reveal how responsive the contractor will be to DOD's future production requirements.

Step 2. Determine the contractor's plans for expanding plant capacity. This information, obtained from interviews with company officials, is also used in the future-production analysis. It permits judgments about the prospects for removing production constraints that are tied to plant capacity. In the Phoenix missile example, seven contractors were making plans for expansion.

Step 3. Identify new production constraints, current and potential, that stem from competing demands. The analysis looks at the full range of products using the same resources. In practice,

most of the search for such constraints takes place at the same time, at the vertical and horizontal steps together, during the site visits to the contractors. All companies GAO visited made more than one product and thus had competing demands that could be at least potential production constraints.

Combining the results of vertical and horizontal analyses produces a matrix that may look complex, but can display competing demands across a wide array of defense and nondefense systems (figure 4). The information also can be stored efficiently in a computer system for easy retrieval.

Figure 4
Sample Matrix of Competing Demands*

Item	Defense products					Civilian products		
	Missiles			Other		Air-craft engines	Auto	Other
Phoenix	TOW2	Other	M1 tank	F100 Engine				

Contractors

Future-production analysis

The third and final element of GAO's evaluation method is the future-production analysis. Completing this analysis and comparing the results against those of the vertical and horizontal analyses yield an estimate of the DIB's ability to produce a weapon system over some future time period. Our method also helps foresee and prevent such production problems as delays, inferior quality, and cost increases. The three steps of the future-production analysis, as applied to a given weapon system, are outlined below:

Step 1. Estimate future levels of production of the weapon system by reviewing DOD's 5-year program. While the 5-year plan tends to become less reliable as its estimates relate to later years, it is nonetheless, a good document with which to begin the future-production analysis.

Step 2. Determine contractors' expectations for future change in demands for products that compete with the weapon system. Do this by reviewing the contractors' forecasts of sales (forecasting mechanisms can range from internal computerized systems for calculating expectations for a broad market to ad hoc procedures for anticipating negotiated sales to DOD).

Step 3. Assess the contractors' abilities to meet future requirements by judging the effect of potential production constraints. Match data on current constraints with estimates of increases or decreases in demand. Also consider probable responsiveness by the contractors to future requirements, judging from the information collected about their possibilities for plant expansion and proportions of military to civilian products. From these factors, estimate the likelihood that future production requirements can be satisfied.

APPLYING GAO'S METHOD TO CASES

Applying our assessment method across a large segment of the DIB was beyond our resources, so we adopted a case-study design to illustrate how the method works. We chose six high-priority weapon systems, distributed two each among the services:

<u>Army</u>	<u>Air Force</u>	<u>Navy</u>
TOW2 missile	F100 engine	Phoenix missile
M1 tank	Global Positioning System	Harpoon missile

At the same time we applied our assessment method to the six cases, we assessed the feasibility and usefulness of that method. That is, while our study teams determined critical items and carried out the other steps, they were also making observations about

the methodology. Because the case-study approach is flexible, we could sometimes make immediate use of the observations to refine the method, after which we modified our field efforts.

We selected high-priority weapon systems from two basic sources: DOD's industrial preparedness "Wedge program," used to identify systems to which the services give high priority, and DOD's Master Urgency List, containing the priorities of the President and Secretary of Defense.

The Wedge program, which entails a separate budgetary line-item for corrective actions, aims to substantially reduce current lead times. When the \$100-million program began, each service was to select one major weapon system and two consumer items to undergo extensive "surge planning." Funds would be allocated to these systems and items to cut their lead times in the event of surge demands. In practice, each service has selected only one weapon system for Wedge analysis and funding. We reasoned that, if the services regarded these systems as the most important areas for surge planning or DIB expansion, any method we developed would have to apply to them. Thus, the three Wedge selections constituted three of our cases; the services criteria for selecting them were as follows:

1. The Army chose the TOW2 missile for Wedge funding. Its selection criteria were: estimated cost for surge production, surge potential per dollar invested, and criticality of the missile's missions. We could find no information, however, on how these criteria were combined or weighted and compared during the Army's selection process.

2. The Air Force, rather than selecting a major system, chose the F100 engine for its F15 Eagle and F16 Falcon fighter aircraft. Its criteria were that engines are long-lead items and that the F100 powers two fighters.

3. The Navy chose the AIM54C Phoenix missile, but provided no justification for the selection.

(At the time we completed our review, neither the Army nor the Navy had as yet halted production of the TOW2 and Phoenix missiles; but this did occur later, due to quality control problems. This report should be read in that context.)

DOD's Master Urgency List itemizes systems given the highest national and DOD priorities, as defined by political, scientific, psychological, and military objectives, and military criticality. GAO selected its three additional weapon systems from this list, one from each service, for the reasons indicated:

4. The Army's M1 tank, primarily because of its high position among all the DOD items on the list and because a major land-based system would broaden the range of contractors we could include in

our analysis. Manufacturers of tanks are likely to produce other components significantly different from those required for the airborne weapon systems chosen from the Wedge program.

5. The Navy's Harpoon missile, partly because it was very high in priority on the list. Having chosen the tank for its dissimilarity to other systems, however, we selected this missile for its similarity to the Phoenix and TOW2 missiles, both produced by Hughes Aircraft in the same plant. Therefore, choosing the Harpoon missile, made by McDonnell Douglas, allowed us to compare and contrast the production operations of two major suppliers of missiles.

6. The Air Force's Global Positioning System, chosen after we rejected major aircraft from the Air Force. (Those rejected included the B1B aircraft, because of its uncertain status at the time of our work, and all Air Force aircraft using the F100 engine, to avoid duplicating our other analyses.) Our analysis of this weapon system did not work out as well as we hoped. When we reviewed the system, it was in transition from development to production, and we found no production history or data. We therefore confined our efforts to reviewing the list of the system's subcontractors, looking for subcontractors identified as producing critical items on the other systems we examined, and reviewing projected levels of production. Thus, our discussion of this system is restricted primarily to discussion of future production.

Chapter 3 of this report presents GAO's analyses of these six weapon systems, which are described in full detail in appendix X.

There are important gaps in GAO's selection of systems. For example, we did not include ships, thus removing shipbuilding contractors from our scope of study. Also, we analyzed the F100 engine, but no aircraft, reducing the likelihood that heavy special forgings, such as those used in aircraft bodies and landing gear, would appear in the analysis. Finally, the items we selected are only illustrative of a method's usefulness. This report is not a comprehensive study of the DIB, and our results are not intended for generalization to all weapon systems.

CHAPTER 3

FINDINGS FROM SIX CASE STUDIES

In this chapter, we present the results of applying our evaluative method to six weapon systems identified in the preceding chapter: the Army's TOW2 missile and M1 tank, the Air Force's F100 engine and Global Positioning System, and the Navy's Phoenix and Harpoon missiles. For each, we discuss identification of critical items and production constraints and the overall ability of the contractors that produce such items to satisfy future production requirements.

It is important to reiterate that, since this is a report of only six case studies, the findings cannot be generalized to all weapon systems. Our presentation is intended only to illustrate what kind of data can be collected and conclusions drawn from them.

CRITICAL ITEMS

A difficult but crucial aspect of assessing the DIB is identifying components and materials that might be associated with delays, inferior quality, or cost increases during production. In this section, we document the Phoenix missile case study in some detail and give a brief account of the five other cases.

Phoenix missile

We began our search for critical components and materials for the Phoenix missile with an "indentured parts" list at Hughes Aircraft Air Force plant no. 44. This list presents lead-time and unit-cost information on all parts Hughes needs to assemble the missile and codes the levels of assembly into which the parts fit. Indenture level 1 is the missile itself. A component at indenture level 12 may fit into another component at indenture level 11 and so on all the way up to level 2 and the three assemblies that, when combined, form the missile.

The indentured parts' list presented a formidable task for analysis. Its 218 pages of computer printout list 6,671 parts with almost 4,000 separately identifiable part numbers. Applying our criticality criteria for supplier lead time and unit cost, we selected 25 items that might prove critical on further analysis, as shown in table 2 on the following page. After reviewing these items and discussing them with the local DOD representatives and Hughes officials, we narrowed the 25 to 21, for which we requested and received 5-year trend data on lead times, unit cost, Hughes' sources of supply, and production problems. Examining these trends, we finally identified 14 components as critical. We scheduled visits with their manufacturers, but resource constraints allowed us to visit sites for only 12 components produced by 11 subcontractors at the second tier of procurement. We did not visit Corning or Sperry Vickers.

Table 2

Second-Tier Critical-Item Candidates for the Phoenix Missile

<u>Item</u>	<u>Company</u>	<u>Lead time</u>		<u>Cost</u>		<u>No. of sources</u>	<u>Some previous production problems</u>
		<u>Days</u>	<u>Trend</u>	<u>Unit</u>	<u>Trend</u>		
Critical							
E.U. harness assembly	LaBarge						
Forging	Reisner						
Forging	Alcoa						
Frequency multiplier	Zeta/CMI						
Gunn effect oscillator	Watkins-Johnson						
Hybrid processor	Sherman						
Impatt diode	Microwave/Varian						
Inertial sensor assembly	Northrop						
Lo network	Microwave						
Radome assembly	Corning						
Rate integrating gyro	Northrop						
Reciprocal pump	Sperry-Vickers						
Servomechanism	HR Textron						
Skin guidance systems	Marquardt						
Not critical							
Balanced mixer	Engelmann Microwave						
Coupling C.H.F.	Aeroquip						
Dip-brazed assembly	Hughes-Treitler						
No. 1	"						
No. 2	"						
No. 3	"						
No. 4	"						
No. 5	"						
Phase shifter	Ceramic-Form						
Port circulator	Microwave						
R.F. switch	Micro Dynamics						
T.O. network	Microwave						

Examining second-tier components, for example, we visited HR Textron, which makes a servomechanism (an electrohydraulic device that provides the main position control) for the Phoenix missile. Beginning again with an indentured parts' list, we narrowed the 157 components of the servomechanism to the 9 potential critical-item candidates listed in table 3. We selected two for further analysis.

Table 3

Third-Tier Critical-Item Candidates
for the Phoenix Missile Servomechanism

<u>Item</u>	<u>Company</u>	<u>Lead time</u>		<u>Cost</u>		<u>No. of sources</u>	<u>Previous production problems</u>
		<u>Days</u>	<u>Trend</u>	<u>Unit</u>	<u>Trend</u>		
Critical							
Drive shaft forging	Corona Forge Division						
Drive shaft	ArtVic						
Noncritical							
Bearing	Torrington						
Bearing	"						
CAP casting	Western Gravity						
Cover casting	Micro Parts/Screwmatic/Aviation Ind.						
Cylinder block	Western Gravity						
Electrical connector	Bendix						
Potentiometer	Beckman						

Applying to the servomechanism the same criteria that we used for the missile at the first tier, we identified as critical the drive-shaft production by Corona Engineering and ArtVic. The drive shaft had a lead time and a unit cost of . Of all the servomechanism's components, this drive shaft had the longest lead time and the second highest price. Further, the unit cost had increased in the last 5 years for both forging and machining.

The other weapon systems

For brevity, we summarize in this section our identification of first-tier, but not second-tier, critical items for the TOW2 missile, the M1 tank, the Harpoon missile, and the F100 engine. (As we could not obtain production data for the Global Positioning System, we could not identify its critical items.)

Selecting candidates for criticality was somewhat easier for the TOW2 missile than for the Phoenix missile. Although the TOW2 missile had 498 components, many were small, inexpensive, and readily available. Looking for all components costing \$20 or more or having an overall lead time of 12 months or more, we listed 9 critical-item candidates (see table 4). We identified the two (gyro and lamp) with the longest lead times as critical; both showed a trend of increasing unit cost and were sole-source items. We also called the warhead critical: it is furnished by the government to Hughes Aircraft, but we found a general lack of coordination of information about government- and contractor-furnished components that made it a potential problem.

Table 4
Second-Tier Critical-Item Candidates
for the TOW2 Missile

<u>Item</u>	<u>Company</u>	<u>Lead time</u>		<u>Cost</u>		<u>No. of sources</u>	<u>Previous production problems</u>
		<u>Days</u>	<u>Trend</u>	<u>Unit</u>	<u>Trend</u>		
Critical							
Gyro	Timex						
Lamp	Canrad-Hanovia						
Warhead	Mason-Hanger						
Noncritical							
Actuators (2)	Borg Warner						
Container	Hitco/Brunswick						
Forward motor forging	PMP/EL						
Forward motor propellant	Hercules						
Lens	Herron Optical						
Wing/control serv-ices/cap/nozzle	TMI						

The 12 critical-item candidates we identified for the M1 tank appear in table 5. Their unit cost ranged from _____ for the _____ to _____ for the _____. Of the 12 items, _____ were sole-source; _____ had a history of production problems. Incomplete data and resource constraints allowed us to visit only nine contractors.

Table 5
Second-Tier Critical-Item Candidates
for the M1 Tank

<u>Item</u>	<u>Company</u>	<u>Lead time</u>		<u>Cost</u>		<u>No. of sources</u>	<u>Previous production problems</u>
		<u>Days</u>	<u>Trend</u>	<u>Unit</u>	<u>Trend</u>		
Critical							
Engine	AVCO						
Fuel tank	Snyder Industries/ Paco						
Gyro	Cadillac Gage						
Image control unit	Hughes						
Laser range finder	Hughes						
Periscope ^b (commanders)	Miller Hollzworth						
Starter motor ^b	Sheller Globe						
Servo torque drive assembly	Singer Kearfott						
Traverse servo	Cadillac Gage						
Thermal receiving unit	Hughes						
Track shoe assembly	Standard Products						
Transmission	Detroit Diesel Allison						
Noncritical							
None							

^bNo site visit conducted.

For the Harpoon missile, we had to modify our assessment method. Officials at McDonnell Douglas Astronautics, the prime contractor, told us that some information was not readily available or did not exist and would take considerable effort to compile. For a compromise, the company produced a list of the 56 missile-body components and materials having the longest procurement lead times, with the most recent average unit cost. We selected nine as critical-item candidates and, from McDonnell's trend data, we identified three second-tier items as critical to production of the Harpoon missile (see table 6 on the following page).

Table 6

Second-Tier Critical-Item Candidates
for the Harpoon Missile

<u>Item</u>	<u>Company</u>	<u>Lead time</u>		<u>Cost</u>		<u>No. of sources</u>	<u>Previous production problems</u>
		<u>Days</u>	<u>Trend</u>	<u>Unit</u>	<u>Trend</u>		
Critical							
Attitude reference assembly	Northrop/ Lear Siegler						
Digital computer-power supply	IBM						
Radar seeker	Texas Instruments						
Noncritical							
Battery	Eagle-Picher/ Yardney						
Booster motor	Aerojet/ Morton Thiokol						
Air inlet duct casting	Anadite/ Alcoa						
Power converter	Eldec						
Proximity switch	"						
Relay	Leach						

Selecting critical items for the F100 engine was difficult, as neither the Air Force nor prime contractor Pratt & Whitney gave us component unit-cost and lead-time figures. Our efforts were severely restricted by lack of data and the length of time it took to obtain what data we could get. Therefore, no summary production table is presented. Pratt & Whitney did provide lead-time charts that it uses for materials' handling. From these, we got an overview of approximate lead times for major assemblies. We also obtained a list of subcontractors for major components, ranked by their dollars of subcontract sales to Pratt & Whitney. We coupled this rather sparse information with interviews with Pratt & Whitney, Air Force, and other DOD officials concerning production problems with the major components. While recognizing the limited nature of this data, we wished to examine some subtier contractors for the F100 engine. Thus, we used the information to select, as second-tier critical items, the Bendix fuel control system and Ladish's major forgings.

PRODUCTION CONSTRAINTS

In five of our six case studies, we sought to identify constraints on the ability, now or future, of contractors to satisfy defense requirements (as discussed above, we could not do this for the Global Positioning System). We found seven types of constraint; six involved physical or material difficulties at the production facility and one, a policy/management issue. In the physical or material group were: shortages of production machinery, testing equipment, raw materials and components, and skilled labor; reliance on foreign contractors; and extensive "queue time." The policy or management constraint was the presence of proprietary processes.

To show how industrial preparedness planners might see the broad picture of constraints, we present our findings in terms of these seven categories as well as by weapon system (see table 7). The tier level (1, 2, or 3) at which each type of constraint was identified is shown. This method of presentation does not warrant a generalization of the findings, but illustrates how results can be reported. The seven constraints are discussed below in more detail.

Table 7
Production Constraints at Tiers 1, 2, and 3
for Five Weapon Systems

<u>Item</u>	<u>Shortage of</u>				<u>Reliance on foreign contractors or materials</u>	<u>Long queue time</u>	<u>Proprietary processes</u>
	<u>Production machinery</u>	<u>Testing equipment</u>	<u>Raw materials and components</u>	<u>Skilled labor</u>			
Phoenix	2	2	2	2	1,2	2	1,2,3
TOW2	1,2	a	1	a	1,2	a	1,2
M1	2,3	2,3	2	2	1,2,3	a	1,2,3
Harpoon	a	2	a	3	2	3	1,2
F100	a	2,3	a	a	1,3	2	1,2,3

^aNo constraint identified.

Shortage of production machinery

Lack of manufacturing equipment or machine-press capacity presented an upper limit on production for four weapon systems (Phoenix and TOW2 missiles, M1 tank, and F100 engine) out of our six. The shortage had not caused late delivery, but a request for an increase in production would have led to significant time delays to procure additional machinery and tooling.

For the Phoenix missile, for example, we determined that subcontractor Marquardt would require additional tooling to exceed production of 55 missiles per month. Four subcontractors (Marquardt, , Watkins-Johnson, and Zeta) for the Phoenix missile

said that shortages of equipment and tooling would constitute a significant constraint if demand increased; so did two subcontractors (AVCO and Detroit Diesel Allison) for the M1 tank. Standard Products, supplying tracks for the M1 tank, was currently meeting production levels, but would require four more presses and new tooling to expand to surge level.

The TOW2 missile presented a more detailed example. Its production was limited to 2,500 missiles per month by the output rate for the beacon shutter actuator assembly, which required a Japanese Matura cutting machine. An additional machine would cost \$200,000 and 22 months in lead time. The Army's surge production level for TOW2 was 3,500 missiles per month. To reach this level would require the cutting machine plus another \$800,000 machine. But buying these machines would not necessarily facilitate an increase in production, because lack of space for them on the production floor could well be another constraint.

Further, the six presses that pack explosives into the TOW2 warhead were identified by the contractor as a "choke point" for quick production increases. Mason Hanger, the manufacturer, expected to acquire additional presses and tooling and to solve a problem with copper liners on some current machines. This would greatly improve their ability to increase production to levels called for in the TOW2 surge plan.

Shortage of testing equipment

Shortages of testing equipment were widespread. Many components of weapons must meet high specifications and tolerance levels; testing for these requires specialized, sophisticated equipment. Certain contractors working only a single or double shift were constrained in meeting production requirements by their testing equipment, some of which worked continuously through three shifts to keep up. Five subcontractors (Bendix, Detroit Diesel Allison, Northrop, Singer Kearfott, and Texas Instruments) ran at least some of their testing equipment 24 hours a day during the work week.

Northrop, for example, had to operate its testing equipment throughout three shifts to keep up with the Navy's requirements for the inertial sensor unit and the attitude reference assembly that supported both the Phoenix and Harpoon missiles. Northrop officials informed us that special testing equipment was their biggest obstacle to a higher rate of production. At Northrop's request, Hughes asked for government funds to pay for additional testing equipment for the Phoenix missile, but the Navy refused.

LaBarge, another producer for the Phoenix missile, found its testing equipment so limited that it had to ship its items to another contractor, Eagle Picher, for testing. LaBarge decided to acquire its own testing equipment, calculating that this would decrease its lead times by 10 to 15 percent.

Singer Kearfott, sole-source supplier of the servotorque drive assembly for the M1 tank, ran its power-conditioning, test equipment 24 hours a day. A delay in the production of this assembly could have caused a shutdown of all or parts of the tank production at General Dynamics. Thus, a breakdown in the testing equipment would severely limit industry's ability to meet defense requirements.

Acquiring testing equipment can take significant time. Eight contractors we visited had testing equipment that could require more than a year to obtain. Santa Barbara Research Center, a third-tier contractor on the M1 tank, could need up to 22 months to acquire new testing equipment. At the extreme limit, Detroit Diesel Allison, another subcontractor on the M1 tank, needed from 24 to 30 months to purchase and implement its equipment.

