Chapter 1

Summary, Major Findings, and Policy Issues

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Chapter 1

Summary, Major Findings, and Policy Issues

INTRODUCTION

Changes in the international security environment present the United States with some far-reaching decisions about the size and character of the Nation's future armed forces and the defense technology and industrial base (DTIB) supporting those forces. The DTIB is the focus of this report. A crucial element of U.S. military power, the base has two principal functions:

1. developing, producing, and supporting military systems in peacetime; and
2. responding to increased military requirements in crisis or war.

The deployment and support of U.S. forces in the Persian Gulf and the performance of U.S. weapon systems in Operation Desert Storm provided some indication of the ability of the current DTIB--built up over decades of cold-war spending-to meet the Nation's security needs. But a key question facing Congress is how to retain the technology and industrial capabilities essential for the defense of the Nation and its interests with much reduced defense budgets. This problem is extremely complex, requiring difficult choices involving tens of thousands of skilled jobs and major shifts in defense spending. Although the consequences of this restructuring will be felt more strongly in some States and congressional districts than in others, the transition to the future DTIB can be expected to generate considerable public debate. The purpose of this report is to provide a framework for that debate, enabling Congress to look beyond the immediate political concerns of individual districts and States to the national security requirements of the Nation as a whole.

The DTIB is the combination of people, institutions, technological know-how, and facilities used to design, develop, manufacture, and maintain the weapons and supporting defense equipment needed to meet U.S. national security objectives.[1] The base consists of three broad components: a research and development component, a production component, and a maintenance and repair component, each of which includes private- and public-sector employees and facilities. The base can also be divided into three tiers: prime contractors, subcontractors, and parts suppliers. While the DTIB is usually thought of as an independent entity, it is in fact a part of the larger civilian technology and industrial base and is increasingly international.

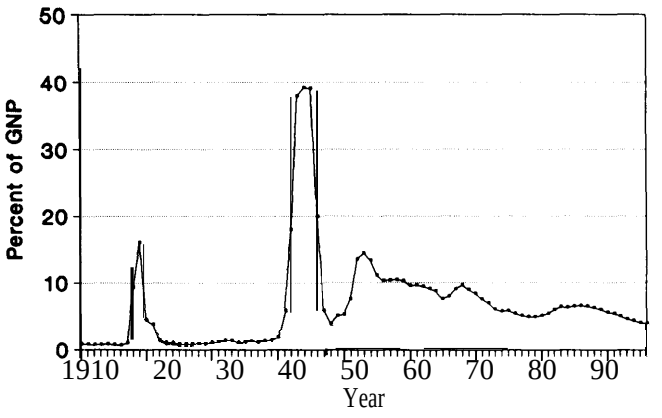
Since 1950, the size and structure of the DTIB have been shaped primarily by the demands of containing the Soviet military threat. While the sweeping changes in the Soviet Union and Eastern Europe provide an opportunity to reduce U.S. defense spending and redirect some technological and industrial resources to meet other vital needs, there is still considerable uncertainty about the durability of the positive changes in the Soviet Union and the nature of other potential threats. The complexity of the current security environment was illustrated by the administration's 1992 defense budget request, which supported a smaller, post-cold war military establishment even as the United States and its coalition partners were engaged in the war to liberate Kuwait.

There appears to be consensus among government policymakers that the United States will remain globally engaged and must retain significant military forces and the means to arm and support those forces. Yet it is equally clear that the defense budget will be cut substantially. Overall defense spending is expected to decline from a peak of 6.4 percent of Gross National Product (GNP) in 1985 to about 3.8 percent of GNP in 1996, the smallest proportion since before World War II (see figure l-l). At the same time, procurement in real terms is projected to fall almost 50 percent between fiscal years 1985 and 1996, from $123.9 billion to $64.3 billion (both figures in 1992 dollars). Between 1990 and 1993, budget authority for aviation is projected to decline by 23 percent, shipbuilding by 26 percent, and weapons and tracked vehicles by about 77 percent.[2] While production of munitions and other consumables may increase temporarily to replenish stocks

[1] U.S. Congress, Office of Technology Assessment, *Adjusting to a New Security Environment: The Defense Technology and Industrial Base Challenge—Background Paper*, OTA-BP-ISC-79 (Washington, DC: U.S. Government Printing Office, February 1991).