While told that the prime contractor for the F100 engine could easily expand production, we found that testing equipment constrained production levels at both Bendix, a single-source, second-tier producer, and its supplier, Garrett Pneumatic, a single-source, third-tier producer. Bendix officials, however, believe that the lack of testing equipment would not necessarily be a capability constraint, as the lead time for testing equipment is within their production lead time for the fuel control system. Lack of tooling and testing facilities had already slightly affected the production of the air motor, according to Garrett Pneumatic's representative.

Shortage of raw materials and components

Several contractors and subcontractors we reviewed were constrained by shortages of either raw materials or components from their suppliers. We found instances where shortages were dealt with in one of two ways, for which the M1 tank serves as an example:

1. Borrow from a completed tank a functional part and install it in a tank still being assembled to avoid interrupting production (this is called "slaving"); or
2. Keep "slave" parts in stock; these are installed in a tank under assembly to keep production and testing moving, but are removed when the tank has been assembled.

Later, when the shortage is made up, the newly arrived parts are installed in the otherwise completed tank.

The Army has used both methods for a long time. The instance that received the most publicity was the "slaving" of the AVCO engine: a shortage of the power pack (engine, transmission, ancillary components, and wiring harness) led to the installation of borrowed parts from 35 tanks, which had to be kept in storage without engines. By the middle of 1983, General Dynamics had

received enough power packs to reduce the stock of "slaved" tanks to 16.

Another instance of long-standing was the "out of station" installation, in upward of a thousand M1 tanks, of "slaved" parts for the thermal receiving unit, one of three critical components of the gunner's primary sight (part of the fire control unit), which Hughes manufactures. The thermal receiving unit, as well as two other components of the gunner's primary sight--laser range finder and image control unit--were generally unavailable for some part of every month. In their place, General Dynamics installed "slave" parts for functional test prior to the assembly plants. After the test, the three units were removed and the opening sealed with a metal plate. When parts arrived from Hughes to make up the shortage, the components were shipped directly to the assembly location, the metal plate removed, and the new parts installed in the now-functional tank.

At the time of our visit to General Dynamics, they referred to the out-of-station installation units as "slave parts." Subsequently, both General Dynamics and Hughes argued that the term was not appropriate. General Dynamics prefers the term "shop queens" and Hughes the term "golden units." However, because of the similarity to the engine slaving situation, where units were temporarily installed and later removed, and General Dynamics' original description of the fire control units as "slave" parts, we will continue to use that term in our discussion. The most important aspect to consider is not the term, but the concept.

We attempted to determine the extra cost of "slaving." General Dynamics paid air freight at about \$25 per unit over the cost of land transport to receive the gunner's sight as quickly as possible. Inserting the slave components took 2.5 hours of labor at approximately \$30 an hour, and removing them, installing the metal plate, removing the plate, installing the new gunner's sight, and performing additional tests took anywhere from 4 to 24 hours at \$25 to \$35 an hour.

General Dynamics, Hughes, and the Army disagree over why these problems occurred. Officials at General Dynamics told us that the Army negotiated a delivery schedule with Hughes that did not synchronize with General Dynamics' M1 tank production schedule. Hughes' officials said that, while Hughes may not have been meeting the schedule needs of General Dynamics, it had never held up the delivery of a tank. According to Army officials, General Dynamics was present at the negotiations between the Army and Hughes and should have resolved then whatever problems it had with the arrangement. This dispute is especially troublesome, since the fire control systems have had a long history of problems, on the M60A3 as well as the M1 tank.

As prime contractor for the M1 tank, General Dynamics sometimes found its production limited by the supply of the servotorque

drive assembly from a second-tier producer, Singer Kearfott. This producer, in turn, was limited by the production of a mirror from the sole-source vendor, Santa Barbara Applied Optics. Production of the mirror was so constrained that it was sent by air freight one or two at a time to Singer Kearfott, and the servotorque drive assembly shipped the same way to General Dynamics.

The importance of these M1 tank components cannot be overstated. A shortage of the servotorque drive assembly can bring the whole production process to a halt. General Dynamics' officials told us that production has, on occasion, stopped for lack of the servotorque drive assembly, but we did not ascertain how often or what a work stoppage costs. We did note, however, that this component was 88 units behind schedule at the time of our review. General Dynamics' officials assert that the production was not halted by this shortage.

Another type of restriction had to do with the supply of raw materials. Five subcontractors that supported the production of the Phoenix missile (Alcoa, Marquardt, and) and the M1 tank (AVCO and Hughes El Segundo) indicated that the unavailability of raw materials would present a significant constraint, if they had to meet an expanded production schedule.

Shortage of skilled labor

A shortage of skilled labor is generally taken as a serious production constraint. Our interviews with contractors and other data indicate that unemployment rates were high, at least in the areas we visited, and the contractors thought they had readily accessible labor. For example, Mason Hanger, a producer of the TOW2 missile, told us that the local unemployment rate was about 10 percent and skilled labor abundant.

While the current supply of skilled labor did not seem to pose a problem, some subcontractors said that the placement of new orders would make it one. Cadillac Gage and Sherman, subtier producers of machined parts and forgings, were concerned about the fact that most skilled machinists were generally older than 50. The lengthy training this occupation requires could constrain production. Microwave, a third-tier supplier for the Harpoon missile, was similarly concerned about the availability of skilled labor.

To summarize, we found skilled-labor shortages in a few areas. For contractors whose major function was assembly or whose work was labor-intensive (procedures and operations were relatively standardized or easily and quickly taught), a shortage of skilled labor was generally not a constraint. If the unemployment rate drops significantly, however, and DOD's production requirements increase, some firms in our report may have difficulty finding skilled labor.

Reliance on foreign contractors

Some experts consider dependence on foreign sources to be a constraint, because international conflict could interrupt supply. For the critical items in the five systems for which we had data, we were able to identify the minerals and ores that the United States imported. We found that many components used some type of material having an import dependency of 50 percent or more. Minerals and ores in our case-study weapon systems that were relatively "import-intensive" appear in table 8. A quick glance shows that every weapon system was dependent on foreign sources for some materials. Although the table does not show it, dependence occurred at all tiers.

An interruption in imports would not necessarily mean a shortage in supply. Domestic deposits or stockpiles could be used, alternative sources found, or nonessential uses curtailed. Nevertheless, the importance of foreign dependence makes it useful to know what the potential constraints are.

Table 8

Imported Materials for Five U.S. Weapon Systems

<u>Minerals and metals</u>	<u>Phoenix</u>	<u>TOW</u>	<u>M1</u>	<u>Harpoon</u>	<u>F100</u>
Alumina, bauxite	X	X		X	X
Asbestos				X	
Cadmium			X	X	
Chromium	X		X	X	
Cobalt	X	X	X		X
Columbium					
Graphite			X		X
Manganese	X		X		X
Nickel	X	X	X	X	X
Platinum metals		X			
Selenium				X	
Sheet mica				X	
Silver	X	X	X	X	
Tantalum		X	X	X	X
Tungsten	X	X	X	X	X
Zinc			X	X	

For example, one second-tier contractor on the M1 tank, , required chromium, cobalt, nickel, and tantalum. More than 60 percent of each material comes from outside the United States. Other materials were imported at a lower rate. A third-tier producer on the F100 engine, Garrett Pneumatics, required cobalt, graphite, and manganese; more than 80 percent of each of these was imported.

Contractors rely on foreign components as well as on imported minerals and ores. A subcontractor on the TOW2 missile, Canrad Hanovia, depended wholly on foreign sources for its quartz optics. A third-tier supplier on the M1 tank, Santa Barbara Applied Optics, was similarly concerned about the unavailability in the United States of sophisticated glass for use in optics for weapon systems. In another area, Hughes El Segundo, a second-tier producer on the M1 tank, had printed-wiring boards assembled in Mexico, and Singer Kearfott, another subcontractor on the M1 tank, relied on hybrid circuits imported from Taiwan and distributed by a domestic firm. Singer Kearfott has recently acquired a domestic vendor as a second source. Texas Instruments, a subcontractor for the radar seeker on the Harpoon missile, depended on an English firm to meet portions of the demand for some components and a German firm for assembling and testing components. Pratt & Whitney, the prime contractor for the F100 engine, was considering using a German supplier of bearings.

It may be difficult to determine the full extent of the constraints. Timex said, for example, that its vendors may not have known the country of origin of some materials that it used to make the gyro for the TOW2 missile, since they bought from U.S. supply houses. Another area of longstanding concern, but unfortunately one we could not pursue, was the level of dependence on foreign suppliers for semiconductor and microelectronic parts. It is estimated that from 80 to 90 percent of the military semiconductors are assembled and tested outside the United States. The exact level, however, is not known.

Extensive "queue time"

"Queue time" refers to the interval during which a customer has placed an order and awaits the beginning of production. The vendor may have scheduled that order after others so that the customer stands in the queue or line behind other customers. During the 1970's, queue times were said to be quite long and to have caused lengthening lead times for defense production. We found that queue time was generally not a major constraint.

In examining queue time, we separated contractors' lead-time figures into four parts: scheduling, materials' acquisition, production, and shipping. As scheduling is defined as the processing of an order for production, the time it takes to schedule is, in effect, the queue time.

At a few facilities, however, especially where forgings and castings were made, we found that extensive queue time might still be a constraint, because of the manufacturers' need to keep a smooth or constant production level. , for example, had a lead time of months for its component for the Harpoon missile, whereas actual manufacturing time was months. A representative told us that simply scheduling orders in a way that avoided production peaks and valleys was part of its lead time.

Another contractor, , had a lead time of months, of which fully were in raw material lead time.

Proprietary processes

Proprietary processes constrained DIB production, we found. Of the 39 contractors we visited, 25 used proprietary processes. Alleviating the constraint by broadening the production base would probably entail new contractors' taking the time to develop processes similar to the proprietary ones. Purchasing the proprietary rights for use by another contractor adds monetary cost to defense items. For example, one company, having patented the design of its TOW2 missile component, required the Army to pay an annual fee for its use.

Agency comments and GAO response

DOD either totally or partially concurs with our identification of these constraints. For example, it concurs with the finding that shortages of production machinery and test equipment pose problems, but notes that the DOD surge-investment program is directed to improving this condition. For the first time, the Congress has approved funding for surge investment for long lead-time inventory. DOD, while enthusiastic about this funding, believes it unfortunate that it is for only one weapon.

As to shortages of skilled labor, DOD notes that assessing and projecting skilled manpower shortages is extremely difficult, because little information can be compiled on supply. Through macromodeling and planning with industry, DOD believes it can identify current and future demands.

On the issue of queue time, DOD claims this peacetime fact of life would change dramatically during wartime.

DOD also concurs with our identification of a large number of proprietary processes. It believes, however, that GAO's report does not include information sufficient to fully evaluate this as a significant production constraint nor does readily available DOD data permit such evaluation. It was not GAO's intent to fully evaluate the extent of problems caused by this or other production constraints; such evaluation lies well beyond the capabilities of a case-study methodology. We have identified the problem concerning proprietary processes, which was widespread in our case studies. Should DOD fully implement a methodology such as the one proposed in this report, sufficient information would be available to evaluate the full significance of proprietary processes and other constraints identified here.

FUTURE PRODUCTION

Applying our methodology, we examined the ability of the DIB contractors to produce five of our case-study weapon systems--the Phoenix and TOW2 missiles, the M1 tank, the Harpoon missile, and

the F100 engine. Prime contractors had few constraints, but the subtier contractors faced a number of current and potential constraints, if not as many as reported in the 1970's.

Phoenix missile

Hughes Aircraft, Phoenix missile prime contractor, expects its production rate to more than double from the 108 missiles in the fiscal year 1983 buy to 265 in fiscal year 1985. Hughes' early production schedule slipped due to design and production problems and testing failures. As production increases, the Phoenix missile may, however, be competing with other Hughes' missiles, such as AMRAAM, Maverick, TOW, and WASP.

The higher production levels will require more support from subcontractors. For example, one subcontractor expressed concern over meeting these goals. We have noted several current and potential problems in subcontractors' production capabilities for some critical items. Further, should the Navy develop a second source for the Phoenix, to what extent would that source rely on the same subcontractors as Hughes, and how would this affect the DIB? These questions must be answered. It would seem advisable to monitor the situation carefully.

TOW2 missile

Hughes is prime contractor for the combined production of Basic TOW, I-TOW and TOW2 missiles, whose total production for fiscal year 1982 was 28,805. As procurement is expected to rise from no more than 26,129 in 1986 to 29,510 in 1988, the prime contractor and subcontractors should be able to meet demand for TOW2 with no significant problems. Hughes, which has dedicated a production line to the TOW2 missile, has no history of late deliveries.

Potential conflict from competing demands should be further analyzed, however. The dedicated production line minimized competition at the first tier, but one subcontractor also produced items for the Hellfire missile system. About 75 to 80 percent of the parts in the TOW2 gyro were common to both TOW2 and Hellfire missiles. There was no indication that the anticipated annual production of 6,000 Hellfire missiles would change. Nevertheless, the situation merits watching.

M1 tank

Contractors supplying the M1 tank had 4 to 5 years of experience with the present design and were working at peak production. It seemed reasonable that the current production level could be maintained. The M1 tank had been given a priority rating, however, requiring contractors to give production of this item precedence over other defense and civilian items. Thus potentially competing demands and dependence on foreign materials could mean future production problems. As the economy improves, lead times could

increase and labor shortages become more serious, constraining production as in the past.

The M1's dependence on foreign sources is well known. This involves raw materials for such critical components as the fire control system; entire components (e.g., precision glass prisms for periscopes); and production equipment (e.g., industrial robots and gun-sight hair replacements). How severe the production constraint is depends on how susceptible these materials are to supply interruptions and their availability in the domestic stockpile.

Further, the "slaving" of parts and schedule problems increased costs and stretched out production schedules in the short term. In the longer term, these problems could seriously limit the contractors' ability to respond to a sudden increase in demand. An M1 tank with "slave" or missing parts is of little value, especially in a time of crisis or surge.

Harpoon missile

In calendar year 1982, McDonnell Douglas Astronautics Company delivered 426 Harpoon missiles to the Navy and the foreign military market, while continuing production on the Dragon, Tomahawk, and Nike Hercules weapon systems and the Delta space launch vehicle, among other major demands from DOD. The Harpoon is an established weapon system whose production dates back to 1975. Production requirements for domestic and foreign military sales are expected to decline from 354 in 1985 to 290 in 1987. If the demand for the Harpoon missile does not increase significantly, we may assume that current production capacity will be adequate until then.

The level of foreign sales is, however, an important variable. The stock of missiles accumulated since suspension of deliveries to Iran in 1979 might be allocated to foreign buyers, but an unexpected increase of such sales could pose a problem.

F100 engine

Pratt & Whitney produced about 35 F100 engines per month. We found few production constraints for this firm, but some potential constraints for its subcontractors. Future production capabilities involve, however, not only those of Pratt & Whitney, but of General Electric and its subcontractors, which will produce most of the engines for the Air Force's F15 and F16 aircraft. The dual-source agreement calls for Pratt & Whitney to produce 40 engines the first year and General Electric, 120. We would anticipate no problems with Pratt & Whitney, for which the 40 represent about one tenth of demonstrated capacity, but as we did not analyze GE's capacity, we cannot say whether total demand will be met.

Global Positioning System

As the Global Positioning System will not be fully operational until in the late 1980's, we could not obtain adequate data; thus

we limited our review to whether any subcontractors were producing critical items for other systems in our case studies. The Air Force identified 11 major subcontractors with contracts exceeding \$10 million, 2 of them also producing critical items for other systems we examined.

SUMMARY

Our vertical analysis shows more current and potential production constraints at the subcontractor than at the prime contractor level. The horizontal analysis reveals significant competing demands for critical items. The future-production analysis indicates that maintaining production levels should be possible for the weapon systems we reviewed. Future production of some components and systems could be a problem, however, warranting attention to them.

CHAPTER 4

RECENT INITIATIVES, CONCLUDING OBSERVATIONS,
AND MATTERS FOR CONSIDERATION

RECENT INITIATIVES

Recent Department of Defense actions show the importance that DOD attaches to industrial preparedness planning. The services have increased their funding for it--Army and Navy funding for 1983 was about twice that of 1980, while Air Force funding increased fivefold. The figures for fiscal years 1984 through 1988 appear in table 9. Other, nonmonetary initiatives, including a task force, joint Air Force-industry symposia, and improved data systems, are discussed in the remainder of this section.

Table 9

Industrial Preparedness Program Funding
for Fiscal Years 1984-88
(in millions of current dollars)

<u>Fiscal year</u>	<u>Army</u>	<u>Navy</u>	<u>Air Force</u>	<u>Total</u>
1984	\$1,241	\$565	\$105	\$1,911
1985	1,409	531	61	2,001
1986	1,371	605	68	2,044
1987	1,680	769	85	2,534
1988	2,871	831	98	3,800

Task Force to Improve Industrial
Responsiveness

The Task Force to Improve Industrial Responsiveness is an indicator of DOD's concern with improving the DIB. Drawing recommendations from a number of previously completed industrial-base studies, the task force proposed changes to DOD's policies. To meet its objectives and improve the DIB in three categories, defense acquisition, industrial preparedness planning, and national resources, the task force listed 18 recommendations in its March 1982 report (Office of Secretary of Defense, March 1982):

1. Establish reportable, production-related goals for the Defense Systems Acquisition Review Council (DSARC) that will help program managers focus on resource constraints and productivity issues early in the acquisition cycle;
2. Require the use of the most effective production rates consistent with available resources and the clear definition and presentation to DSARC principals of the effect of variations in those rates;

3. Require an analysis of industrial resources that allows program managers to identify the capital investments, timing of financial commitments, and other resources needed to support initial production;
4. Require a closer consideration of industrial preparedness planning in making decisions about peacetime production rates and productivity improvements;
5. Require that all programs be considered in industrial preparedness planning and that the funding requirements for such planning be clearly defined and reported to the DSARC principals;
6. Change the defense acquisition regulation by adding clauses about surge conditions and by improving the definition of industrial preparedness planning concepts;
7. Require an increase of emphasis on industrial-base issues in advance procurement planning and source selection;
8. Assign the responsibility for the management and oversight of industrial resource planning to the Office of the Secretary of Defense and other DOD components;
9. Integrate the separate but related industrial resource programs under a single program for resource oversight;
10. Require the development of a composite, production-base analysis for identifying industrial-base shortfalls and for assisting in the determination of priorities for the best allocation of resources;
11. Prescribe the timing for the planning and submission of industrial-preparedness planning information to make it as useful as possible for budgeting and resource-allocation decisions;
12. Require the components of DOD to maintain critical-item lists and the Office of the Secretary of Defense to consolidate the lists of critical items;
13. Prepare a statement for the Secretary of Defense that will promote initiatives to improve the industrial base and highlight the importance of the industrial base to the nation's deterrence policy;
14. Develop a comprehensive guide entitled "Improving Productivity in Defense Contracting" that will identify available approaches and sample clauses for integrating capital-investment incentives and technology-modernization programs into DOD contracts;

15. Propose amendments to the Defense Production Act of 1950 that would do the following: (a) remove the obstacles to title III projects by providing "up-front" funding for them (reducing the annual Office of Management and Budget review, and other congressional authorization and appropriations review periods for such projects); (b) add a new title IV requiring that the Department of Labor continuously review with DOD the local, "sectoral," and national labor problems in the DIB and propose and implement solutions to them, consult regularly on industrial preparedness planning issues with labor representatives, and report annually to the Congress; and (c) remove unnecessary title VII restrictions on voluntary agreements with industry and extend the act by 5 years;
16. Tie together the programs in DOD that generate information on the availability of materials, so that the Office of the Secretary of Defense can consider how to "head off" problems (including those with projects under title III of the Defense Production Act of 1950) before they become severe;
17. Fix responsibility within the Office of the Under Secretary of Defense for Research and Engineering and other DOD components for the exchange of information on the availability and the shortage of materials; and
18. Update and consolidate current guidance on manufacturing technology, and establish procedures for closer coordination among the services.

DOD's plan to implement the task force recommendations called for 14 actions in the form of writing or revising directives, instructions, regulations, guides, manuals, or policy statements. Of these actions, only three had been published, eight were about ready for publication, and three were at less advanced stages of processing at the time of our review (the end of 1983).

Of special interest is task force recommendation 10, calling for development of a composite production-base analysis (PBA). Currently, each service prepares an annual PBA (report) on the status of its own industrial base to identify shortfalls and to determine allocation of resources to support service requirements. A composite PBA would consist of a comprehensive analysis of the ability of the industrial base to respond to peacetime, surge, and mobilization requirements, based on consolidated, production-base data collected from all the services, as well as from other federal agencies and industry.

DOD does not, however, intend to develop the composite PBA recommended by the task force, believing that this would entail micro-management of the services by the Office of the Secretary of Defense. This decision was conveyed to us by the Staff Director

for the Industrial Policy of the Office of Under Secretary of Defense for Research and Engineering during our review.

With respect to a composite analysis, we note that our method for identifying production capabilities and constraints presented in this report could be applied consistently across all the services as well as individually by one or more services. Should DOD find implementing our methodology feasible in terms of costs and available resources, the coordinated approach would maximize benefits.

Beyond the normal, lengthy revision process, DOD officials have pointed out, some of the delays have resulted from a deliberate effort to resolve differences among the services prior to publication. Implementation has not been delayed, they have added, because the services have begun to take action on the available drafts. The recommendation to amend the Defense Production Act, however, was not acted on before the Congress extended it without the amendments. Consequently, the opportunity to enact these changes has been lost for the near future.

Blueprint for Tomorrow

The Blueprint for Tomorrow, a mutual Air Force-industry undertaking, is a series of meetings and working sessions between Air Force officials and defense contractors. More than 40 companies and associations are invited. Participating firms, generally large, are either prime contractors or subcontractors directly supplying prime contractors. There are working panels on fighter/attack, large, and other aircraft; propulsion; and tactical missiles. For subcontractors, a workshop on structure and product of the DIB helps to identify constraints that inhibit efficient production under varying circumstances. The Air Force intends to identify and develop opportunities for corrective action on production shortages as input for its PBA.

The Air Force-industry symposia represent the principal mechanism settled on by the Air Force to construct its PBA and identify DIB constraints. Its fiscal year 1985 PBA will include the precision-guided munitions' requirements of all three services.

Integrated industrial data management system

Another important effort is the recent completion of an "integrated industrial data management system" (IIDMS) for the Air Force by the Analytic Sciences Corporation. Performed at the direction of the Office of the Secretary of Defense, this contract produced a description and definition of a system to automate the collection, analysis, and dissemination of economic and production information that portrays the ability of the U.S. defense industries to support the current and future defense program, including surge and

mobilization conditions. The three services and representatives of the Joint Chiefs of Staff have held several meetings to follow up on the need for and implementation of the IIDMS. Determining the feasibility of a ten-month pilot phase is the major current effort in this area.

Army system for automation of preparedness planning

For preparing its PBA, the Army has developed an automated system that takes advantage of a considerable amount of industrial-preparedness planning data. Called the "U.S. Army System for Automation of Preparedness Planning," the project is still in its early stages, but has been centralized and is operated by the Industrial Base Engineering Activity at Rock Island, Illinois. Data gathered from several sources, including the major systems' commands, the Defense Industrial Plant and Equipment Center, and the Defense Logistics Agency, are fed directly into the Army's analysis.

CONCLUDING OBSERVATIONS

We commend DOD's efforts to improve industrial preparedness planning. Changes have come slowly, however, and we observed some important problems during our review. Further, we do not believe that the initiatives described above will fully address certain issues raised in our review, particularly the need for an accurate data base on subcontractors' capabilities. Our findings that data collection and analysis in support of industrial preparedness can be improved are summarized in this section. We also highlight some factors that should be considered in making improvements and briefly suggest how to minimize costs associated with implementing a better method of data collection and analysis.

Selecting critical items

To maximize usefulness of information produced, the "most important" systems and components should be selected for data collection and analysis. As noted earlier, there is no assurance that the most essential items are selected for industrial preparedness planning. An expanded subtier analysis requires a method that focuses quickly and economically on critical components and materials. For determining critical items, we believe it is important to go beyond looking at only one or a few criteria, such as long lead times, to apply a consistent set of criteria.

Obtaining better data

From our case studies, we conclude that it is clearly possible to

- identify critical weapon system components and materials produced, not only by prime contractors, but also at the lower tiers of the DIB;

- identify current and potential production constraints on the ability of individual contractors to meet defense requirements; and
- assess the overall ability of contractors to meet planned production levels of weapon systems.

Most current and potential production constraints occur, our analysis indicates, not at the level of the prime contractors, but at the lower tiers of the DIB. From our case studies, we learned that understanding of subtier production capabilities would be improved by systematic data collection and analysis that is now lacking. The latter activities should be directed to such factors as subcontractors' physical plant capacity, foreign sources of components and raw materials, scrap and rework rates, proprietary production processes, actual and potential production levels, numbers of shifts and days on which production machinery and testing facilities operate, unit costs, lead times, vendors of components and materials, and delivery histories. Additionally, demand data are needed on components and materials that draw productive resources away from weapon system production.

Establishing baseline data

The importance of establishing a data base that identifies trends in past production problems is indicated by our data collection and analysis. High unit costs and long lead times for components and materials may indicate current constraints. Knowledge of increasing costs and lead times, as indicated by trend variables, could contribute to anticipation and prevention of future constraints.

Improving accuracy and verification

Greater accuracy and verification of production data are still needed. We encountered instances of prime contractors' giving us data on subcomponents that differed substantially from the data provided by the subtier producers of those items. In constructing our assessment method and conducting our review, it was highly useful to collect data from subcontractors at all tiers. Making site visits can increase the general knowledge about the subtier contractors among program managers and service representatives. Gathering data firsthand and asking follow-up questions helps clarify issues. Information from several tiers is extremely useful; it helps in verifying the accuracy of data from different sources.

But collection of subcontractor data remains a problem with the new DOD initiatives, as data collection for both prime and subtier contractors will be conducted by the prime contractors. Also, current plans do not provide for independent data verification by the services.

Focusing on cooperative efforts

For many weapon systems, there is a need for consistent data collected from and coordinated with the Army, Navy, Air Force, DOD's industrial preparedness planners, contractors, and subcontractors. Some recent DOD initiatives are being conducted as tri-service efforts. We believe that this is appropriate and that the focus on coordination should be continued and expanded. One important aspect may be to institutionalize this coordination in a central unit having responsibility for collecting, computerizing, and analyzing data on the DIB.

How many weapon systems, components, materials, and contractors should be included in the data base? There are several alternatives for making a logical choice:

1. Focus on the weapon systems that the services deem the most important or urgent. Begin collecting data at the prime contractors and analyze it at a central unit, where suppliers of most critical items, whether of one or several weapon systems, can be identified. Select some of these subcontractors for additional data collection by questionnaire and by site visits. Use horizontal analysis to identify items from several different systems being produced by one subcontractor and to judge which of the critical items to examine below the first tier.

2. Select systems from a "rotating sample" of contractors; e.g., in a given year, subject some contractors to intensive data collection, while others supply data less formally. Reverse the order of collection the following year. For example, visit contractor A in year 1, for interviews, examination of records, and so on, while asking contractors B and C simply to return a questionnaire. Then, in year 2, conduct a site visit to contractor B, with contractors A and C completing questionnaires, and so forth. The cycle could be broken for items that pose particular problems or for which industrial preparedness planners needed more data.

3. Analyze a particular class of weapon systems. For example, if it were necessary to determine the possibility that problems would be associated with production of a new missile, apply GAO's intensive method of data collection and analysis to missiles rather than, say, tanks. This approach could be especially useful to identify competing demands for contractor production materials and resources linked to all the services. To the Air Force's credit, it is making some progress in this approach through its Precision Guided Munitions Study. To be conducted in two phases, with final competition scheduled for May 1985, this study will attempt to determine aggregate tri-service requirements for precision guided munitions and the contractors' ability to meet them.

DOD's response to problems

Our examples show that DOD and the services often have been aware of problems in the DIB, yet have done less than they could

have to resolve them. Even some of the recent initiatives and recommendations for improving the functioning and management of the DIB have suffered delays. Some production problems are long-standing, and the difficulties with subcontractors' abilities to produce components needed by prime contractors to assemble major weapon systems are well known. If DOD wants to make systematic improvements in the production system, we believe it needs better methods for identifying problems and resolving them.

Agency comments and GAO response

DOD fully or partially concurs with the issues we have discussed above under "Concluding observations." It believes, however, that the need for more information on the subtier procurement base has been recognized; all policy revisions, including those on defense guidance, stress this aspect. Critical-path methodology is now being utilized for analysis, but because of limited resources to perform detailed analysis and the ultimate cost of correcting problems detected, the analysis is limited to the most critical weapon systems. Further, DOD has implemented an effective system of prioritization in its programming and budgeting processes and included policy concerning it in its revised regulations for industrial preparedness planning. Such policy forms a fundamental part of DOD guidance to the services for programming and budgeting.

We believe that DOD's revised policies and guidance acknowledge in principle many of the problems and needs we identified. Our experience has shown, however, that in practice changes are slow, if they occur at all. This lag is due at least in part to the inadequate structure of the DD 1519 system. Further, while a prioritization system has been implemented, the results of that system are less than clear. Each of the weapon systems GAO analyzed for this study was selected for its clear and stated importance to DOD and the services, yet it was within these very high-priority system that we identified current or potential production constraints.

With respect to our specific comments on DOD's response to problems, DOD concurs, but believes that recent congressional approval for surge investment represents a major milestone signifying that funds in service programs and budgets for improving the industrial base are not at risk.

We share DOD's hopes that the surge investment will help solve some problems, along with increased attentiveness to identified problems and a quicker response to addressing and correcting those most relevant. In analyzing the data and drawing conclusions, we fully considered constraints on DOD resources. Our own work on the six weapon systems was also bound by resource limitations; consequently, we have given attention to ways our data collection and analysis method could be most efficiently implemented. To correct every existing or potential production constraint is, we realize, well beyond current or expected DOD resource levels. Nonetheless,

we believe DOD can improve its methods for identifying and analyzing problems, thereby becoming better able to assign priorities and decide which problems to address first. The results of any such efforts remain to be seen.

Minimizing cost of industrial preparedness information

The costs of implementing our data collection and analysis method could be minimized by using existing systems. If the level of DD 1519 efforts were reduced, some of the data collection functions could be incorporated into the duties of program managers, plant production officers, or other plant or service representatives. By upgrading the mechanisms and substructure already in use for DD 1519, the data collection burden could be relieved. By using DOD's advanced computer capability, analysts could automate the new data and prepare the analyses at a central unit such as the Army's Industrial Base Engineering Activity. Finally, costs could be controlled directly by focusing only on critical items and on the criteria used to identify them.

MATTERS FOR CONSIDERATION

Overall, GAO is concerned with shortfalls in the information available for identifying problems in the DIB. Better information is only a minimum need; it is not, in itself, a solution to the issue of when and how to respond to problems. We are encouraged by DOD's recent initiatives in this area and believe the implementation of these initiatives should focus on

- the extent to which information and production problems occur at the subcontractor level, below that of the prime contractors;
- actions that can be taken to improve the armed services' understanding of and response to problems in the defense industrial base; and
- the need for services to improve their monitoring and verification of contractor data.

Our efforts have identified two other important matters that should be considered by defense industrial preparedness planners:

- the usefulness of implementing a method, such as the one presented in this report, consistently across all of the armed services in a way that insures continuous, accurate, and generalizable information on the state of the DIB; and
- the desirability of further expanding cooperative, tri-service efforts, such as naming a central unit in the Department of Defense for collecting, computerizing, and

analyzing DIB data or instituting a DOD-wide composite production-base analysis, such as that recommended by the Task Force to Improve Industrial Responsiveness.

AGENCY COMMENTS AND GAO RESPONSE

The Department of Defense noted that this report recognizes a number of initiatives it has taken to resolve problems in the DIB. DOD is confident that, in many instances, efforts already initiated in revised regulations about to be released capture the spirit and intent of our report.

DOD believes these elements to be an inherent part of policy already implemented by DOD or to be included in revised policy issuances. The requirement for each service and the Defense Logistics Agency to develop an annual production-base analysis encompasses all of the elements identified in our report.

Again, we commend DOD's efforts in this area. As already noted in this report, however, we believe that DOD's efforts only partially address the issues raised. Current and planned DOD initiatives do embody the concept of a vertical-horizontal analysis. DOD can improve its system for implementing this concept, however, by incorporating a methodology such as we present in this report, which more fully addresses the issues raised in our concluding observations than do current DOD methods.

For example, DOD methods do not apply a consistent set of criteria at each production level for identifying critical items. Often items are deemed critical based solely on the suggestion of the contractor involved. Our methodology, on the other hand, develops and consistently applies a set of criticality criteria. This allows us to identify some important items for analysis not identified by current DOD systems.

Basing a system on mailing DD Forms 1519 to contractors for completion (compliance is voluntary) provides only limited data accuracy and verification. Our methodology, conversely, stresses uniform data collection at each DIB tier and verification and accuracy checks back to source documents. Again, we believe that DOD can do more to increase cooperative efforts. While the Integrated Industrial Data Management System is a strong step in what we believe to be the right direction, under the DOD system, each service and the Defense Logistics Agency create separate production-base analyses, based on their own, independent collection of data. However, as mentioned previously (see page 41), we find the idea of a composite production-base analysis, rather than separate individual PBAs, to be attractive. A strong point of GAO's methodology is that data collection is a fully cooperative effort with all services sharing data. Cooperative data collection and analyses not only can decrease collection costs, but can increase the strength of resultant analyses.

GLOSSARY

Administrative lead time. The time between the initiation of a procurement action and the awarding of a contract or placing of an order; estimated time between release of a purchase order and contract award.

Critical item. GAO defines a critical item as one to which one or more of the following conditions apply: (1) it requires long lead times for production and delivery or has a history of lead-time growth; (2) it is expensive or has a history of cost increase; (3) its production depends on a small number of contractors; (4) it relies on a foreign source for components or materials; and (5) it has a history of production problems, such as late deliveries.

The Department of Defense defines a critical item as an essential item in short supply, or expected to be in short supply for an extended period, to which both of the following conditions apply: (1) the item's not being available will seriously impair the operational readiness of ship, aircraft, or shore operations, or ship or aircraft conversion, alteration, construction, repair, or overhaul programs and (2) the item's availability in stock has fallen to the point at which the stock will be exhausted before deliveries are due under outstanding contracts.

Additional conditions applying to individual parts of such items are that (1) failure would prevent satisfactory operation of the system of which it is a part or create safety hazards; (2) the part is sufficiently complex that it requires special production techniques or controls; (3) the part requires special treatment or handling during transportation or storage; (4) the part imposes a heavy maintenance and supply support burden; (5) the part has a long production lead time.

Defense industrial base. The private and public capacity to produce and support the military material required for the national defense; it is generally estimated to include 25,000 to 30,000 prime contractors and 50,000 subcontractors. The government currently owns about 65 facilities that are typically used for producing items unique to the military, such as nuclear weapons.

Industrial preparedness program. DOD plans, actions, or measures for transforming private and public industry from peacetime activity to an emergency program supporting the national defense; includes industrial preparedness measures such as modernization, expansion, and preservation of production facilities and contributory items and services.

Manufacturing Technology Project (MANTECH). A production-oriented DOD project to evaluate public and private manufacturing processes, techniques, and equipment in order to provide for the timely, reliable, economical, and high-quality mass production

of material DOD requires. MANTECH also bridges the gap between prototype production and mass production by applying practical new processes or techniques on a pilot-production scale. The project does not normally encompass existing processes, techniques, or equipment in the manufacture of specific systems, components, or end items. Nor does it apply to the development or the improvement of the mass production of specific weapon systems; such efforts are normally funded as part of a specific weapon program.

Master Urgency List (MUL). A secret DOD ranking of priorities in research and development, procurement and production, construction, and test resources programs; the President designates the highest national priorities and the secretary of defense designates DOD's high priorities.

Mobilization. Mobilization expands the active armed forces by organizing or activating additional troops to respond to requirements that exceed those of peacetime and by activating all the national resources needed to sustain such forces in a general war; it may occur in stages, full mobilization for a limited war, and total mobilization for a total war.

Outyear. A fiscal year occurring after the current one. For example, if the current fiscal year is fiscal year 1985, outyears would include fiscal years 1986, 1987, etc.

Prime contractor. Contractor who sells to and contracts directly with DOD.

Procurement lead time. The time between initiation of a DOD procurement action or placement of a contract and receipt of the procured material, whether from outside the procuring department or from manufacturing within the department; the sum of administrative and production lead time.

Production lead time. Estimated time between a DOD purchase order award and delivery of the first production quantity.

Subcontractor, subtier contractor. A contractor who has no direct contractual relations with DOD and sells to a prime contractor.

Subcontractor planning. See Vertical planning.

Surge. A condition in which the active armed forces rapidly expand peacetime facilities, equipment, and priorities for obtaining materials, components, and other resources.

Vertical planning. The extension of procurement planning from prime contractors to subcontractors, vendors, or suppliers for the emergency production of subassemblies and components.

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September 20, 1982

The Honorable Charles A. Bowsher
 Comptroller General
 U.S. General Accounting Office
 441 G Street, N.W.
 Washington, D.C. 20548

Dear Mr. Bowsher:

I am writing in my capacity as Vice Chairman of the Joint Economic Committee's Subcommittee on International Trade, Finance, and Security Economics and Ranking Minority Member of the Senate Appropriations Committee.

New budget authority for national defense is projected to increase from \$263 billion in 1983 to \$408 billion in 1987, for a five-year total of approximately \$1.7 trillion. This increase in demand for weapon systems, including requests for a wide variety of new and advanced weapons, has come at a time when the U.S. defense industrial base (DIB) may have substantial difficulty in meeting the demand for critical components, and, to a lesser degree, critical materials, for major weapon systems in terms of quantity, quality, timeliness, and cost. These components are generally thought of as critical in the sense that (1) at least one required weapon system cannot be produced without them, (2) component production depends upon a small number of subcontractors, many of which are foreign companies, (3) international hostilities could lead to lengthy delays in weapons production and to higher costs, and (4) segments of the U.S. defense industrial base suffer from a lack of production technology, materials, or shortages of the skilled labor necessary to readily expand the capacity of these component suppliers.

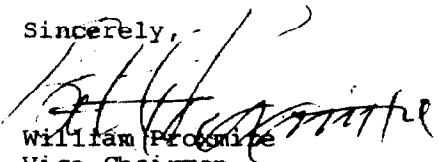
Committee staff have raised this subject with staff from your Institute for Program Evaluation (IPE) regarding a possible methodology for examining DIB issues. This basically involves using a case-study approach to look at a number of weapon systems produced in the last five years to provide a better understanding of specific factors related to DIB problems. In particular, the study would examine why DIB production delays, quality problems, and cost or price increases occurred and what mechanisms were used by the Department of Defense to address these problems. This information would then be used to develop a framework within which to anticipate DIB problems identifiable for items proposed for funding in the Five-Year Defense Plan.

The Honorable Charles Bowsher
September 20, 1982
Page Two

It would be helpful to the Congress for the General Accounting Office to explore the possibilities of developing such a methodology in order to assess the potential for addressing the DIB issues mentioned above. I understand that such a feasibility study can be completed in three months time. I would like your staff to provide a briefing on this methodology and its potential usefulness at the end of the exploratory phase of your work, followed by a formal report at the full completion of your efforts.

If you have any questions, please call Richard Kaufman, Assistant Director and General Counsel to the Joint Economic Committee at 224-5171.

Sincerely,



William Proxmire
Vice Chairman
Subcommittee on International
Trade, Finance, and Security
Economics

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IMPROVING THE ABILITY OF THE DIBTO MEET DEFENSE NEEDS:POSSIBLE APPROACHES

In this appendix, we present an overview and discussion of major approaches to improving the Defense Industrial Base that have been suggested by various authorities. Unless otherwise indicated, we do not evaluate the relative merits of the approaches. Of course, specifying how the DIB might be strengthened assumes some view of the qualities that characterize a healthy DIB and obstacles to strengthening it.

Certain themes seem to recur concerning the capabilities or qualities of a properly functioning DIB. Simply put, in meeting military needs for products, the DIB must fulfill requirements concerning (1) quantity and kinds, (2) quality, (3) cost, and (4) schedule.

There seems little question that the DIB can produce any item that is technologically feasible or within the state of the art. But much attention is focused on the last three concerns--quality, cost, and schedule. In this appendix, then, we discuss ways to improve the DIB's capabilities for providing strong options and alternative systems for fulfilling military needs; producing the selected systems at an acceptable level of quality and on an acceptable schedule; and controlling costs.