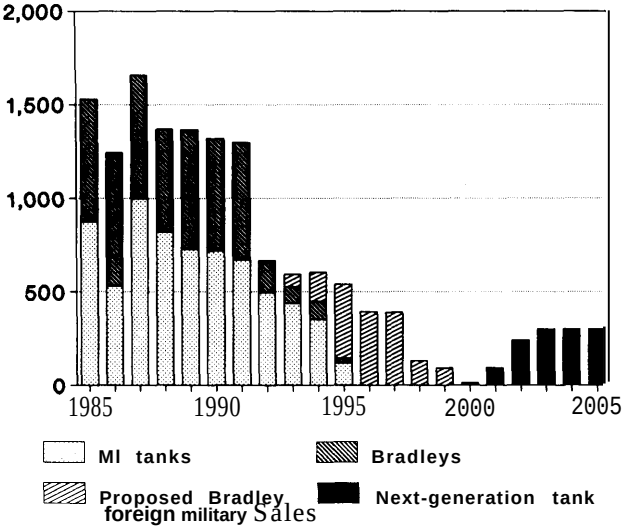
[2] Stephen A. Cain, *Analysis of the FY 1992-93 Defense Budget Request* (Washington, DC: Defense Budget Project, Feb. 1991), tables 7 and 8.

Figure 1-1—U.S. Defense Spending as a Percent of GNP



SOURCE: *Budget of the United States Government, Fiscal Year 7992* (Washington, DC: U.S. Government Printing Office, 1991), part Seven, historical tables, table 3.1; and Stephen A. Cain, *Analysis of the FY 1992-93 Defense Budget* Request (Washington, DC: Defense Budget Project, February 1991), table 15.

Figure 1-2—Armored Vehicle Production Projected Through 2005



NOTE: MI tank figures include proposed foreign military sales to Saudi Arabia and Egypt, with Egyptian coproduction.

SOURCE: U.S. Department of the Army, May 1991.

consumed during the Gulf War, procurement of major weapon platforms will decline sharply over the next decade because of large existing inventories and shrinking force.

Direct funding for defense research and development (R&D) is expected to fall 23 percent.[3] This latter figure substantially understates the actual total reduction in defense R&D funding that is likely to occur, however, since much private-sector R&D is linked to procurement levels, which are also falling rapidly.[4]

The projected changes in the production and R&D budgets will have profound effects on many defense sectors. In addition to overall reductions, there will be a reallocation of funding priorities as the Services end current programs and move ahead with modernization. The reduced demand for weapon platforms will result in a production "trough' over the next 5 years in defense sectors such as armored vehicles (see figure 1-2), followed by longer intervals between procurement cycles. As a result, there maybe gaps between the end of several current programs and the start of production of next-generation systems. Decisions about the DTIB made over the next few years will determine the survival of some defense firms and government organizations. More importantly, these decisions will determine in large measure the Nation's ability to develop and deploy advanced military weapons systems in the opening decades of the next century. Once plants and laboratories are closed and their personnel scattered, they can take years to reconstitute; the unique skills embodied in the design and engineering teams that conceive of and build weapons like the F-15 fighter and the Tomahawk cruise missile are neither easily maintained nor quickly replaced.

An example of the difficult choices facing Congress is whether the United States should cease production of Ml tanks and Bradley Fighting Vehicles. The production trough shown in figure 1-2 makes it clear that the Nation must decide which armored vehicle R&D and production capabilities it should attempt to preserve, and how these capabilities (people, facilities, organizations, and subtier producers) might be maintained with limited or no new production. Possible strategies include terminating production and concentrating on R&D, increasing foreign sales, continuing procurement for U.S. forces, and upgrading older Ml tanks and Bradleys. A host of other weapon systems raise similar choices about preserving defense R&D and production capabilities.

In making such choices, Congress should recognize that technology is changing so rapidly that by the time a major new threat arises, totally new types

[3]Ibid., table 9.