Two general qualities, stability and flexibility (which often, but need not, conflict), underline much consideration given to improving the DIB. Concern for stability arises when addressing many DIB-related subjects, e.g., product design, fluctuations in Department of Defense purchases, numbers of available contractors, prices of raw materials, and DOD's programming and budgeting process itself. Stability is desirable for achieving goals relating to cost, schedule, and quantity. At the same time, DIB flexibility can help enhance the capabilities of DIB products to meet the threat, pursue new technological opportunities, and provide DOD decisionmakers with alternative options for achieving these ends. To achieve either stability or flexibility is difficult; arriving at a healthy balance between them presents an even greater challenge to policymakers.

Nor is it easy to coherently present approaches for treating the array of DIB-related problems. Acting to resolve one problem can cause a major impact on other aspects of the DIB. Further, it is often difficult to assign primary responsibility for proposed remedies to either the federal government or industry, as both play important roles.

If we group the possible approaches by type of activities, however, two categories emerge:

- Problem-solving approaches--In the broadest sense, all actions taken to improve the DIB are problem-solving. But certain actions are directed to specific problems, such as programs for stockpiling materials, specific actions for better estimating program costs, and programs to encourage modernization of production equipment or processes. Such approaches to more complex problems would include: decisions on desirable mixes of weapon system designs and annual decisions made within DOD's overall programming and budgeting systems.
- Fundamental-incentives approaches would shape or establish certain basic structures (frameworks or environments) within or affecting the DIB. Such structures guide or control incentives that heavily influence problem-solving decisions concerning DIB operations (as opposed to decisions on specified problems). By using basic incentives to shape the myriad of contractor and government actions affecting the DIB, such approaches could encourage healthier DIB operations. Examples of fundamental-incentives approaches include budgeting by missions within DOD, rather than by line items, and expanding design and price competition on major acquisition programs, instead of relying on sole sources.

The remainder of this appendix presents various major approaches to improving the DIB under the problem-solving and fundamental-incentives categories, dividing each presentation into two parts, "description" and "discussion."

This summary is not exhaustive, as it leaves unnamed many programs for improving one or more aspects of the DIB or related activities. We do believe it represents the major approaches so far advanced by various authorities to better the DIB's operation.

PROBLEM-SOLVING APPROACHES

Most actions to improve the DIB take the problem-solving approach. Problem areas of the defense acquisition process are identified and actions taken to improve their operation. A particular program or policy that implements a problem-solving approach can usually be distinguished from the nature of the approach itself. We maintain that distinction in the following discussion, focusing on particular programs only as they illustrate one of the four types of problem-solving approaches: programming and budgeting; operational requirements and system design; productivity enhancement measures; and schedule responsiveness approaches.

Programming and budgeting

A programming and budgeting process sets out objectives and a plan to reach them. To the extent it is coherent, this is a

controlling activity that links together the various possible problem-solving approaches to resource management.

Description

One immediate, tangible influence on the DIB is DOD's annual cycle of procurement decisions. A better managed procurement cycle, it is suggested, could result in certain major programs receiving more items ordered at a given cost. Another result might be more achievable DOD procurement plans and increased stability within the DIB, the latter permitting more efficient use of DIB resources.

Programming and budgeting decisions are concerned with the relationship between setting and programming new initiatives, re-programming current activities, any terminations of programs, and budgeting for these decisions. The capstone of DOD's programming and budgeting effort is the annual Five-Year Defense Program (FYDP). The FYDP reflects decisions in the Planning, Programming, and Budgeting System (PPBS) and expresses DOD's (and the services') major choices of direction for the current (budget) year and the next four "outyears."

How can the programming and budgeting process be improved? Suggestions focus on DOD's ability to formulate more accurate projections of cost and funds and to adapt those plans, as costs or funds or both change. The object is to establish and maintain achievable plans despite changing conditions, subject to military needs.

Discussion

The DIB's sole buyer for most of its products is DOD, whose programming and budgeting actions therefore have direct impact on the DIB's functioning, annually and cumulatively over time. The DIB can use its resources most effectively and efficiently when responding to a reasonably stable requirement. DOD decisionmakers, on the other hand, must constantly adjust programs and budgets to changing needs, constraints, and opportunities. Thus, the DIB's need for stability is confronted by DOD's need to adapt to changing circumstances. DOD decisions represent a substantial portion of the changing environment to which the DIB itself must then adapt.

Funding instability is a principal manifestation of various difficulties in DOD's programming and budgeting process. Aside from changing system requirements and design, addressed below, a key element of this instability and its inherent effects on the DIB has been funding constraints. On-going programs create a cumulative pressure on DOD's overall budget that is increased by the steady addition of new programs, themselves also often subject to cost growth beyond projections. Of course, levels of budget funding also increase, but new funds tend to lag increasing costs. The DIB, which must react to program changes--mainly at the subcontractor level--has suffered.

Two lines of action that have been advanced to bring greater program stability are (1) better cost and funding projections, and (2) better cost control, including programming decisions in light of cost growth. Put differently, DOD needs more realistic projections of likely costs and funding levels at the start of program planning. Similarly, actual growth of program costs must be better controlled (this entails many cost-saving steps during the conduct of programs).

Programming is a vital aspect in the control of overall cost growth. The traditional response to cost growth, trimming back the program's annual buys, destabilizes the programs and often exacerbates the problem. Instead, greater scrutiny of the affordability of new program initiatives and on-going programs would be desirable. Realistic funding and cost-growth projections would aid in the measurement of affordability.

Operational requirements and system design

DIB management requires judgments of what performance capabilities are operationally required and how to design systems to meet these performance requirements. These judgments proceed from forecasts of possible military threats or tasks, combined with assessments of the kinds of capabilities consequently needed, the ability of technology to provide those capabilities, and the likelihood the DIB can produce what is needed on a satisfactory schedule and for an affordable cost.

Description

There have been suggested at least three approaches DOD might take to translate its operational performance requirements into system designs for the defense industry. They are to

- state requirements in terms of operationally measurable performance, instead of detailed technical (military) specifications ("mil specs");
- stabilize the design of a system over the course of system development and procurement; and
- encourage alternative design approaches to meet the array of operational requirements--for example, adopt more austere, functionally-dedicated systems, as well as complex or multi-function systems.

Discussion

The greater the number (or rate) of system design changes, the greater the attention and effort required from the DIB. Concern begins with definitions of requirements. Certain product mil specs are necessary--for example, requirements that tracked vehicles be no wider than available transport vehicles will permit. It is argued, however, that the DIB can more effectively and

efficiently respond to a description of the required operational performance than to a mil spec as a statement of product design requirements.

Also, system design should be stabilized to permit orderly production. Suggested means range from strict adherence to early statements of requirements, to various approaches allowing for evolutionary changes over time. The strict approach, while facilitating accurate cost-estimating and increased production efficiency, could also reduce program flexibility; that is, it could work against unplanned but innovative design changes that might increase efficiency or performance or reduce costs.

The "design-to-cost" approach aims to reduce the ill effects of changing requirements and designs. This approach sets a definite cost-goal for a product, but permits the contractor (or the service) to change the design and/or performance goals, so long as the cost goal is met. Design-to-cost, some (Gansler, 1980) think, would produce an excellent performance balance in the DIB: costs would be specifically controlled, yet a healthy flexibility on design maintained.

Productivity enhancement measures

Productivity is defined variously, from a broad sense of "good management" to a narrower concern with efficiency. Given the scope and structure of this appendix, we view productivity as it relates to contractor production activity. We focus on greater efficiency and responsiveness in the production process, improved product quality, and cost reduction or avoidance.

Description

Measures that enhance productivity range from simplifying the design of a production item to the wholesale rearrangement of a production process. The measures can rely on either a financial incentive for a firm's productivity improvements, direct federal payment for the improvements, or (often) some combination of the two financing methods.

We first discuss two major approaches to productivity enhancement, manufacturing technology and DOD's Industrial Modernization Incentives Program. We then turn to a more general approach, economic production rates (EPR).

DOD's Manufacturing Technology (MANTECH) Program demonstrates state-of-the-art approaches to specific steps in the production process. A contractor receives direct federal payment for the cost of demonstrating the full-scale production applications of new technological approaches, whose conceptual feasibility has already been demonstrated in the laboratory. A key MANTECH program goal is to assure that investments in laboratory research and development--technologically new and high-risk approaches, not better applications of off-the-shelf technology--can be translated into

factory-level production. MANTECH-produced approaches are considered public rather than proprietary, available to any firm desiring to implement them.

Another major effort, DOD's Industrial Modernization Incentives Program (IMIP), was initiated in 1982 as an umbrella approach to productivity enhancement. Now a DOD-level effort, IMIP grew out of earlier service-level modernization efforts, principally the Technology Modernization (TECHMOD) Program. As under TECHMOD, IMIP ties together the various productivity concepts into a factory-wide view. It focuses, not on a particular item or process, but on ways to modernize an entire production line.

As did TECHMOD, IMIP encourages industrial modernization of an on-going procurement program by offering a contractor substantial contractual incentives to improve hardware or processes. The contractor bears by far the greater spending burden in implementing modernization. What is the incentive? Resulting cost savings are heavily weighted toward increasing the contractor's profit, with the government sharing in the cost-reduction benefits only later in the program. IMIP usually involves some, though relatively little, direct federal spending--say, for MANTECH-type demonstration projects or where DOD believes the potential for industry-wide application of an improvement warrants government funding to avoid the improvement's being claimed as proprietary. Also, DOD specifically intends IMIP to benefit subcontractors and vendors as well as prime contractors, either by IMIP clauses passed through the primes or by direct contracts from DOD.

DOD aims to achieve its economic production rate goals as often as practicable. The rate determined to be cost efficient for a given production line, the EPR will vary with different systems or items to be produced and with different production capabilities. For example, as a production process is modernized or overall production capacity increased, the EPR of any item may rise. EPR is, then, a relative calculation.

Discussion

That measures to enhance productivity are useful is widely accepted; the degree of usefulness is less certain.

MANTECH, IMIP (or TECHMOD), and similar measures have been cited for both greater efficiencies, including cost reductions or avoidances, and more advanced production equipment and techniques. There seems also to be a widespread sense that these measures have produced commercially beneficial spinoff technologies and practices. Yet attempting to determine and measure these achievements presents difficulties. A question remains, which party, DOD or industry, should assume the risk for these and similar productivity programs? As DOD pays the costs for carrying out MANTECH projects, it assumes much of the risk. The number of active MANTECH projects (some 400-500 at any given time) may indicate that DOD's assumption of risk creates strong incentive for industry to participate.

To reduce costs by seeking economic production rate goals is one element of recent efforts to improve DIB productivity. Using EPR in conjunction with multiyear procurement has been recommended to gain the cost reduction and production benefits of a stable, efficient rate of production. As of fiscal year 1984, more than ten major weapons systems were approved or proposed as EPR programs, for cost savings projected at \$2.6 billion over the period 1981-88. Such projections, of course, assume stable designs and annual program buys at the projected rates.

Schedule responsiveness approaches

Certain approaches are recommended largely to meet various scheduling needs, perhaps to avoid delays in a programmed delivery schedule. Among these approaches are stockpiling, multiple sourcing, and multiyear procurement (MYP), as discussed below:

Stockpiling

The provisioning of certain critical means of production in excess of current needs, stockpiling anticipates changed production requirements in the future. It can reduce long lead times or avoid other stumbling blocks to meeting demands for increased production.

Description

In the face of sudden shortages of critical components or materials, stockpiling can facilitate rapid expansion of current production lines or continued (or increased) production. Stockpiling includes, for example, actions by a prime or subcontractor to lay up reserves of materials, component parts, production equipment, or subsystems. This may be done in anticipation of increased demand for a currently produced item or of being awarded the contract for a new system.

Stockpiling also includes more far-reaching actions by the government to put aside strategic reserves of, for example, critical machine tools or foreign-supplied raw materials. Stockpiling may, finally, extend to storing end items themselves (e.g., when the services store war reserve material in Europe).

Discussion

Stockpiling is nearly universally, though qualifiedly, accepted as a necessary measure to aid smooth production or transition to increased production requirements. We found no discussion in the literature fundamentally critical of stockpiling as a generally beneficial device for reducing long lead times or otherwise smoothing the transition to higher production rates.

There are, however, qualifications to stockpiling:

- It requires up-front spending, i.e., direct expenditures that are anticipatory only, without immediate benefit; and

- Stockpiling is faced with the difficulty--which may increase as one tries to project further into the future or to broader national production requirements--of predicting the character and extent of future requirements. This uncertainty is amplified during peacetime by the lack of detailed knowledge, pointed out in this as well as other studies, of what competing demands may arise when production rates are suddenly increased for many major systems.

Multiple sourcing

Seeking the same product from more than one supplier, multiple sourcing may apply to any part of the acquisition cycle--from design to provision of materials, as well as parts, components, subsystems, and even end items. Both the government and the defense industry engage in multiple sourcing (at the prime- and subcontractor levels).

Description

Multiple sourcing is practiced for one or more of four principal reasons: to maintain or expand the production base, to guard against delivery schedule interruptions or stoppages, to insure that alternative designs are available to DOD decisionmakers, or to reduce or control costs through price competition.

The first three of these purposes may be pursued by directly funding, at whatever price, more than one source for a design or production contract, while the fourth focuses on price as a significant factor. Although the first three purposes may be pursued through multiple sourcing without primary reference to cost, there may be some amalgam, where cost reduction is integrated as a primary goal to be pursued by itself or with the others.

Multiple sourcing is used throughout the DIB, though to varying extents and for differing purposes among the different buyers. The DOD's use of multiple sourcing is heavily weighted toward maintaining or expanding the industrial base or protecting delivery schedules. Only occasionally does DOD seem to pursue multiple sourcing where possible price advantages play a key role; even then, price advantages usually seem secondary to other purposes (such as schedule or the size and character of the production base).

Among the defense contractors themselves, multiple sourcing appears fairly widespread. By definition, of course, these contractors will contract only for subsystems or materials or the like, not for major end-items. Another major difference between DOD-as-buyer and contractors-as-buyers seems to be that a prime contractor or subcontractor will seek multiple sources, not only to protect a delivery schedule, but more often to obtain a better price. It is less clear whether maintenance (or expansion) of the industrial base plays as key a role in a contractor's multiple sourcing as in DOD's.

Discussion

We have noted that DOD seldom seems to engage in multiple sourcing in its price-competitive form, that is, with price reduction as a primary goal. Two factors may largely account for this:

- Price competition itself is often not a principal DOD procurement goal, either in relevant statutes and regulations or as understood by many key DOD procurement personnel.

- Barriers may exist to a program manager's seeking price competition. For example, the time and costs of qualifying a second or third source during the annual budgeting cycle may appear too great to sustain with the funds the manager has available in the immediate future. The manager also may be concerned about the quality or standardization of products from the new sources.

Multiyear procurement

Multiyear procurement (MYP) refers to the government's contracting for more than a single year's requirements at a time. The concept encompasses a number of possible contracting and funding approaches, two of which stand out:

- "Multiyear contracting" commits the government to contract requirements for a period of from two to five years, but does not require full funding beyond the usual annual authorization/appropriation cycle; and

- "Multiyear funding" of multiyear contracts occurs when Congress authorizes and appropriates full funding beyond the usual annual cycle.

These two approaches need not be joined in a particular MYP--situation that sometimes leads to confusion as to what multiyear procurement entails. In fact, the overwhelming majority of MYP seems to consist of multiyear contracting alone.

Description

DOD has practiced MYP in some fashion for about 20 years, renewing and widening the emphasis in recent years. MYP in the sense of multiyear contracting involves only particular ("line item") acquisition programs. To be designated for MYP treatment, a program must meet several guidelines that embody both congressional and DOD concerns: overall dollar savings projected from MYP should be significant and the national security served; cost projections should be of a high degree of confidence; and finally, the program requirement (projected annual quantity) and the item's design should be stable and DOD's commitment to adequate annual funding strong.

Programs meeting these criteria are eligible for MYP; should they be so designated, they become "fenced off" from annual

programming/budgeting changes. Should the contract be terminated anyway, however, the contractor may recover some portion of both nonrecurring and recurring costs, up to a standard liability limit.

Discussion

The DOD has projected that MYP could result in an average of 10-20 percent savings in unit costs through improved economies-of-scale, lot buying, decreased borrowing costs, better utilization of industrial facilities, and reduced administrative burdens. Also projected are higher quality products, due to increased industry productivity investments, and a more robust DIB (especially at the subcontractor level), due to prolonged market stability.

MYP treatment can benefit a particular program as well. Perhaps the single greatest benefit to an acquisition program and to contractors responding to its requirements is stability. This means that DIB production efficiencies can minimize growth in real costs caused by unforeseen lurches in program plans. Additionally, stability may permit an accelerated production rate, affording further efficiencies.

Several questions arise, however, about MYP's overall benefits. Does program instability continue even in MYP programs? We found that, of 22 candidates for MYP during fiscal years 1983-84, only one met all the pre-MYP criteria (U.S. General Accounting Office, September 30, 1983, p. 1). All but that 1 apparently failed to meet the cost-confidence criterion, and 13 were questionable in terms of the design-stability and/or funding-commitment criteria. If these candidate programs are typical and turn out to be unstable, it will be even more difficult to assess MYP's benefits to them.

Also, how great are the cost savings to the government, even assuming consistent program stability? DOD's projection of cost savings over 7 years for 12 fiscal year 1983 MYP programs was \$879 million. Using more realistic discount methods, we found that these same programs would result in savings of \$186 million. In percentage terms, DOD projected over 9 percent cost savings, while GAO's projected discount rate resulted in a 2 percent savings (U.S. General Accounting Office, July 27, 1982, chart 3).

FUNDAMENTAL-INCENTIVES APPROACHES

We separate fundamental-incentives approaches to improving the DIB from problem-solving approaches because of the different kinds of activities the two seem to represent. Fundamental-incentives approaches attempt to shape certain basic structures operating within or closely affecting the operation of the DIB. These structures are believed to guide the operation of what one analyst (Gansler, 1980) has called the "natural incentives" that

govern contractor and government actions (including the array of problem-solving actions) affecting the DIB.

In looking at approaches to improving the DIB or DOD actions that affect the DIB, three seem representative of fundamental-incentives approaches: (1) increasing competition in the DIB; (2) structuring a framework of government financial incentive policies directed at the DIB; and (3) mission budgeting. Of these, the first two propose structures for better harnessing basic contractor motivations in DIB activities. The third addresses incentives that guide DOD in its own decision-making on major budgets and programs. Of course, the three approaches also may act on each other, as activities within the DIB and DOD have mutual impact.

Competition

Competition for DIB products usually refers to two categories of activity, design and price competition. The first occurs between two or more alternative design approaches to a stated DOD need for performance capability. Such approaches may range from different hardware systems that accomplish a task in roughly the same manner (e.g., different fixed-wing aircraft in the air-to-air mission) to different hardware systems premised on different operational approaches to the task (e.g., fixed-versus rotary-wing aircraft in the anti-armor mission, and both versus ground-based systems).

Price competition normally refers to a choice between two or more versions of the same kind of product at different prices, as measured against some standard, such as unit price.

Description

"Competition" (whether of design or prices) may apply to a wide range of actions. At one end of the spectrum, it may involve only paper alternatives; for instance, a competition on design study proposals themselves, which may include price bids on the design studies. Further along the continuum, competition may involve actual field tests on different systems, although the tests may be run separately in conditions that may not be equivalent. Competition may also contrast design or price alternatives in more robust ways, for example: Working prototypes may compete against each other directly in "flyoffs" or "shootoffs." Developed, even fielded, systems compete against each other, or together with one or more new candidate systems (as the Army conducted in 1983 with anti-tank weapons). Finally, competition may be held, not just once during system acquisition, but periodically.

Winners of competitions are generally awarded contracts on one of two bases. "Winner-take-all" awards are self-explanatory, while "split awards" normally mean the winner takes a majority share of the total procurement quantity, the loser taking the

minority share. Split awards enable the loser to maintain production, so as to compete again for the next round of awards.

Discussion

Various authorities have suggested that increased competition will strengthen the DIB, improving quality and costs of DIB products. This is an obvious benefit to DOD and also therefore to the DIB, whose strength is largely measured in terms of meeting DOD's needs.