[4]Defense contractors invest in R&D primarily through government-reimbursed Independent Research and Development (IR&D), which is tied to ongoing procurement contracts, or other corporate funds in the expectation of winning a production contract.

of weapons and defense manufacturing capabilities may be required. Although those charged with fighting a potential war always worry about not having the most capable weapons on hand, weapons eventually become obsolete. Thus, a period free from an immediate large military threat allows opportunities to investigate new weapon concepts and potentially to leapfrog a generation of systems. Between World Wars I and II, for example, the Army's DTIB strategy for armored vehicles concentrated on component development and the design and limited prototyping of new tank models, which were subsequently produced during World War 11.[5] Some aircraft designers argue that the United States could maintain its performance edge in fighter aircraft with a similar emphasis on prototype development, combined with limited, intermittent production to modernize forces when necessary.

While the DTIB has produced some outstanding weapon systems, as demonstrated in the Gulf War, it also has a number of serious weaknesses that will affect its ability to meet national goals of peacetime production and crisis response. Numerous studies conducted over the past decade have detailed these weaknesses, including the high cost of weapon programs, growing dependence on foreign sources for critical components, and a shrinking number of subcontractors doing defense business. The causes of these adverse trends are two-fold: regulatory controls that increase the cost of conducting defense business and discourage many firms from participating in defense efforts; and the lack of a national defense technology and industrial strategy and predictable funding levels that would enable both private firms and government organizations to prepare for the future.

Firms are responding to current and anticipated budget reductions by attempting to increase arms sales abroad, reducing facilities, cutting investment in new technology and physical plant, eliminating personnel, and, in some cases, attempting to diversify into the civil sector. The ad hoc nature of the reductions to date has further exacerbated the overall problems of the DTIB.

There has been a tendency to treat the private-sector portion of the base like any other private business, with contracts bid competitively and working capital provided by loans or equity investments. In fact, this element of the DTIB does not operate in a free market. The government is the only customer for defense products and regulates profits, production processes, product design, and a host of other factors. This monopsony (single-customer) relationship gives the government considerable power.[6] In the Past, the government used its power to entice firms into the defense business by reducing financial risks and providing guaranteed profits. Beginning in the 1980's, however, the government focused on expanding competition while limiting potential profits, thereby increasing business risk.

To obtain a better grasp of the changes that are occurring in the DTIB and what congressional actions, if any, might be called for, Congress asked the Office of Technology Assessment (OTA) to examine the Nation's defense technology and industrial needs in the emerging security environment and to suggest options for moving to a smaller and more efficient DTIB that can meet those needs. The objectives of this report are as follows:

1. to survey ongoing changes in the international security environment that will affect DTIB requirements,
2. to describe the current condition and trends in the DTIB,
3. to identify the desirable characteristics of the future DTIB, and
4. to sketch out broad alternative strategies available to the Nation for moving to the future base.

A separate report, scheduled for release in the spring of 1992, will explore in greater detail specific policy options to support these strategies.[7]

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[5]Richard M. Orgorkiewicz, *Armor* (New York, NY, Frederick A. Praeger, 1960); and R. P. Hunnicut, *Firepower* (Novato, CA: Presidio Press, 1988).

[6]Office of the Under Secretary of Defense for Acquisition, Final Report of the Defense Science Board 1988 Summer Study, *The Defense Industrial and Technology Base (Washington DC:* October 1988), p. 12.

[7]This assessment is part of a broader effort t. identify trends in the U.S. technology and industrial base and examine U.S. policy options. A companion OTA assessment, *Technology Opportunities for Economic Conversion, is ongoing in the* Industry, Technology, and Employment Program. Other recent related OTA reports include: U.S. Congress, Office of Technology Assessment, *Holding the Edge: Maintaining the Defense Technology Base,* OTA-ISC-420 (Washington DC: U.S. Government Printing Office, April 1989); U.S. Congress, Office of Technology Assessment, *The Defense Technology Base: Introduction and Overview,* OTA-ISC-374 (Washington, *DC:* U.S. Government Printing Office, March 1988); U.S. Congress, Office of Technology Assessment, Global *Arms Trade: Commerce in Advanced Military Technology and Weapons,* OTA-ISC-460 (Washington DC: U.S. Government Printing Office, June 1991); and U.S. Congress, Office of Technology Assessment *Making Things Better: Competing in Manufacturing,* OTA-ITE-443 (Washington, DC: U.S. Government Printing Office, February 1990).