Some evidence shows that price competition results in reduced unit prices. We reviewed empirical studies addressing the effect of competition on prices. All ten studies suggest that competition usually brings unit-price reductions. Only some of these studies, however, considered whether price reductions included the cost of competition itself; for example, for establishing additional sources.

Beyond these features, however, certain authorities see in competition another quality improvement. They believe that, properly structured, competition may become a force impelling nearly all DIB actions toward significantly improved products, schedules, and costs. Thus understood, competition would be self-enforcing. Contractors would eventually lose a contract, if their prices rose or product or schedule quality fell unacceptably in contrast to other competent contractors' capabilities.

Recent Air Force action to make competitive its next buy of fighter engines has been cited as a good example of competition. The Pratt & Whitney (P&W) F100 engine, though chosen years ago as the engine system for all F15 and F16 aircraft, was nevertheless placed in competition with an alternative engine, the General Electric (GE) F110. As the alternative GE system offer was judged superior overall, GE will be awarded 75 percent, to P&W's 25 percent, of the next buy--a split award. The Air Force will repeat the competition for the engines in a year to insure any continued benefits in product, schedule, or cost that competition may afford.

Two assumptions seem to underlie this view of competition as generating fundamental incentives for improvement across the DIB:

1. Competition in the DIB must be widespread, rather than merely a contracting approach used in a minority of projects. The DIB as a market place must feel the challenge to offer the best possible products, schedules, and prices. There is significant disagreement as to whether genuinely price-competitive programs include both negotiated and formally advertised contracts, or should be limited to the latter. If the latter, competitive contracting in the first half of fiscal year 1983 comprised only 8 percent of DOD's contract dollars. If the former view is taken, as DOD does, competition comprised over 35 percent of DOD's

contract dollars. (These rates assume DOD's revised statistical calculations introduced in 1981.)

2. Competition within a given program should be continuous (or periodic), lest there be no opportunity to correct for a particular contractor's ineffectiveness once a contract is let. DOD's practice apparently is to call an acquisition program competitive through its full course, if at any stage there has been some form of either design or price competition.

Financial framework

Financial incentives to improve the DIB may be created by DOD or other federal policies directly aimed at contractor interests and behavior. Attention has focused, for example, on how contractor profit ought to be treated--whether it should be limited, perhaps enhanced, through government action.

Description

Concern about limiting contractor profits arises in large measure from a view that, beyond the initial procurement contracts, competition for major DOD systems is relatively rare. This causes some fear that defense contractors may extract what amounts to unfair profit. Critical to any approach to limiting profits are policies defining what expenditures are to be counted as allowable costs, against which profit is measured. Likewise important is whether profit is measured as a percentage of sales proceeds, of value of investment assets, or some other baseline.

Federal tax policy may influence DIB contractors much the same way it does the rest of industry, by encouraging or discouraging various expenditures. In particular, tax depreciation schedules allowed for investment in assets have been a focus of attention. Two major approaches are permitted for depreciation accounting: the straight-line method, which permits steady depreciation over the useful life of the asset; and accelerated depreciation, which permits greater depreciation earlier in the asset's life, due to a greater use rate in that period.

Discussion

There appear to be two broad questions in the area we term "financial framework:" (1) Is there an identifiable framework of financial incentives operating to shape the DIB in a consistent, beneficial fashion? and (2) Whether or not such an overall framework exists, do the several kinds of incentives operate at least individually to shape contractor behavior as intended by DOD policy or practice?

For any given company and product at any given time, it seems obvious that there is a synergism of effects of the various financial policies. This synergism is subject to change over time. But

such a framework need not shape a contractor's behavior, much less the DIB's character as a whole. Financial policies and practices may conflict with each other, perhaps resulting in an opposite incentive than one intended by DOD policy.

As to the second question, there seems no reason to doubt that individual financial incentives often act as intended on contractors. Yet it is also possible, in given cases, that other factors can play a decisive role. For instance, contractors may have other interests or needs that are equally or more important to them than short-term financial benefit.

Mission budgeting

A distinction has been suggested between the process (e.g., the PPBS) by which DOD reaches its major procurement decisions and a deeper budget structure giving rise to fundamental incentives guiding these decisions. The latter structure is said to derive from the objects of budgeting decisions--that is, from the items that budgeting decisions are basically about.

Description

Although budgets are arranged into general categories, the objects of major procurement budget decisions by DOD have long been primarily line items, that is, particular programs. A major alternative suggested for budget decisions is the set of operational purposes or missions--e.g., counter-air warfare or sealift forces--that are themselves funded.

Mission budgeting, which instead focuses budget size on operational ends, is presented as offering a fundamentally different set of incentives. Budgets for which various decisionmakers are responsible are independent of particular programs. If a given program turns out to be ineffective or overly costly, the decisionmaker would have an incentive to pursue alternative program solutions without fear of losing the missions' budget share. Theoretically, this arrangement leads to greater DOD flexibility in programming, which in turn encourages greater openness to promising alternative solutions from the DIB.

Finally, mission budgeting is presented as resulting in many fewer micro-management decisions on the part of high-level (e.g., DOD and congressional) decisionmakers, since their focus would no longer be primarily on particular programs.

The effects of mission budgeting in the DIB might be greater diversity of product options, from which DOD would choose. These effects could proceed from interrelated changes in DOD's behavior: senior decisionmakers might be more open to alternative approaches to achieving missions; increased DOD programming flexibility could encourage DIB contractors to improve their products and efficiency for fear of losing program contracts; and greater overall stability

in DOD resource management might result from both the reduced aggregate impact of problems in individual programs and, possibly, over time, more viable mission-budget levels.

Discussion

Mission budgeting in some form has been suggested for DOD use for years. Indeed, mission categories (both strategic and tactical) are sometimes used by DOD or the services as budget categories. But these instances are relatively few. Those few budget categories today labeled by operational missions remain defined essentially by the line items within them.

A possible weakness of mission budgeting may derive from its strength of encouraging alternative program development and flexible programming. To the extent that the content or direction of a program changes, DIB contractors are constrained to change with it. This would appear to increase instability within the DIB.

Also, there is the possibility that the degree of a firm's or the DIB's perturbation from program changes may be influenced by the inherent complexity of the systems procured. This complexity might increase program susceptibility to unplanned changes with their costs and production burden. If DOD's procurement plan included a greater number of simpler systems than is currently the case, the DIB as a whole might respond more easily to flexible programming practices. Likewise, mission budgeting could create strong incentives inside DOD for cost control and flexible programming.

GROUPS AND INDIVIDUALSINTERVIEWED BY GAOCONGRESSIONAL BUDGET OFFICEDEFENSE LOGISTICS AGENCY

Production Services Branch

DEPARTMENT OF COMMERCE

Bureau of Economic Analysis, Defense Branch

Bureau of Industrial Economics

International Trade Administration

DEPARTMENT OF DEFENSE

Industrial College of the Armed Forces

Office of the Deputy Under Secretary of Defense, Acquisition Management, Staff Director for Industrial Policy

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Air Force Plant Representative Office, F100 Engine, Pratt & Whitney

Deputy Chief of Staff/Research and Development, Directorate of Development and Production, Aeronautical Systems Division, F100 Engine Project Office

Global Positioning System Project Office

Headquarters, Air Force, RDCM, Manufacturing and Management Division

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Offices at Wright Patterson Air Force Base

DEPARTMENT OF THE ARMY

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Army Armaments, Munitions, and Chemicals Command, Industrial Preparedness Division

Army Materiel Development and Readiness Command, Industrial Mobilization Branch

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Naval Weapons Engineering Support Activity

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DEVELOPMENT OF GAO'S METHOD

The goal of the defense industrial base is to produce goods and services in response to defense requirements. In striving to achieve that goal, the DIB encounters various production problems. Of special concern are longer-than-expected production and delivery times, higher-than-expected costs, and lower-than-expected quality. These problems may be due to such production constraints as shortages of skilled labor, production machinery, test equipment, raw materials, or components; a reliance on foreign producers; extensive queue time; or restrictions resulting from proprietary processes.

Unrealistic expectations can also produce problems, e.g., the planned delivery times, costs, and quality may represent unrealistic goals. If these are hopelessly optimistic, the services and DIB contractors may be faulted for agreeing to unrealistic expectations. Removal of production constraints, however, cannot solve problems that arise from unrealistic expectations, which are outside the scope of this report.

In weapon systems, production problems usually can be traced to critical items, individual components, or materials that cause or could cause production problems. Any method to assess DIB capabilities must identify critical items and determine, as well as possible, the production constraints that cause the problems. Currently, there is no sure way to identify critical items or establish the cause of production problems. Moreover, no perfectly accurate method can be developed; only better methods than those currently in use.

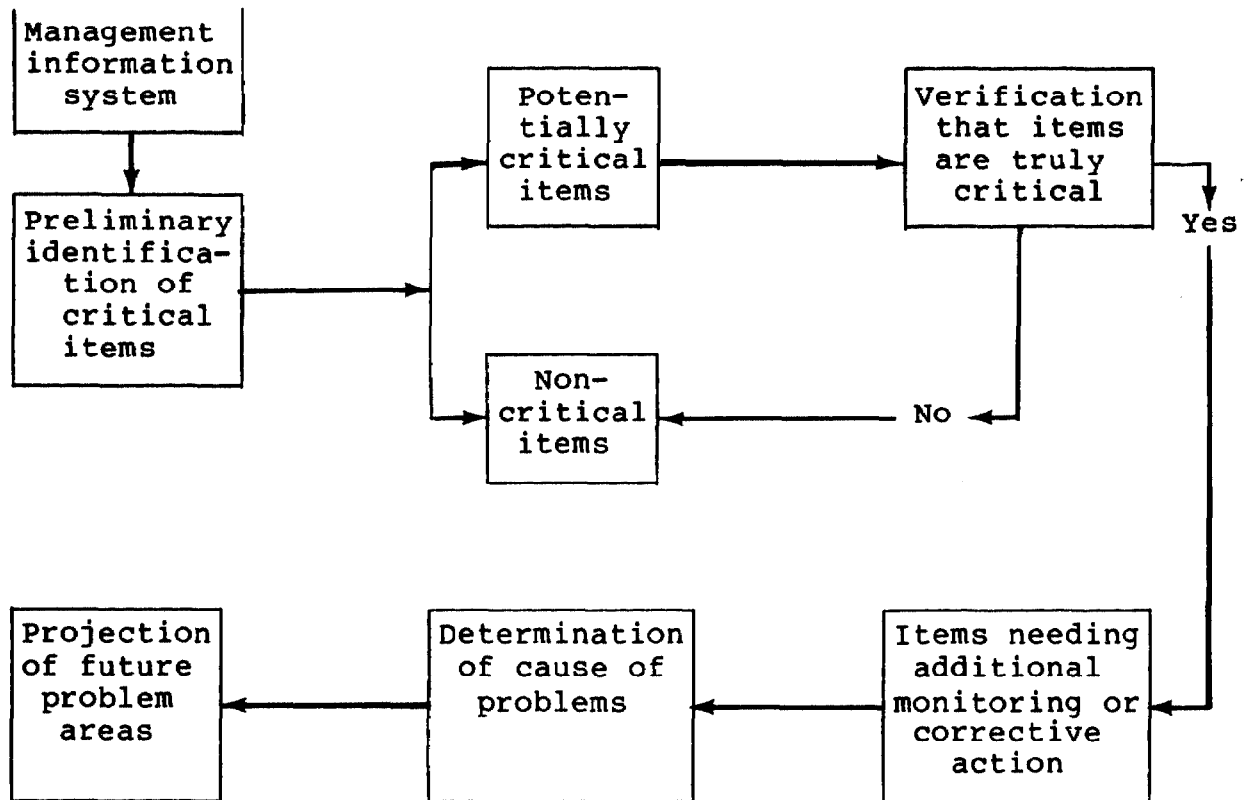
Methods may vary: in the information used to identify critical items; in the rules used to declare which items are critical; and in how the cause of a DIB problem (a production constraint) is determined. For this study, the General Accounting Office developed a general approach to assessing DIB capability, diagrammed in figure 5 on the next page. With this method, data from information systems (typically drawn from the higher tiers of the DIB) are used to make a preliminary identification of critical items. By itself, such information is insufficient to determine critical items, as past experience has shown. Because the large number of components and materials needed for weapon systems will quickly overwhelm any approach that requires detailed examination of all items, a quick, easy approach is needed for preliminary identification.

Thus, components and materials are divided into the two categories, potentially critical and noncritical items, permitting a more detailed analysis of the relatively small number of the former. During this phase, the correctness of the earlier judgments is reconsidered and the causes of current or potential production problems sought.

When an assessment of the future capability of the DIB is desired, one further step is required. Production problems are

Figure 5

General Approach for Assessing
DIB Capability



projected to the future by looking at current and potential constraints in view of projected defense requirements.

By reviewing DOD procedures for assessing the DIB, we determined that current methods are not satisfactory, confirming the need to develop an improved methodology. The next sections discuss key elements of our method for assessing the DIB and how the method was developed.

DEVELOPING A METHOD FOR ASSESSING
CAPABILITIES OF THE DIB

This section briefly describes the three key elements (vertical analysis, horizontal analysis, and future production analysis) of our improved methodology for assessing DIB capability (more detail is presented later in the appendix.)

Vertical analysis has two main purposes: to identify critical items and their associated contractors, and to identify production constraints. For each contractor identified as producing a critical item, a horizontal analysis is conducted of all weapon

systems, components, or materials produced by that contractor that require the same or similar components as those identified in the vertical analysis as critical and that may constitute competing demands.

Future-production analysis then combines what has been learned from the vertical and horizontal analyses with estimates of future demand by the services, as identified in the Five-Year Defense Program. Through this analysis, potential production bottlenecks can be identified before they occur. If a large number of weapon systems are reviewed, the new method can give a more complete picture of the demands on the DIB and the production capability to meet these demands.

Genesis of the new method

In a document prepared for the Industrial College of the Armed Forces in 1981, the basic theory of a horizontal-vertical framework was presented.¹ The context was of a lead-time/critical-path methodology. Critical path refers to the sequence of activities in a production process that requires the most time, thus determining the overall production time. By identifying items involved in the critical path, it is asserted, the critical items are identified, where reducing component lead time can reduce overall system lead time. The theory embodies the idea that lead times are the common thread by which DIB capacities can be measured. The authors state that:

"In addition to their adverse impact on our ability to achieve our near term readiness objectives, the lead time increases experienced in the past few years also have seriously degraded our already limited capability to expand production rapidly to meet projected surge and/or mobilization requirements. Therefore, lengthening lead times can be regarded as universal indicators of more deep-seated problem areas. They are a singularly important common thread that can be used to link the near term readiness, surge and mobilization areas into a related whole for analysis and management purposes."²

Additionally, the concepts behind vertical and horizontal analyses are set forth in Army Regulation 700-90. Vertical planning is called for on each critical assembly, component, or product. This planning relies on the prime contractor to provide data, identify problems, and take corrective actions, as well as

¹Fedorochko, William and Edward V. Karl, A Contemporary Approach to Three Real World Problems: Near Term Readiness, Surge, and Mobilization, Industrial College of the Armed Forces, Class of 1981.

²Fedorochko, 1981, p. 33.

to nominate lower tier contractors for questioning on their production capabilities. Vertical planning extends tier by tier, until plans are developed for all critical subcontract items.

Major subordinate commands of the Department of the Army Materiel and Readiness Command are responsible for horizontal planning; they must insure consistency among all subcontractor planning from different sources producing the same end item. Further horizontal planning, measuring the total domestic capacity against total services' requirements, is necessary.

The Army program's heavy reliance on data from DD 1519 for crucial inputs is a major shortcoming. The program suffers from the inherent problems associated with DD 1519 data, described elsewhere in this report. Further, it relies mainly on prime contractors for data collection; no true horizontal analysis is conducted. Thus, there are again data gaps and accuracy problems.

Our methodology builds upon and extends the earlier work on the vertical-horizontal concept. As a consequence, both procedural and data differences exist between the earlier efforts and our method. Procedural differences occur, for example, because of the criteria we use to classify components or materials as critical, the method of data collection, and the type of data verification used. Data differences occur because we collected different types of data from different sources. For example, the method as we define it collects both generic plant data and data specific to critical items. It attempts to measure current output and capacity, costs, lead times, and vendor problems.

VERTICAL ANALYSIS

The purpose of vertical analysis is to identify critical items and their associated contractors and production constraints. Critical items are components or materials likely to be associated with delays, inferior quality, or cost increases in production of a weapon system. The steps an analyst takes in the vertical analysis of a weapon system are diagrammed in figure 2 of the text of this report and discussed below. An example of how the vertical analysis process might be applied to the Phoenix missile system appears in figure 3.

Step 1. Gather data from appropriate DOD and Department of Commerce officials through interviews to determine what information exists about production problems within the DIB, at the weapon-system level or at lower tiers of procurement. Material obtained might include, for example, special studies by the services on the potential of contractors to surge their production of weapon systems. Collecting such information immediately precedes site visits to defense contractors.

Step 2. Mail a data-collection guide (see appendix VIII) to the prime contractor. Follow this with a site visit to obtain documentation to complete the data-collection instrument and

conduct semistructured interviews with local government representatives and contractor officials. First contact the appropriate service representative (if there is one) responsible for monitoring production activity. This may be an Air Force plant representative officer, a technical representative, or the service manager of production. Also visit the representative of the Defense Contract Audit Agency (DCAA), if present at the site. Identify any studies these government representatives may have completed or may have on-going. Ask them to provide a list of items on the weapon system they consider critical, allowing them to use their own judgment as to what makes an item critical. Later compare this data to lists developed by other means to determine where similarities and differences occur.

Next, collect data from and interview contractor's officials. In the example used in figure 3, this meant interviewing Hughes Aircraft project management officials. Gathering documentation on generic data (covering company-wide operations) and system and component data permits a better understanding of how the system or item being examined fits into the overall operation of the contractor, as follows:

- o Generic data includes information on the contractor's organizational structure, physical-plant size, productive capacity, and sources for additional information. In our example, this would include data about Air Force plant no. 44, where the Phoenix and several other missiles are produced, and data specific to the Phoenix missile itself.

- o Data specific to the universe of components for the individual weapon system are necessary to determine which of these components and materials are most critical in producing the system. Included are production levels, number and type of employees, unit cost, lead times, amount of subcontracting, identification of foreign-source items, scrap and rework rates, identification of rare ores or minerals, late delivery history, and examples of actions taken by the firm to overcome or anticipate potential shortages or production problems.

Finally, observe firsthand the production of the system or component by means of a "walk-through" of the plant floor. This may provide additional understanding of such matters as how the item is built or assembled, employee activity, levels of scrap or rework items, the method of inventory control, limits in productive capacity due to one or more "bottleneck" machines, the amount of testing equipment present, and how item testing is performed.

Step 3. Define the universe of components and materials for the weapon system (also the first step in performing the critical-item analysis). Using data already collected, establish the universe of components and materials as much as possible at this point without collecting data from subcontractors. This is usually done by reviewing company documents, such as indentured parts lists,

that identify all components purchased and provided by the contractor for assembling the weapon system.

Step 4. Use this data to identify critical components by applying the following criticality criteria:

- a. Long and/or growing lead times for production and delivery,
- b. High unit-cost and/or large cost-growth over time,
- c. Dependence for production on a small number of contractors,
- d. Reliance on a foreign source for production of components or materials, or
- e. Evidence of prior production problems or constraints, such as late deliveries.

Analyze both present and historical lead times to identify critical items; part of the reason for long lead times may be competing orders for similar components, which result in bottlenecks and extended queue time. Also, the growth in lead times over a period, such as five years, may indicate a worsening of the problem and increased production constraints.

What constitutes a long lead time? This is relative--there is no absolute figure. First list component and material data in descending order of lead time, then examine the data for natural groupings or "breaks." For example, for the TOW missile, the initial cut-off point for selection of critical items to be examined further was 52 weeks' lead time. In contrast, for the Phoenix missile, the initial cut-off point was 22 weeks' vendor lead time.

Costs of components are considered similarly. If demand exceeds supply, high unit-costs may initially result; this may subsequently induce additional production.

Analyze contractor records to determine which items are produced by a sole vendor or a few sources. If numerous sources are available, capacity may be higher and more responsive than if total reliance is placed on one supplier. Because extended time may be necessary to qualify additional sources, the availability of multiple sources can indicate a "warm" base, that is, readily available additional capacity.

Prime contractors' vendor lists (with addresses) sometimes reveal components or materials that are produced by foreign companies. In other cases, the identification is not so straightforward, since foreign firms may have U.S. mailing addresses or distribution companies. In these cases, only through follow-up interviews with the subcontractors can these foreign dependencies be identified.

Finally, look for evidence of prior production problems in contractor records and interviews with contractors and service representatives. Such events as late delivery of items to the contractor from the subcontractor and product failure during testing are indications of potential criticality.

The large number of components and materials for many of the systems make a two-step screening process necessary:

a. Collect comprehensive lead-time and cost data on as many components and materials as is feasible. Choose one to two dozen items with the highest cost and longest lead time for initial consideration (the actual number will vary, depending upon where natural breaks occur in the data). To this list, add any additional items identified as critical by the service representative, DCAA official, or contractor.

b. Gather additional data on the above items, including 5-year historical data, on such factors as lead time, unit costs, and prior production problems. Analyze the data set to select a few items for further data collection by visits to subcontractors.

After the criticality criteria were applied to the components and materials used to produce the Phoenix missile, as shown in figure 3, a number of critical components were identified. These included the servo mechanism, gunn effect oscillator, skin guidance section, and others.

Collect additional data on the critical items to determine the production constraints that may be making them critical. Gather further data on the production history of the critical items and analyze the data in depth. Collect detailed data to help explain why lead times or prices are high and/or increasing and why any late deliveries have occurred. (More information is collected on these items during site visits to their producers as the next part of the vertical analysis.)

Step 5. If an item is deemed critical, start again at Step 2 and perform the vertical analysis again on the second procurement tier. If the item is determined to be noncritical, no further analysis is performed.

Data collection continues at tier 2 of the production process. For example, as shown in figure 3, we visited Watkins-Johnson to examine production of the gunn effect oscillator. At this time, we also gathered information about the oscillator from DOD headquarters and the government plant representative (although there may be no plant representative for a subtier contractor). Then, we collected data from the management of Watkins-Johnson (producer of the gunn effect oscillator) and applied the criticality criteria (step 4) to the components of the oscillator. From this analysis, we identified a number of critical components for the oscillator, including the varactor and diode gunn effect produced by Microwave Associates. Continuing the vertical analysis, this

dictated a visit to Microwave (the producer of the critical items shown). This continued, with uniform data-collection at each plant, until in the judgment of the analyst, the current or potential critical items were identified, and no additional components or materials were critical item candidates.

HORIZONTAL ANALYSIS

The main purpose of horizontal analysis is to identify competing demands for production resources. Briefly, for one contractor, the steps in horizontal analysis (discussed more fully in the following pages) are as follows:

1. Determine past and current production levels of the weapon system or component/material and the competing demands for production resources from DOD and the civilian sector.
2. Determine the contractor's plans for expansion.
3. Identify new production constraints.

For each prime contractor or subcontractor, competing demands can be requirements for identical systems or components, similar systems or components, or dissimilar systems or components that might pull productive resources away from the item under consideration. For example, vertical analysis as applied to Pratt & Whitney involved as a first step identifying items produced, not just for a single service, but also for the other military services and the civilian sector (see table 10). As the first step in horizontal analysis of P&W's production of the F100 aircraft engine, we identified other engines (as shown) that the contractor also produced and that competed for its production capacity.

Table 10

Example of Competing Demands:
Pratt & Whitney Production of F100 Aircraft Engine,
1984-88

Competing engines	
Defense use	Civilian use
J52408	JT8D
J52P8B	JT9D
TF30P414 W/AB	PW2037
TF30P414 L/AB	PW4000
TF33PW100	

Though horizontal and vertical analyses are conceptually distinct, the search for competing demands is embedded within the vertical analysis. Beginning with the prime contractor, horizontal

analyses are conducted for contractors at each tier, as critical items are traced down through the various levels. For each contractor and subcontractor, a horizontal analysis will produce results of the kind shown in table 10. The data collection and analyses of competing demands are done at the time of site visits made for the vertical analysis.

Horizontal analysis is conducted only for items produced by contractors working on the weapon system in question. No attempt is made to determine the ability of other firms in the DIB to produce the item. For example, when we determined Pratt & Whitney's levels of production of engines for the F100 and other military and commercial aircraft, we did not identify other contractors producing or capable of producing aircraft engines to meet the demands of the economy or DOD. We restricted the analysis to the single contractor because of our resource constraints; correspondingly, our conclusions were similarly constrained. If this method were applied, however, to all defense contractors or all contractors for a particular item, such as aircraft engines, a more complete and generalizable picture of the overall capability of the DIB to supply this item could be formed.

The various steps of horizontal analysis are detailed below:

Step 1. Determine production levels and competing demands. This step links to the search for production constraints in the vertical analysis, in that both steps attempt to measure the demand for an item and the ability of the producer to supply it. (For example, we examined the capability of Pratt & Whitney to produce F100 engines.)

During step 1, we collect two additional pieces of information to use in the future-production analysis: the proportion of the contractor's business accounted for by the critical item and the mix between the contractor's defense and civilian business. The higher the percentage of the contractor's capacity dedicated to producing defense goods, the greater DOD's leverage in being able to affect the priority of competing goods, should both defense and civilian customers require the same or transferable inputs.

It is more difficult to obtain data about civilian sector than military sector demands; contractors generally are more reticent to divulge information on civilian systems that could adversely affect their competitive stature. An attempt can be made, however, to identify, either through secondary data provided in company market reports or stock market submissions, civilian sector demands currently competing with defense goods for the companies' resources. For example, it can be shown that Pratt & Whitney produces four different commercial engine models in addition to its F100 and other military versions.

Step 2. Determine the contractor's plans for expanding plant capacity through interviews with company officials. Later, such information is used in the future-production analysis, where

it permits judgments about the prospects for removing production constraints that are tied to plant capacity.

Step 3. Identify new production constraints, current and potential, that stem from competing demands. Since a vertical analysis alone probably would not detect production constraints arising from competing demands, employ further analysis by looking across the full set of products that might use the same resources. In practice, of course, most of the search for production constraints, whether a vertical or a horizontal step, takes place at the same time, i.e., during the site visit to the contractor.

FUTURE-PRODUCTION ANALYSIS

The third and final element in assessing DIB capability is identifying the future demand for the weapon system and judging contractors' capabilities to meet this requirement. In theory, the results of a complete application of GAO's new method could be used to estimate the ability of the DIB to produce a given weapon system over some future time period. That is, as critical suppliers are identified for items at current production levels, an examination of those companies' future requirements (shifting both up and down) could give an indication of whether any production problems will be exacerbated or diminished. Future-production analysis aims to foresee the production problems of delays, inferior quality, and cost increases that may occur unless action is taken.

Future-production analysis involves three steps:

Step 1. Estimate future levels of production of the weapon system. This is done by gathering data on the levels planned by DOD in the Five-Year Defense Program (FYDP). While we realize that the outyear planning levels contained in the FYDP frequently change and often do not later correspond to actual production levels, this DOD planning document can be used for at least initial analysis of future DOD demands on the DIB.

Step 2. Determine contractors' expectations for future changes in demand for products that compete with the weapon system. This is accomplished by working with the contractors to review their mechanisms for forecasting potential sales. Such forecasting mechanisms range from an internal computerized system for calculating future sales expectations to direct negotiation with DOD where defense-related sales made directly to a service are a major proportion of sales. Whenever possible, review data on sales expectations. As some firms do not routinely calculate and store these data, only estimates from sales managers may be available. Nonetheless, this is an important step: not only is the demand level for the weapon system or component under consideration at this time, but also the company's expectations of its overall future production. More specifically, expectations for systems or components that directly compete with the one chosen for analysis can be determined.

Pursuing the Pratt & Whitney example (table 10), information was gathered, not only on the 1984-88 expected production levels for the F100 engine, but also on the other aircraft engines, civilian and defense, that P&W produces.

The expected production for five other defense-related aircraft engines and four with civilian applications, added to the F100 demands, could be analyzed in light of any plant expansions planned by the contractor.

Estimates of future production in our analysis follow the same structure as for current production, emphasizing peacetime demand, with surge and/or mobilization demands only peripherally considered. Estimates of peacetime future demand, as presented in the FYDP, and of peacetime contractor production form the basis for the future-production analysis.

Step 3. Assess the contractors' abilities to meet future requirements by judging the effect of potential production constraints. By matching data on current constraints with estimates of future increases or decreases in demand, estimate the likelihood that future production requirements can be satisfied. This assumes that peacetime conditions continue, and no national emergency-type measures are taken to mitigate constraints. Also factor in judgments of contractors' probable responsiveness to future requirements, basing this on the information collected about possibilities for plant expansion and the mix of weapon system business with other products.

DATA COLLECTION METHODS AND VERIFICATION

Actual application of our analytical methods described in this appendix relies heavily on site visits to defense contractor plants. Through such visits, information is collected to complete and lend background support to the structured data-collection instrument (a questionnaire, reproduced in appendix VIII). Review of contractor financial, production, and employment records is necessary to verify the accuracy of the data collected. Doing a cross-check of contractor records illustrates why a standard data-collection instrument is necessary. For example, lead times or unit costs of components or materials as reported by the prime contractor can be checked against same figures reported during site visits to the subcontractor producing those components or materials. Any discrepancy in the data reported by the two contractors should be analyzed to determine its cause.

Part of the on-site visit process is a review of the information available from on-site service representatives. While we do not assume nor require any particular management system to be applicable, nonetheless, it is important to review whatever service information is available, how it is used, and how the weapon system is managed. This is important, because current information systems or any new systems likely would rely on the service representatives for implementation.

CONTRACTORS AND SUBCONTRACTORS VISITED

<u>System or component</u>	<u>Tier 1 prime contractor</u>	<u>Tier 2 subcontractor</u>	<u>Tier 3 subcontractor</u>
F100 engine	Pratt & Whitney	Bendix Ladish	Garrett Pneumatics
Global positioning system	Rockwell International		
Harpoon missile	McDonnell Douglas	Texas Instruments Lear Siegler IBM Northrop	Cercast
M1 tank	General Dynamics	Hughes El Segundo Bendix Singer Kearfott Detroit Diesel Allison Standard Products Synder Industries Cadillac Gage AVCO	Santa Barbara Research Center Hughes Carlsbad Santa Barbara Applied Optics
Phoenix missile	Hughes Aircraft	Textron Marquardt Reisner Sherman Northrop Zeta Labarge Alcoa Varian Watkins Johnson Microwave Cercast	ArtVic Corona Forge Cercast Microwave Associates Hi-Rel Microwave
TOW2 missile	Hughes Aircraft	Timex Canrad Hanovia Mason and Hanqer	

BACKGROUND

This details the objectives of our assignment and our estimate of the types of information needed in our visit to . The information, for the most part is specific to the . It is hoped that making you aware of our data needs in advance will minimize any inconvenience our visit may cause you and your staff.

The term Defense Industrial Base (DIB) generally refers to the sum total of business firms producing products or services that eventually support the production of equipment (or services) purchased by DOD. This often used term, the DIB, is a handy generic descriptor which implies the existence of structural or organizational homogeneity and a more or less dedicated or captive core of productive resources; this is not only misleading, it is also erroneous. The fact of the matter is today's defense industrial base is a many-tiered, heterogeneous mixture of private sector and government-owned resources.

We have structured two objectives for this assignment. The first objective is to examine the feasibility of developing a better method for examining the capability of the defense industrial base (DIB) to meet current and projected production demands. The second objective is to demonstrate the feasibility of applying this method across the three Services (Army/Air Force, and Navy) and for diverse types of weapon systems. The latter demonstration is intended to be illustrative, not comprehensive.

Two characteristics of a better method for examining DIB capability are more accurate estimates of problem areas and providing information that would allow the Department of Defense to anticipate and correct DIB problems for items proposed for funding in the Five-Year Defense Plan.

The methodology chosen for this assignment is a vertical-horizontal analysis method as tested by selected case-studies. Vertical analysis traces the flow of subsystems, components, and raw materials through the various levels of subcontractors and suppliers who are responsible, together with the prime contractor, for production of all elements of a weapon system. Horizontal analysis looks across one contractor or subcontractor to analyze the full extent of relevant weapon systems or components or materials that are produced and require the same or similar components as those identified in the vertical analysis as pacing. In this way, we will discover for these case studies the DIB's capacity to produce critical pacing items. We will use lessons learned and analytic techniques developed in our evaluation of past DIB problems and apply them to an assessment of the DIB's capability to produce some weapon systems programmed in the Five-Year Defense Plan.

LIST OF GAO QUESTIONSGeneric Plant Data

1. What is the organizational structure of your company? (If available, please provide a copy of your organizational structure).
2. How many separate plant facilities does your company operate? (If more than one, please provide a list of the facilities.) # _____
3. What is the size of each physical plant?
 _____ sq. ft. _____ sq. ft. _____ sq.ft.
4. Do you anticipate any significant increase or decrease in plant capacity?
 Yes _____ No _____ Explanation _____
5. What percentage of your company's total sales are your sales of the
 ? _____ %
6. How many employees do you have? (If possible, please state the number by
 function.) # _____
7. Do you pre-buy materials for any defense system components? (Do you buy
 materials in anticipation of orders?) Yes _____ No _____
 If so, for which systems? If so, how are pre-buys financed?
8. Are any defense system components and/or materials obtained from foreign
 sources? (If so, please identify the components/materials by source and/or
 any co-production agreements with foreign governments.)
9. Do you have a weapon or item priority system?
10. Do you keep procurement or price history records?
11. Do you keep quote history records?
12. Is there a file on bills-of-raw material?
13. Do you sell supplies or materials to your vendors?

Component/Material/Process Specific Data

1. How many employees are directly involved in producing the
?

Administrative	_____	_____
Support	_____	_____
Engineering	_____	_____
Production	_____	_____
Other	_____	_____

2. In how many physical plants do you produce these items?
Number _____.

3. (a) How many _____ did you produce for _____ during
each of the five fiscal years 1979 through 1983?

(b) How many of each item were you capable of producing during those five
years?

	<u>FY79</u>	<u>FY80</u>	<u>FY81</u>	<u>FY82</u>	<u>FY83</u>
--	-------------	-------------	-------------	-------------	-------------

Actual production:

Potential production:

(c) What are the limiting factors? (e.g., lack of orders, raw materials,
skilled personnel, product demand, production facility limitations).

4. What are the normal tours of duty of the production of this item?

Number of shifts per day	_____
Number of days per week	_____
Number of hours per day/shift	_____

5. What percentage of your equipments' total operating capacity is used to
produce the _____? (What is your machine loading
percentage attributable to these items?)
_____ % _____ %

6. What is the normal life of your manufacturing and test equipment?

1-5 years	_____
5-10 years	_____
greater than 10 yrs	_____

7. What is the average lead time necessary to acquire manufacturing and test equipment? What can be done to accelerate availability?

8. For FY79 through 83, what were the unit costs of the
? FY79 _____ FY80 _____ FY81 _____ FY82 _____ FY83 _____

9. In terms of priorities, where does production of the
fit into your overall production schedule (i.e., versus
production of commercial or other government components)?

10. What percentage of your work on the _____ is
subcontracted?
(Please state in terms of total cost to produce for each fiscal year 1979
through 1983.)

FY79 _____ FY80 _____ FY81 _____ FY82 _____ FY83 _____

11. (a) What parts/materials/processes do you consider the most critical, in
terms of time and cost, to produce the _____ ?

(b) What methods do you use in monitoring the status of the
critical components at your plant? (If available,
please supply charts or schedules.)

(c) What methods do you use in future scheduling activities or routing
these component production milestones at your plant(s)? (If
available, please supply charts or schedules.)

12. Please provide any examples of actions taken by your company to overcome
or anticipate potential shortages or production problems in critical
materials or subcontractor/vendor produced or supplied items.

13. (a) What are the normal lead times for the _____ ?

(b) Please give the date you received your last order and the date the first item(s) were delivered.

(c) How much time is spent on the following activities in producing the ?

	<u>In-house</u>	<u>Outside</u>
Scheduling	_____	_____
Material	_____	_____
Production	_____	_____
Shipping	_____	_____

14. (a) Please provide a list of all outside parts/materials or processes used in the manufacturing of the . Please include name of the supplier/vendor, alternate source, part name, part number, quantity of last buy (by fiscal year or last order), and number used in each component/assembly

<u>Supplier/ Vendor</u>	<u>Alternate source</u>	<u>Part name</u>	<u>Part number</u>	<u>Quantity of last buy</u>	<u>Number used per component assembly</u>
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

(b) Please provide the administrative and production lead times for each part/material/process for each fiscal year 1979 through 1983.

<u>Part/Material/Process</u>	<u>FY79</u>	<u>FY80</u>	<u>FY81</u>	<u>FY82</u>	<u>FY83</u>
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

(c) For FY 79-83, what were the unit costs of the parts materials/processes used in the manufacture of the _____ ?

<u>Part</u>	<u>FY79</u>	<u>FY80</u>	<u>FY81</u>	<u>FY82</u>	<u>FY83</u>
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

15. (a) Have you had any late deliveries from suppliers?
 Yes _____ No _____

If so, do you have an accounting of them?
 Yes _____ No _____

(Please provide a copy of your last report.)

(b) Have you had any late deliveries of the _____ to
 for the _____ ?

Yes _____ No _____

If so, do you have an accounting of them?
 Yes _____ No _____

(Please provide a copy of your last report.)

16. Do you keep an in-house backup for parts produced by suppliers/vendors?
 If so, for what items?

<u>Part Number</u>	<u>Description</u>
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

17. What rare materials or ores are used in the _____ ?

18. Please identify any foreign sources of parts and/or materials used in the _____ . Do they supply items under a co-production agreement?

19. What are your scrap rates for the _____ ?

20. What are your rework rates for the _____ ?

21. Is your method of producing the _____ proprietary?
 Yes _____ No _____

22. Please list other systems that _____ are produced
 for and their buyers.

23. How would each of the following affect your firms' ability to increase
 defense production of the _____ in response to
 increased military demands?

	No problem	Moderate problem	Significant problem
Availability of skilled labor	_____	_____	_____
Availability of equipment and tooling	_____	_____	_____
Availability of materials	_____	_____	_____

24. Would any of the conditions listed below limit your firm's willingness or
 ability to devote larger amounts of productive capacity to military
 production?

	No problem	Moderate problem	Significant problem
Requirement for specialized production processes and testing for military products			
Burden of government paperwork			
Uncertain prospect of continuing volume of business			
Low profitability relative to civilian production			
Obligation to civilian customers			
Other (please specify)			

Thank you for your cooperation.

INFORMATION SYSTEMS

Before developing a new method to assess the capability of the Defense Industrial Base to produce weapon systems, the General Accounting Office deemed it important to determine what information sources already existed and what types of data they provided. Currently available systems for identifying DIB problems vary in intended use, specific information provided, audience, and applicability to GAO's study (policymakers may need different kinds of information than do government managers or contractors).

In this appendix, we identify some of the major information systems government managers now use. These systems provide, variously: general information about DIB problems; specialized indices or specific information about cost rises, lead times, or quality; and specialized information on potential problems. Some systems identify potential mobilization problems or parts affected by DIB constraints. The Department of Defense has a major responsibility to provide such data, but other government agencies and commercial companies also produce information relevant to the DIB, such as periodic reports on lead times and prices.

GENERAL INFORMATION SYSTEMS

The major way that DOD obtains information on weapon system constraints is through program management of contractors. The government service representative is responsible for and works closely with a single weapon system, overseeing its design, production, and performance.

DOD and the services also conduct or fund research studies that deal directly with production constraints in one or several weapon systems. Some generalized studies recapitulate known DIB constraints, while others evaluate capacity constraints for selected defense industries.

A few studies employ sophisticated analytical techniques, such as input-output analysis, to identify production constraints at the macroeconomic level. For example, DOD's Defense Economic Impact Modeling System (DEIMS) provides macroanalysis of the expected impact of major defense expenditures on the entire economy.

Other information systems relevant to the DIB include capacity studies and special DOD spending-impact studies done by the Department of Commerce's Bureau of Economic Analysis (BEA). Also, the Congressional Budget Office (CBO) reports monthly on the impact of DOD spending on the economy and periodically on DIB constraints. CBO's reports identify generalized changes in price level and lead time based on input from DOD and commercial sources.

COST-REPORTING SYSTEMS

Several cost-reporting systems provide information on cost estimates and price changes for specific weapon systems. DOD's

Selected Acquisition Reports (SAR) record production and acquisition-cost information for major weapon systems for which total costs exceed \$1 billion or costs of research, development, testing, and evaluation exceed \$200 million. Where cost estimates change from one period to another, the SAR identifies the reason. The highly aggregated level of SAR cost information, however, limits analysis on an individual component and comparison between weapon systems. GAO annually summarizes SAR data.