ORGANIZATION OF THIS REPORT

The report is organized into five chapters and two appendices. This chapter summarizes key findings and policy issues. Chapter 2 outlines potential threats to the United States and its allies, the future U.S. force structure that may be developed to counter these threats, and the implications of alternative force structures for the DTIB. Chapter 3 surveys the structure and current condition of the DTIB, and chapter 4 examines trends and problems in the base, including strategies of defense companies for responding to continuing budget cuts. Chapter 5 outlines some desirable characteristics of the future DTIB and discusses alternative national strategies for moving to a base that is capable of meeting the Nation's long-term security needs. Appendix A describes the integrated U.S. and Canadian defense industrial complex, known as the North American Defense Industrial Base, and explores some of the implications for the DTIB of increased economic integration with Mexico. Appendix B contains a brief discussion of defense industrial databases and industrial base analytical models.

As part of this study, the OTA assessment team sent surveys to several hundred defense industry executives requesting their views on changes in the DTIB and actions being taken or that could be taken to ensure a viable future base (see box l-A). Information from the survey, as well as from subsequent interviews with company and government personnel, is incorporated in the text of this report. In addition, selected survey observations appear in boxes marked 'OTA DEFENSE INDUSTRY SURVEY. ''

FINDINGS

Changes in the Security Environment

The threat of a short-warning Warsaw Pact military attack against Western Europe has disappeared. The integrated command structure of the Warsaw Treaty Organization was dissolved on April 1, 1991, and Soviet armies that only a few years ago were deployed in the heart of Europe are now withdrawing to the borders of the U.S.S.R. These changes have transformed the former threat of a short-warning conventional attack into a long-warning threat. A Soviet attack on NATO's central front would require the Soviet Union to reconstitute

OTA DEFENSE INDUSTRY SURVEY

Box l-A—Defense Survey Approach

The OTA Defense Industry Survey solicited industry views on three main topics:

1. the size and composition of the future defense technology **and** industrial base (DTIB) in the year 2000,
2. how the transition to the future base ought to take place, and
3. how the future base ought to be managed.

Respondents were provided with the definition of the DTIB and the force structure forecasts used by OTA.

The survey was divided into three areas: 1) **General Observations on the Defense Technology and Industrial Base** (soliciting general information on size of respondents' firms, estimates of future Us. defense budget changes and corporate responses, and challenges facing the firms); 2) **Assessments of Specific Policies and Problems** (soliciting views on government acquisition regulations, competition, and special programs such as **Manufacturing Technology);** and **3) New Ideas** (soliciting industry's suggestions for the restructuring of acquisition, the management of research and development, and manufacturing). Survey questions were designed to allow respondents to provide their views m essay format.

The American Defense Preparedness Association (ADPA) and the National Security Industrial Association (NSIA) assisted **OTA in** reaching a wide range of industry. The survey was sent to members of the Manufacturing Management Committee and Procurement Committee of the NSIA and to the general membership of the **ADPA. The OTA** assessment team appreciates the assistance of **ADPA** and NSIA in reaching industry. The associations, of course, had no role in developing the conclusions of this report. In cases where several executives from the same corporation received the survey, many corporations chose to consolidate their replies. While the response rate cannot, therefore, be calculated exactly, overall it exceeded 25 percent. The OTA assessment team was impressed by the care and thoroughness that many respondents gave to their replies and thanks them for their time and effort.

Photo credit: Wick World Photos

Probably the clearest sign of the end of the cold war is the destruction of weapons such as these Czech tanks being dismantled with cutting torches.

its forces over a period of years and then fight its way across Eastern Europe. With the reduction in East-West tensions, the danger of nuclear war has also diminished considerably, as reflected by the reduced alert status of U.S. nuclear forces.