DOD managers use price-level information to monitor the DIB; watching for, say, rapid price rises that serve as flags to identify problem areas. For example, price changes for certain commodities, such as electronics and some raw materials, significantly affect DOD procurements. Prices of several-thousand commodities are listed in the Producer Price Index (PPI), published by the Department of Labor's Bureau of Labor Statistics (BLS).

LEAD-TIME REPORTING SYSTEMS

Two DOD agencies GAO visited provide information on weapon-system lead times. The Navy Shipbuilding Support Office (NAVSHIPSO) publishes information on shipbuilding components, while the Joint Aeronautical Material Activity (JAMAC) concentrates on aeronautical items. Both systems collect from contractors lead-time data on several-hundred specific weapon-system components, perform some analysis, then usually publish information for groups of items, rather than specific parts.

QUALITY REPORTING SYSTEMS

Systems that report on the ability of selected weapon system components to meet quality standards help managers identify serious quality problems. DOD's centrally managed Government Information Data Exchange Program (GIDEP) allows the services to exchange technical data from engineering reports, reliability-maintainability data, methodology information on testing systems, and failure information generated when significant problems are identified. No classified or proprietary data are included.

Another system, the Air Force's Contractor Management Systems Evaluation Program (CMSEP), can evaluate a contractor's management system in an attempt to detect or prevent deficiencies in cost, schedule, or performance. CMSEP is broken down into nine functional areas, including engineering, industrial material management, quality assurance, etc., and uses various management-system indicators. Evaluators review the contractor's system for the policies and procedures used to implement production; completeness and accuracy of documentation required by the contract; and whether the contractor is complying with the documented procedures.

If, in checking the contractor's operation against the management-system indicators, a deficiency is found, the evaluator completes a deficiency record, stating where the flaw occurred. Air Force and contractor representatives then discuss the matter

informally. If no accord is reached, a deficiency report is filed. The contractor then must respond with an action plan to address the situation, after which the Air Force monitors progress on the plan.

MOBILIZATION REPORTING SYSTEM

DOD devotes significant efforts to identifying the country's capability to rapidly increase defense production and to assigning priorities to production of weapon systems. If lead times become excessive, DOD uses these priorities to allocate scarce resources at contractor plants. By compiling information from industrial preparedness planning documents (DD form 1519s), the services attempt to identify contractors' capabilities to significantly increase production of weapon systems or components. Also, a service may ask contractors for additional reports on their production planning efforts.

The Master Urgency List also presents information on production capabilities and potential constraints, as well as assigning priorities to weapon systems for receipt of scarce production resources.

PARTS IDENTIFICATION SYSTEMS

For long-standing defense-production problems, there are information systems to identify parts that may be affected. The Department of Commerce prepares information concerning parts supplied by foreign vendors, while the Defense Logistics Service Center (DLSC) compiles parts' information, including sources of supply, for its data base, the Federal Item Identification Guide.

The Troop Support and Aviation Readiness Command (TSARCOM) is experimenting with generic coding of lead times, specifying selected items by critical material, industrial process, and skilled labor category. TSARCOM representatives believe this coding will allow quick identification of potential problem items. For example, should a large shortage of titanium forgings occur, TSARCOM's data base could be used to identify the items affected.

GENERAL INFORMATION ABOUTGAO'S CASE-STUDY WEAPON SYSTEMS

To collect information about the six weapon systems chosen for its report on assessing defense production capabilities and constraints, the General Accounting Office used the case-study approach. This required visits to the prime contractors responsible for the systems, the government agencies responsible for monitoring their manufacture, and selected subtier contractors who supplied components to the prime contractors.

For each weapon system, this appendix provides a system description, information on funding, and estimates of current and future production. We also include references to other recent GAO reports on these weapon systems.

The Department of Defense provides in its Selected Acquisition Reports quarterly information on quantities, unit and total estimated costs, and appropriations to date for all weapon systems, information that GAO summarizes in an annual report to the Congress. Pertinent information on five of the GAO's six case-study systems appears in table 11. (Information is not provided for the F100, as it is not a complete weapon system.)

PHOENIX MISSILE

A pulse-doppler, radar-directed, air-to-air missile with a 100-mile-plus range, the AIM54 Phoenix is used solely for point defense on carrier-baseable F14 fighters. As the primary, fleet-defense, long-range armament for the F14 Tomcat fighter, this missile has been operational with the U.S. Navy since 1974. Its successor, the AIM54C, now in production to meet airborne threats through the 1990's, is one of the world's most technologically advanced tactical missiles.

The Phoenix is the only missile that can be launched from an aircraft in multiple numbers with each missile aimed at a different aerial target. With low induced drag, tail controls, and a long-burning-time, solid-rocket motor, the Phoenix's mission is to be launched at long-range against small, highly maneuverable targets, as well as larger, high-speed threats. The missile is to be effective against high-performance fighter aircraft at any altitude, cruise missiles, and supersonic bombers, all in the presence of sophisticated countermeasures.

Selective upgrading of individual units and components improved the design of the Phoenix. It now has a new digital-electronics unit, inertial-navigation reference system, and a solid-state radar transmitter. These give the new Phoenix greater range, accuracy, operating flexibility, and reliability.

At 1,008 pounds, the Phoenix AIM54C missile is 13 feet long and 15 inches in diameter, with a 3-foot wing span.

The 133-pound warhead is detonated by proximity or impact fuse.

Hughes Aircraft Company produced the missile in Air Force plant no. 44, a government-owned, contractor-operated facility in Tucson, Arizona. An Air Force plant representative and a Navy technical representative, both located in the plant, monitored the work. After our audit was completed in June 1984, the Navy suspended acceptance of Phoenix missiles at Hughes because of quality-control problems. In May 1984, prior to delivery suspension, the Navy decided to seek a second assembly source based on financial considerations.

Table 11
Selected Growth Information
on Cost and Quantity of Five Weapon Systems^a

<u>Estimates</u>	<u>Weapon system</u>				
	<u>M1 tank</u>	<u>TOW missile</u>	<u>Phoenix missile</u>	<u>Harpoon missile</u>	<u>NAVSTAR GPS</u>
Quantity					
Initial	3,323	3,364	735	4,324	4
Current ^b	7,071	6,699	2,680	3,405	40
Unit cost (thousands)					
Initial	\$ 904	\$ 122	\$ 632	\$ 248	\$32,975
Current ^b	2,760	330	1,159	1,029	58,350
Total cost (thousands)	19,517.1	2,207.4	3,105.2	3,505.2	2,334.0
Appropriations made	3,548.0	^c	1,483.1	1,379.1	589.4
Needed to complete	15,969.1	^c	1,622.1	2,126.1	1,744.6
Percent appropriations made	18.2	^c	47.8	39.3	25.3

SOURCE: U.S. General Accounting Office. Status of Major Acquisitions As of September 30, 1982, GAO/NSIAD-83-32. September 7, 1983.

^aNo comparable information is available for the F100 engine, as it is not a weapon system, but a component of the F15 Eagle and F16 Falcon fighter aircraft.

^bAs of September 30, 1982.

^cGAO does not compile appropriations' information for the TOW missile, which is nearing the end of its production run.

Funding for development and procurement of the Phoenix missile between fiscal years 1982 and 1985 is shown below:

	Fiscal year			
	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>
<u>Phoenix</u> <u>AIM54A/C</u>	<u>Actual</u>	<u>Planned</u>	<u>Proposed</u>	<u>Proposed for</u>
	<u>funding</u>	<u>funding</u>	<u>funding</u>	<u>authorization</u>
Development:				
\$ million	31.5	22.8	4.0	-
Procurement:				
Quantity	72	108	324	265
\$ million	162.6	260.7	454.6	^a

^aTo be determined.

In May 1983, Hughes was producing 10 to 12 Phoenix missiles a month, which was about 70 percent of the available capacity of 14 to 16 missiles. At that time, Hughes planned to increase available capacity to 20 per month by October 1983. Proposed annual production for fiscal year 1985 is 265 missiles, an average of 22 per month.

From the early stages of the pilot production contract, Hughes has been behind schedule in delivery of the AIM54C Phoenix missile. Technical problems and unavailability of one component due to low test-yields during pilot production caused the delays. Slippage in the pilot program carried over somewhat to other years.

TOW MISSILE

The tube-launched, optically-tracked, wire-guided (TOW) missile is the Army's heavy assault weapon against such targets as tanks, armored personnel carriers, and bunkers. Since its initial deployment in 1970, the Basic TOW has undergone two major improvement programs: in the first, I-TOW, an improved warhead was developed; in the second, TOW2, more extensive modifications included a heavier warhead and improved propellant and guidance system.

All versions of the TOW system operate essentially the same. Holding the sight crosshairs on the target, the gunner launches the missile. The infrared tracker in the launcher, sensing radiation from the source in the missile, detects any deviations from the gunner's line of sight to the target. Computer-generated commands, sent to the missile through two fine wires, bring it back onto the gunner's line of sight to the target.

The Army TOW missile is assembled by Hughes Aircraft Company's Missile Systems Group at its Tucson Air Force plant no. 44, which we visited. Tooled up in May 1983 to produce a mix of 3,500 I-TOW

and TOW2 missiles per month, the group actually produced a maximum of 2,500 TOW2's. This was sufficient to meet maximum peacetime procurement objectives of 1,709 TOW2's per month, or 20,510 annually.

Beginning in fiscal year 1984, however, the Army requires TOW2 missiles almost exclusively. A limited number of basic and I-TOW missiles will be produced. The President's fiscal year 1984 budget calls for spending \$1.2 billion for TOW2's over the next 5 years. Production data by program year and model appear in table 12.

Table 12

TOW Missile Production Estimates
(no. of missiles)

<u>Program (fiscal) year</u>	<u>Model</u>			<u>Total</u>
	<u>Basic TOW</u>	<u>I-TOW</u>	<u>TOW2</u>	
1979 ^a	20,397	-	-	20,397
1980 ^a	6,555	9,346	-	15,901
1981 ^a	2,016	11,024	3,875	16,915
1982 ^a	4,586	12,670	11,549	28,805
1983 ^a	1,222	7,222	14,315	22,759
1984 ^b	129	3,600	22,400	26,129
1985 ^b	1,760	3,976	15,839	21,575
1986 ^b	-	-	19,510	19,510
1987 ^c	-	-	15,164	15,164
1988 ^c	-	-	29,510	29,510
Totals	<u>36,665</u>	<u>47,838</u>	<u>132,162</u>	<u>216,665</u>

^aActual production

^bOn order as of February 1985

^cPlanned production

M1 ABRAMS TANK

The Army's main battle tank for the 1980's and 1990's, the M1 Abrams tank is its most expensive weapon-system acquisition now planned. Development occurred during most of the 1970's, reaching relatively full production at 60 monthly in November 1982. Ultimately the Army plans to acquire 7,058 tanks at a March 1983-estimated cost of \$23.1 billion.

A fully tracked, low-profile, land-combat, assault-weapon system, the M1 tank possesses armor protection, shoot-on-the-move capability, and a high degree of maneuverability and tactical agility. It allows the four-man crew to engage the full spectrum of enemy ground-targets with a variety of accurate point and area fire weapons.

The M1 has demonstrated greater combat capabilities than the currently deployed M60 series of tanks. Crew survivability is greatly improved through a new type of armor, compartmentalized storage of fuel and ammunition, and an automatic system for fire extinguishing that protects crew and engine compartments. With new stabilization and thermal-imaging systems, the M1 can acquire and fire at targets in darkness as well as in daylight. Its lower silhouette adds to the M1's survivability, as do the high speeds and agility made possible by its 1,500 horsepower turbine engine and advanced torsion-bar suspension. As of 1984, the tank was to be modified for chemical, neurological, and nuclear warfare. A more lethal 120-mm gun was to replace the current 105-mm gun, and the armor further improved.

General Dynamics Land Systems (GDLS), which bought the former Chrysler tank operations in March 1982, assembles the M1 weapon system. Currently, the M1 tank is assembled in two interdependent plants in Lima, Ohio, and Warren, Michigan. In addition, the Warren facility fabricates suspension components and the Lima facility, hulls and turrets for both plants. The first M1 tanks were delivered from the Lima facility in February 1980, and from the Warren facility in March 1982.

At 70 tanks monthly, production levels when we did our study represented a compromise between initial plans for an ultimate goal of 90 and recent production levels of 60. Funding constraints, however, dictated the less-than-fully desired levels. The Army's most recent production plans by program year and model appear in table 13.

Since 1978, the General Accounting Office has issued six reports relevant to the M1-tank weapon system:

- Comparative Life Cycle Cost: A Case Study, PSAD-78-21. Washington, D.C.: August 16, 1978.
- Major Deficiencies Disclosed in Testing of the Army's XM1 Tank Warrant Slower Production, PSAD-79-67. Washington, D.C.: April 16, 1979.
- XM1 Tank's Reliability Is Still Uncertain, PSAD-80-20. Washington, D.C.: January 29, 1980.
- Late Fire Control System Deliveries for Army's M-60A3 Tanks Jeopardize Combat Readiness Improvements, LCD-80-79. Washington, D.C.: June 30, 1980.
- Logistics Planning for the M1 Tank: Implications for Reduced Readiness and Increased Support Costs, PLRD-81-33. Washington, D.C.: July 1, 1981.
- Large-Scale Production of the M1 Tank Should Be Delayed Until Its Power Train Is Made More Durable, MASAD-82-7. Washington, D.C.: December 15, 1981.

Table 13M1 Production Levels and Estimates
(no. of tanks)

<u>Program (fiscal) year</u>	<u>Model</u>			<u>Total</u>
	<u>M1</u>	<u>M1 extended^a</u>	<u>MIEI</u>	
1979	90	-	-	90
1980	309	-	-	309
1981	569	-	-	569
1982	741	-	-	665
1983	-	114	-	855
1984	-	780	60	840
1985	-	-	840	850
1986	-	-	720	720
1987	-	-	720	720
1988	-	-	720	720
1989	-	-	730	730
Totals	<u>2,374</u>	<u>894</u>	<u>3,790</u>	<u>7,058</u>

^aThe M1 extended tank represents an effort to use armor improvements on the M1 tank.

HARPOON MISSILE

An all-weather, sea-skimming, antiship missile with a range in excess of 50 miles, the Harpoon is deployed world-wide aboard U.S. Navy and allied surface ships, submarines, and aircraft. It is expected to be the mainstay of any antiship capability through the 1990's.

Targeting data for the Harpoon is provided by its command and launch subsystems. After launch, the missile is directed by a mid-course guidance system with no inputs from the launching platform. When the target comes within the search area of the active radar seeker, the seeker detects and "locks-on" to the target until the missile strikes.

The McDonnell Douglas Astronautics Company (MDAC), a component of McDonnell Douglas Corporation, produces the Harpoon missile and launch subsystems. For calendar year 1982, out of total sales for MDAC's St. Louis Division of about (percent) was related to the Harpoon missile and launch subsystems. This included foreign military sales.

Suspension of Harpoon deliveries to Iran resulted in MDAC accumulating a pool of about 205 Harpoon missiles and various quantities of Harpoon launch kits, warheads, etc. Although part of the pool was used to meet U.S. and foreign requirements, about 120 missiles remained as of May 1983. Consequently, MDAC had a stockpile

of Harpoons that could be used to meet an unanticipated surge in missile demand or production problems.

Harpoon production deliveries started in calendar year 1975. Through May 1983, MDAC had delivered 2,645 missiles. The fiscal year 1983 basic contract awarded to MDAC in March 1983 for \$215.5 million included the purchase of 384 missiles (231 for the Navy and 153 for foreign countries). Production estimates for fiscal years 1984 through 1987 are as follows:

<u>Fiscal year</u>	<u>Estimates by</u>	
	<u>MDAC</u>	<u>DOD</u>
1984	437	-
1985	524	354
1986	500	360
1987	425	290

GAO has issued one study of the Harpoon missile. Issues Affecting the Navy's Antiship Cruise Missile Programs, C-MASAD-81-11, Washington, D.C., February 28, 1981.

F100 ENGINE

Designed by Pratt & Whitney, the F100 turbofan engine powers the Air Force's F15 Eagle and F16 Falcon fighters with about 24,000 pounds of thrust, providing an 8:1 ratio of engine thrust per pound of engine weight. No other U. S. engine under development will exceed this ratio, which translates into increased maneuverability in combat (e.g., the capability of turning more sharply).

Advanced technology incorporated in the engine includes higher compression ratios, a hotter turbine, electronic engine-control, and reduced-size augmentor. Future improvements may include a gear-type main fuel pump, for improved reliability over the van type, and a digital electronic engine. The F100 Engine Model Derivative (EMD) would provide for improved thrust and durability by means of an increased air-flow fan, a full-life, low-pressure turbine, and an advanced augmentor.

The engine is currently produced by the Pratt & Whitney Aircraft Group of United Technologies Corporation at its East Hartford, Connecticut, Manufacturing Division. According to a recent dual-source agreement resulting from an Air Force competition, however, Pratt & Whitney will produce 40 engines the first year and General Electric (the new contractor), 120.

Through 1982, P&W has delivered about 3,000 engines (domestic production, installations, and spares) for Air Force and Foreign Military Sales (FMS) F15's and F16s. Annual production for the

last three years has averaged 500 engines and required the services of one-fifth of P&W's 38,000 Hartford employees.

GAO has issued two studies on the F100 engine:

- Pricing of F100 Engines for the F15 and F16 Aircraft Programs, PSAD-79-50. Washington, D.C.: March 9, 1979.
- Are Management Problems in the Acquisition of Aircraft Gas Turbine Engines Being Corrected? PSAD-80-72. Washington, D.C.: September 30, 1980.

GLOBAL POSITIONING SYSTEM (GPS)

When fully operational in the late 1980's, the Air Force's satellite-based Global Positioning System (GPS) will provide continuous, reliable, and accurate navigation and positioning information world-wide, regardless of weather or electronic countermeasures. It will also provide information on nuclear detonations.

The GPS features three major segments:

- Satellites--Each includes a navigation package and integrated, operational, nuclear-detonation system, with upper-stage boosters making up the space segment, which requires 18 satellites in 3 orbital planes about 11,000 nautical miles above the earth.
- User segment--Consists of receiving and processing equipment for aircraft, ships, land vehicles, and personnel.
- Ground-control segment--Consists of stations located in various parts of the world that continuously track the satellites and correct their position with an on-board atomic clock.

In May 1983, the Air Force awarded Rockwell International's Space Operations and Satellite Systems Division of Seal Beach, California, a \$1.2-billion, multi-year procurement contract for 28 production spacecraft. Rockwell is prime contractor for the space segment.

For the control segment, International Business Machines, Federal Systems Division, Gaithersburg, Maryland serves as prime contractor. For the Air Force's portion of the user segment, the prime contractors are the Advanced Products and System Company, Electronic Corporation, Torrance, California, and Rockwell International, Avionics and Missile Group, Cedar Rapids, Iowa.

GPS has been under development since 1973. Through fiscal year 1988, the system is estimated to cost \$3.9 billion. Of this, \$2.5 billion is for the space segment, including 12 research and development and 28 production spacecraft. The ground-control

segment and the Air Force's portion of the user segment will cost an estimated \$440 million and \$935 million, respectively.

The first launch of a production spacecraft is scheduled for August or September 1986. Rockwell foresees no problems with producing the satellites within the 45 months estimated for detailed fabrication, assembly, and testing (the latter two processes taking 22 months).

GAO has issued six reports on the GPS:

- Navigation Planning: Need for a New Direction, LCD-77-109. Washington, D.C.: March 21, 1978.
- Status of the NAVSTAR Global Positioning System, PSAD-78-37. Washington, D.C.: April 25, 1978.
- NAVSTAR Global Positioning System--A Program With Many Uncertainties, PSAD-79-16. Washington, D.C.: January 17, 1979.
- Should NAVSTAR Be Used for Civil Navigation? FAA Should Improve Its Efforts To Decide, LCD-79-104. Washington, D.C.: April 30, 1979.
- NAVSTAR Should Improve the Effectiveness of Military Missions--Cost Has Increased, PSAD-80-21. Washington, D.C.: February 15, 1980.
- DOT Should Terminate Further LORAN-C Development and Modernization and Exploit the Potential of the NAVSTAR/Global Positioning System, MASAD-81-42. Washington, D.C.: September 18, 1981.