Nevertheless, the global security environment remains complex and frill of uncertainties. The United States must hedge against a possible Soviet reversion to global confrontation or new challenges to U.S. security from other sources. In addition, regional conflicts are more likely to involve the use of advanced conventional weapons, ballistic missiles, and chemical, biological, and nuclear weapons. Thus, instead of a "clear and present danger, ' the United States faces a spectrum of lesser but more ambiguous threats in an overall security environment characterized by increased fluidity and uncertainty.

At the same time that the global security environment is undergoing a major transformation, severe fiscal constraints arising from the ballooning Federal deficit and competing domestic needs are also forcing cuts in the U.S. defense budget. Internationally, the Nation faces persistent trade deficits and mounting competition in industrial and technological areas that formerly went almost uncontested. As a result, many policy analysts have urged the redefinition of U.S. national security to emphasize the vitality of the domestic economy, the welfare of the American people, and the international competitiveness of civilian industry.

In light of these fiscal and security trends, both the administration and Congress have advocated prudent reductions in U.S. armed forces, with the aim of retaining a military flexible enough to respond to a wide range of unforeseen circumstances. President Bush has outlined the administration's vision of "deliberate reductions to no more than the forces we need to guard our enduring interests-the forces to exercise forward presence in key areas, to respond effectively to crises, [and] to retain the national capacity to rebuild our forces should this be needed.'

[8]Weekly compilation of Presidential Documents, vol. 26, No. 31, Aug. 6, 1990, pp. 1190-1194.

To this end, the Nation will need ready forces and equipment capable of dealing with limited regional conflicts, along with the ability to reconstitute larger forces in the event of a serious crisis or war. By the end of the decade, the U.S. military will likely consist of fewer active and reserve forces armed with advanced weapons, many of them upgrades of current systems. American forces will have a reduced overseas presence and will therefore need greater strategic mobility; they will also be more dependent on mobilization of reserves to respond to major military threats (see table l-l).

These changes in U.S. force structure, together with fiscal constraints, will have important implications for the DTIB, as discussed in chapters 2 and 5. A few examples illustrate these implications. First, a reduction in Army heavy divisions and Navy carrier task forces could result in a several-year hiatus in tank and aircraft carrier production. Second, changes in military operations may necessitate the development of new types of weapons and may also create different surge requirements for theater conflict. Third, the general reduction in procurement funds will require more attention to lowering the cost of systems and increasing the reliability of fielded systems. Finally, a reconstituted Soviet threat can no longer be the principal planning contingency, with all other potential threats subordinated to it.

These implications for the DTIB helped establish the parameters for OTA's assessment of how the Nation can rationally reduce the base to preserve essential capabilities. The results of this assessment are a list of proposed characteristics of the future DTIB and identification of the strategic choices and tactical decisions involved in the transition to that base, as discussed in chapter 5 and outlined below.

Table l-l--Characteristics of Future U.S. Forces

- Smaller active and ready reserve forces
- Less forward basing, greater strategic mobility
- Continuing weapons performance advantage
- Substantial nuclear capability
- Chemical and biological defense capabilities
- Greater dependence on mobilization

SOURCE: Office of Technology Assessment, 1991.

Table 1-2—Desirable Characteristics of the Future Base

- Advanced research and development capability
- Ready access to civilian technology
- Continuous design and prototyping capability
- Limited, efficient peacetime engineering and production capabilities in key defense sectors
- Responsive production of ammunition, spares, and consumables for theater conflict
- Healthy, mobilizable civilian production capacity
- Robust maintenance and overhaul capability
- Good, integrated management

SOURCE: Office of Technology Assessment, 1991 ."Characteristics are not necessarily listed in order of priority.

Desirable Characteristics of the Future Base

Desirable characteristics of a DTIB that would support future military needs are listed in table 1-2. First, and most important, the future base will need to retain an advanced R&D capability. In a period of uncertainty about the nature of future threats and acknowledged concern over the state of U.S. technological competitiveness with other countries, preserving the R&D component of the base must receive first priority. While production will still receive more overall funding, a relative increase in R&D funding will help reduce pressures to move rapidly into full-scale production, thereby promoting a more deliberate approach to the defense acquisition process. The defense base must also have greater access to civilian technologies in sectors, such as electronics and telecommunications, where innovation is driven increasingly by commercial applications. Such access will require changes in current defense procurement laws and regulations that have increasingly isolated the DTIB from civilian industry.