AGENCY COMMENTS

This appendix contains the reproduced letter of December 7, 1984, and its attachment from the Department of Defense, Under Secretary of Defense, Research and Engineering, which we received in response to our request to comment on a draft of this report.

The comments in the attachment referred to page numbers of our draft report; these page numbers became obsolete when we processed the draft for printing and publication. Thus, we have translated the obsolete page numbers into their corresponding page numbers appearing in the final printed report.

Our response to DOD's comments is contained in the text of this report, chapters 3 and 4.



RESEARCH AND
ENGINEERING

THE UNDER SECRETARY OF DEFENSE

WASHINGTON DC 20301-3010

7 DEC 1984

(AM)

Mr. Frank C. Conahan
Director, National Security and
International Affairs Division
U.S. General Accounting Office
Washington, DC 20548

RECEIVED

DEC 17 1984

GAO/PEMD

Dear Mr. Conahan:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "Assessing Production Capabilities and Constraints in the Defense Industrial Base," dated September 4, 1984 (GAO Code No. 97317), OSD Case No. 6606. The DoD generally concurs with the overall report.

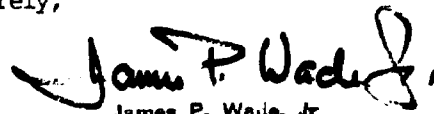
The findings of the report are consistent with the many other investigations and special studies which have taken place within the past three years. The report recognizes a number of the initiatives taken by the DoD to bring about resolution but observes that progress has been slow, given the complexity of the problems. It must be noted, however, that the DoD has concluded a number of other significant analysis efforts which postdate the GAO review.

The DoD has had difficulty understanding portions of the report due to the apparent mixing of observations on peacetime constraints and surge/mobilization constraints. Frequently, it is not clear what requirement the GAO was working against or concerned with. While these constraints are not mutually exclusive areas, the context in which each is addressed needs to be clearly described. Restructuring the final report to separate these two areas would enhance clarity and understanding.

In some instances the problems that have persisted are more symptomatic of resource commitment and allocation than any fault with the program management. In addition, the DoD is confident that its revised regulations capture the spirit and intent of the GAO report in its presentation of "matters for consideration." The DoD initiatives, however, must be pursued within the realm of reality and resource availability.

Specific comments relative to each of the report findings are enclosed. The comments include qualifications and clarifications to enhance understanding and point out actions that have been taken by the DoD, but not fully reflected in the report.

Sincerely,


James P. Wade, Jr.
Acting

Enclosure

GAO DRAFT REPORT - DATED SEPTEMBER 4, 1984
(GAO CODE No. 973176) OSD CASE No. 6606

"ASSESSING PRODUCTION CAPABILITIES AND CONSTRAINTS IN THE
DEFENSE INDUSTRIAL BASE"

FINDINGS TO BE ADDRESSED IN THE DoD RESPONSE TO THE GAO DRAFT REPORT

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- o **FINDING A: Concern Growing Over Adequacy Of Defense Industrial Base.** GAO found that concern has been growing over the past five years about the ability of the Defense Industrial Base (DIB) to meet national defense requirements. Among the factors stimulating this concern are (1) production problems such as shortages in materials and components, (2) a major shift in DoD's war-fighting scenario to emphasize conflicts of indefinite duration anywhere on the globe, and (3) the large proposed increases in Defense spending. According to GAO, these factors, together with the improving economy, pose the question whether the DIB can meet defense requirements without bottlenecks and price pressures. (pp. 1-4) ¹

DoD POSITION: Concur. While the level of emphasis and concern for industrial readiness (historically) seems to rise and fall, it is nonetheless continuously monitored by dedicated staffs within and other federal agencies. The emphasis placed on improving overall defense posture by this Administration naturally brought about revived attention to the ability of the industrial base to meet national defense requirements. The industrial base capabilities and/or problems were, to a large degree, already known and so were many of the solutions. What was missing was the commitment (at all levels) to do something about them and allocate the necessary resources. In reality, what has been documented in recent studies is, in effect, a reaffirmation of prior condition descriptions. Their utility is, however, undeniable and necessary in order to again generate the momentum required to implement the solutions. The industrial base is adequate to satisfy the DoD five-year program. However, unless there is continued support for such actions as surge investment in long lead time components and Title III of the Defense Production Act, defense requirements related to a mobilization will most likely encounter limitations and bottlenecks.

- o **FINDING B: DIB Faces Six Major Constraints.** GAO's review of major studies of the DIB showed that among the direct and indirect constraints on the DIB's productive capacity, six are of the greatest concern. These are:
 - (1) shortages of capital equipment,
 - (2) difficulties in obtaining necessary equipment from subcontractors,

¹ In the place of page number references to the draft report given DOD for review, GAO has substituted the corresponding page numbers in this final version.

- (3) reliance on foreign producers for components or on imports of raw materials,
- (4) inordinately long "queue time" between purchase orders and delivery of defense items,
- (5) shortages of skilled labor for producing defense equipment, and
- (6) use of proprietary processes by defense contractors. (p. 2)

DoD POSITION: Concur

- o **FINDING C: DoD's System For Collecting DIB Data Is Inadequate.** GAO found that current methods of assessing the DIB use either data aggregated by industrial sectors or system-specific data now collected from contractors and subcontractors by DoD through its Form 1519. GAO concluded that, while the aggregate data is useful, industrial preparedness planners and program managers must also have DIB information that is specific to individual weapon systems. GAO also found that DoD's Form 1519 system is used only sporadically and is inadequate. GAO reported near unanimity among contractors, program managers and previous studies that the data which is reported on Form 1519 is inaccurate. (pp. 9-10)

DoD POSITION: Partially concur. Problems with the DD Form 1519, as the singular method for industrial preparedness planning, has long been recognized. However, the problem has not been so much with the form but with the availability of resources to fully exercise the system as it was designed. For example, because of higher priority requirements, the Air Force discontinued its Form 1519 type of planning in 1978. New and revised DoD policy now provides for the use of other methods of planning and data collection such as sector analysis, data item description mobilization/surge planning, and surge contracting in addition to the Form 1519. The program now benefits from a combination of both plant and item specific planning activity and aggregated data by industrial sector. Planning information can now be contracted for as a line item in a production contract. The application of this method is highly desirable for industrial preparedness planning on the most critical items. For other items, the voluntary Form 1519 approach may be sufficient or desirable depending on the type of item or the availability of resources. Detailed policy has been fully coordinated within the Department of Defense and will be published in November 1984.

- o **FINDING D: The Lack Of Accurate Data Confirmed The Need For A New Method Of DIB Assessment.** GAO found that the lack of accurate information on specific weapon systems and the various tiers of contractors confirmed the need for developing a new method of assessing DIB capabilities. GAO said its method

reflects the system which is to be assessed—one with descending levels of suppliers in tiers of primary and subsidiary contractors, with each level subject to production constraints affecting critical items as well as competition for existing resources within both tiers and individual contractors. GAO reported that its proposed method applies:

- (1) a vertical analysis that identifies items critical to an individual system down through the tiers of suppliers, evaluating production constraints at each level;
- (2) a horizontal analysis that evaluates the competition for production resources within each firm; and
- (3) a future production analysis that extends this analysis to DoD out-year requirements estimates.

GAO concluded that this combination of analyses will provide a more comprehensive view of the state and capabilities of the DIB than has thus far been available. (pp. 11 - 18)

DoD POSITION: Concur. The GAO outlined approach involving vertical, horizontal and future production analysis is fundamentally the same as that already required in Defense Guidance (critical path methodology application) to the Military Departments in the development of their respective programs.

- o **FINDING E: The Purpose Of The Vertical Analysis Is To Identify Critical Items And Production Constraints By System.** GAO reported that the purpose of its vertical analysis is to identify critical items, the contractors that produce them, and the resulting production constraints. Critical items are components or materials that are likely to be associated with delays, inferior quality or cost increases in the production of a weapon system, and GAO used five criteria to identify them. (These are long or growing lead times, high or increasing unit costs, the existence of only one or a few suppliers, reliance on foreign sources of supply and any history of production problems). GAO noted that a production constraint would be any factor which limited the production rate or would do so if the rate were slightly higher. GAO also said that it continued the vertical analysis of system-specific critical items and production constraints through the second and third tiers of subcontractors. (pp. 11 - 16)

DoD POSITION: Concur.

- o **FINDING F: Horizontal Analysis Seeks To Identify Competing Demands For Production Resources.** GAO reported the main purpose of the horizontal analysis is to identify competing demands for the production resources available to each contractor and subcontractor examined in the vertical analysis. For a given contractor, GAO looked at the products it produces

which compete with the system in question for production resources, the contractor's plans for expanding plant capacity, as well as the full range of products which utilize the same resources. The aim is to identify current or potential production constraints resulting from resource competition. (pp. 16 - 17)

DoD POSITION: Concur.

- **FINDING G: Future-Production Analysis Assesses The Contractor's Prospective Ability To Produce The Weapon System.** GAO stated that the future-production analysis is intended to provide an assessment of the DIB capability to produce a weapon system over some period out into the future. GAO noted that the first step is to estimate the future production level of the system from a review of DoD's five-year program, and the second is to identify the contractors' expectations for change in demand for competing products. GAO then compared data on current production constraints with estimates of demand in order to evaluate the contractors' ability to meet future peacetime requirements for the system. GAO concluded that such an analysis can help foresee and prevent production problems such as delays, inferior quality and cost increases. (p. 18)

DoD POSITION: Concur.

- **FINDING H: GAO Picked Six High Priority Systems For Illustrative Application Of its New Method Of DIB Analysis.** GAO adopted a case study approach to illustrate how the new method of DIB analysis works, since applying the method across a large segment of the DIB was beyond GAO's resources. GAO reported that six high priority weapon systems were selected for DIB analysis from two sources—DoD's industrial preparedness "Wedge Program" and the DoD Master Urgency List. The six systems are the Army's M1 tank and TOW 2 missiles, the Navy's Phoenix and Harpoon missiles, and the Air Force's F100 aircraft engine and Global Positioning System. GAO also reported that it was unable to apply the analysis to the Global Positioning System because of a lack of production data, and, therefore, confined its analysis of critical items and production constraints to the other five systems. GAO emphasized that since the case studies are only illustrative of the method's usefulness, this report cannot be viewed as a comprehensive study of the DIB, and the results cannot be generalized to all weapon systems. (pp. 18 - 20)

DoD POSITION: Concur.

- **FINDING I: Five Systems Analyzed Show Eight² Production Constraints.** GAO identified the critical components and materials, and then the constraints on the present and future capabilities of contractors to satisfy requirements for five of the systems studied (this was not possible for the Global Positioning System). GAO identified eight constraints on production of the five systems, six of which involved physical or material difficulties at the production facilities and two³ of which involved policy or management issues. (p. 27)

² The number of production constraints was reduced to seven in GAO's final report.

³ The second management issue was deleted from GAO's final report.

DoD POSITION: Concur.

- **FINDING J: Shortages Of Production Machinery And Test Equipment Pose Problems.** GAO found that a lack of manufacturing equipment or machine press capacity has curtailed production of four of the systems examined. GAO reported that the shortages have not caused late deliveries, but requests for production increases would have led to significant delays as a result of the need to procure additional machinery and tooling. GAO also found that shortages of test equipment were surprisingly widespread among contractors on the five systems subjected to the GAO analysis. (pp. 27 - 29)

DoD POSITION: Concur. The DoD surge investment program is directed to improving this condition. The Congress, for the first time, has approved funding for surge investment long lead time inventory. Unfortunately, it is for only one weapon.

- **FINDING K: Several Subcontractors Were Constrained By Shortages Of Components Or Raw Materials.** GAO found that several subcontractors were constrained by shortages of either raw materials or components from their suppliers. GAO reported instances where such shortages were dealt with by one or another version of a technique known as "slaving." One form of slaving reportedly used on the M1 tank is to borrow a part from a completed and tested tank in order to install it on a tank still being assembled. A similar form, described by GAO, was to keep the "slave" parts in stock, install them in production tanks and return them to stock after testing. GAO concluded that while both versions of slaving were ways to keep production and testing going in the face of a critical component shortage, it is at the expense of extra costs. (pp. 29 - 31)

DoD POSITION: Partially concur. With the exception of the M1 tank, the report does not give evidence of any other systems being curtailed and the condition has had only a slight impact on the tank program. The issue of whether the shortage of critical components caused added expense or extra costs is not very clear. The acquisition of the parts would probably cost much more.

- **FINDING L: Shortages of Skilled Labor Are Not A Production Constraint.** GAO found that, while shortages of skilled labor would represent a serious production constraint, they now exist in only a few areas and do not pose a problem. GAO reported, however, that some subcontractors advised placement of new orders would create such shortages. GAO concluded that, if the unemployment rate drops significantly and DoD production requirements increase, some contractors will have difficulty in finding skilled labor. (p. 31)

DoD POSITION: Concur. The ability to assess and project skilled manpower shortages is extremely difficult because very little information can be compiled on supply. The DoD, through macro modeling and planning with industry can identify current and projected demands.

- **FINDING M: Reliance On Imports Of Components And Materials Is Potential Production Constraint.** GAO found many components in the five systems studied that used some material with an import dependence of 50 percent or more (this was true for each system at each level of supply). GAO also found that the contractors in question rely on foreign components as well as materials. GAO concluded that, while interruption of imports of such components and materials would not automatically mean a supply shortage, reliance on foreign sources is still a potentially serious production constraint because international conflict could interrupt supplies. (pp. 32 - 33)

DoD POSITION: Concur.

- **FINDING N: Queue Time Not Generally A Production Constraint.** GAO found that "queue time," the interval between the customer's order and the beginning of production, is not generally a major production constraint. GAO noted, however, that for some manufacturers, queue time may still be a constraint because of the need to keep a smooth production schedule in the face of peaks and valleys in demand. (pp. 33- 34)

DoD POSITION: Concur. During peacetime this is a fact of life. During wartime this would be dramatically changed.

- **FINDING O: Proprietary Processes Constrain DIB Production.** GAO reported that of 38 contractors visited by GAO during the review, 25 used proprietary processes. GAO found that the widespread use of such processes to produce defense components has the effect of limiting the number of producers of a given item and so driving up component costs. GAO concluded that proprietary processes constrain DIB production. (p. 34)

DoD POSITION: Concur. The report, however, does not include sufficient information on which to fully evaluate whether this as a significant production constraint, and readily available DoD data also does not answer this question.

- **FINDING P: Most Production Constraints Are Faced By Subcontractors.** GAO combined its future production analysis with the results of vertical and horizontal analysis to assess the overall ability of the DIB to produce the five case study systems. GAO found that prime contractors faced relatively few production constraints but that subcontractors were confronted with many of them. GAO reported, for example, that its analysis of the Harpoon Program showed 13 production constraints, but only two were at the prime contractor level. GAO concluded that most current and potential production constraints are faced by subcontractors. In addition, GAO concluded that maintaining existing production levels for the systems reviewed should be possible, but future production of some components and systems could pose problems. (pp. 34 - 37)

DoD POSITION: Concur.

- **FINDING Q: DoD Task Force Is Implementing Recommendations To Improve The DIB.** GAO found that DoD has shown its concern about the DIB and interest in improving it by forming the Task Force to Improve Industrial Responsiveness. GAO reported the the Task Force's 1982 report identified 18 recommendations designed to improve the DIB in the following three areas: defense acquisition, industrial preparedness planning, and national resources. GAO found that the Task Force identified 14 action documents required to implement its recommendations. (GAO noted that only three of those had been issued by the end of 1983, but eight were ready for publication at the time of the GAO review, while the other three were at less advanced stages of processing.) In addition, GAO reported DoD officials said that some of these delays represented deliberate efforts to resolve differences among the Services prior to publication, and that implementation has not been delayed since the Services have begun to take action on the available drafts. GAO also noted that the Services have DIB initiatives underway such as the Air Force's Blueprint for Tomorrow and Integrated Industrial Data Management System, and the Army system for Automation of Preparedness Planning. (pp. 38 - 42)

DoD POSITION: Concur.

- **FINDING R: DoD Initiatives On DIB Analysis And Data Collection Are Not Adequate.** GAO found that DoD initiatives to improve preparedness planning do not address all the analytical issues raised in the review, particularly the need for an accurate data base on subcontractor capabilities. GAO said its case studies have shown it is possible (1) to identify critical components and materials produced by both prime contractors and subcontractors, and (2) to identify actual and potential production constraints on individual contractors; and to assess the overall ability of contractors to meet system production plans. GAO concluded that most current and potential production constraints occur, not with prime contractors, but at the lower tiers of the DIB. GAO said its case studies reveal that an understanding of DIB subtiers requires information that is not now available on the subcontractors operating at the secondary and tertiary levels. GAO also said that obtaining data from several production tiers is useful because it permits verification of data from different sources. GAO found instances of prime contractors providing data on subcomponents that differed from that provided by the subcontractors. GAO concluded that there is much need for greater accuracy and better verification of the production data available on the several tiers of the DIB. (pp. 42 - 45)

DoD POSITION. Partially Concur. The need for more information on the subtier base has been recognized and all policy revisions, including Defense Guidance, stress this aspect. This type of analysis utilizing the critical path methodology is being utilized. However, due to limited resources to perform this detailed analysis and the ultimate cost for correction, this is limited to only the most critical weapon systems.

- **FINDING S: The Scope Of The Data Base On The DIB Should Be Expanded.** GAO said that, for many weapon systems, there is a need for consistent data which has been collected from and coordinated with the Services, industrial preparedness planners and contractors. GAO found that there are several alternative approaches to determining how many weapon systems, components, materials and contractors should be included in the DIB data base. One would be to focus on the weapon systems which the Services deem most important. Another would be to select systems from a rotating sample of contractors, i.e., to subject a portion of contractors to intensive data collection each year. A third would be to analyze particular classes of systems, e.g., missiles or tanks. GAO does not, however, present a conclusion on which alternative is to be preferred. (p. 44)

DoD POSITION: Concur. A system of prioritization has been implemented and is very effective in the DoD programming and budgeting process. The policy is contained in revised regulations for Industrial Preparedness Planning and is a fundamental part of Defense Guidance to the Military Departments for programming and budgeting.

- **FINDING T: DoD Responses To Production Constraints Can Be Improved.** According to GAO, its analysis revealed examples in which DoD and the Services are aware of DIB problems but did little to resolve them. GAO concluded it is imperative that DoD have a method for identifying production problems and addressing them quickly and effectively. GAO also concluded that DoD's system for responding to such problems can be improved. (pp. 44- 46)

DoD POSITION: Concur. The recent approval by the Congress for surge investment is a major milestone and hopefully will convey that funds in Service programs and budgets are not a risk for improving the industrial base.

- **FINDING U: Costs Of Implementing The Proposed Method Of DIB Data Collection And Analysis Could Be Minimized By Use Of Existing Systems.** GAO found that the costs of implementing the proposed method of DIB data collection and analysis could be minimized by using existing systems. One way to do this, GAO said, was to incorporate some data collection functions into the duties of program managers and plant personnel. Another way to relieve the data collection burden would be to upgrade the system already in use for DoD's Form 1519. GAO also said it should be possible to take advantage of DoD's advanced computer capability and perform the DIB data collection and analysis function at a central facility, such as the Army's Industrial Base Engineering Activity. (p. 46)

DoD POSITION: Concur. The cost of data collection will necessitate pursuing the least cost options taking full advantage of existing capability.

- o **FINDING V: Several Important Matters Should Be Considered By Industrial Preparedness Planners.** GAO concluded that its review had identified several important matters that should be considered by defense industrial preparedness planners. These include the following:
- (1) the extent to which information and production problems occur at the subcontractor level, below that of the prime contractors;
 - (2) actions that can be taken to improve the Services' understanding of and response to problems in the defense industrial base;
 - (3) the extent to which the Services can improve their monitoring and verification of contractor data;
 - (4) the feasibility and cost of implementing the proposed method of DIB analysis consistently for all of the Services, so as to insure continuous, accurate, and generalizable information on the state of the defense industrial base; and
 - (5) the desirability of creating a central unit in the Department of Defense for collecting and analyzing data on the defense industrial base.
(pp. 46 - 47)

DoD POSITION. Concur. These elements are an inherent part of policy already implemented by DoD or are included in the revised policy issuances. The requirement for each Military Department and the Defense Logistics Agency to develop an annual production base analysis encompasses all of the elements identified in the report.

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