Maintaining defense R&D and production capabilities in a constrained fiscal environment will revolve around continuous design and prototyping. Since it is more difficult and time-consuming to rebuild technological and industrial capabilities than to mobilize manpower, retaining the capability to develop the next generation of weapons and to mobilize against a reconstituted threat will require preserving facilities and personnel devoted to design, systems integration, prototype testing, and manufacturing. Thus, future DTIB decisions must maintain enough design and engineering teams to produce new components and systems on demand. In a period characterized by more research and less production, it will be necessary to build and test prototypes between major procurement cycles. Another consequence of smaller defense budgets and longer weapon development cycles will be an increased emphasis on improvements and retrofits of existing platforms, which will help sustain the

ability to manufacture subsystems and keep both subtier firms and primes in the defense base.

The DTIB will continue to need a responsive production or "surge" capacity to support limited conflicts, but that capacity should be small and geared toward essential materiel such as ammunition, spare parts, and consumables.[9] If cuts in U.S. active forces are accompanied by proportionately smaller inventories of these items, there may be a greater need for defense industrial surge in response to a limited crisis or war. Responsiveness must be funded and periodically tested.

The wartime consumption and production rates needed to meet a reconstituted Soviet threat would likely be hundreds of times larger than peacetime production. The Nation cannot afford to maintain a "warm" defense industrial base large enough to satisfy this contingency. Since a reconstituted Soviet threat or major new threat will take years to develop, however, the wartime mobilization base for a major conflict can be less responsive than was required in the past. This wartime mobilization base would consist of two elements: a dedicated defense base for the procurement of major platforms, and a mobilizable civilian production capacity. The first of these elements would be sized to meet peacetime defense procurement needs, yet flexible enough to form the core around which the larger wartime-mobilization base could be regenerated when needed. The second element requires a healthy national manufacturing base, with sufficient quality personnel that can shift their knowledge and skills from commercial production in peacetime to defense work in a national emergency.

Since military weapon systems will likely remain in inventory longer than in the past, maintenance will become more important. The shift from the urgent production and deployment of new systems during the cold war era to the overhaul, remanufacturing, and upgrading of deployed systems over the coming decades will have important implications for the structure of the maintenance base, requiring a reexamination of the mix between the public and private sectors. It will also require additional emphasis on designing systems for improved reliability to reduce the need for future repair and overhaul.

Photo credit: U.S. Department of Defense

The B-52, first deployed in 1955, demonstrates that a weapon platform can be upgraded by improving components or munitions.

Finally, the DTIB must have good, integrated management to achieve its objectives in a fiscally constrained environment, avoiding both extremes of micromanagement and neglect. The test of management is whether the DTIB adequately meets the goals of affordable peacetime acquisition and wartime responsiveness. Despite the success of Operation Desert Storm, projected modernization costs of strategic bombers and other systems indicate that current base management does not pass the affordability test. If the base is allowed to restructure in the current ad hoc manner, it may be unable to respond to a future crisis. An essential requirement for managing the transition to the future DTIB is to ensure better communications between peacetime acquisitions personnel and the officials who plan for defense industrial responsiveness in crisis and war.

Broad Strategic Choices

To achieve the desirable DTIB characteristics outlined above, the United States will need a long-term defense technology and industrial strategy for identifying and maintaining the critical facilities, technological know-how, and people needed to develop future systems and to provide a core for

[9]Office of Technology Assessment, op. cit., footnote 1, p. 3. This report maintains the definitions of surge and mobilization used in *Adjusting to a New Security Environment. Surge is the* term used within DoD to refer to the expansion of military production in peacetime without the declaration of a national emergency. *Mobilization* refers to the rapid expansion of military production to meet materiel needs in a war and involves the declaration of a national emergency. Several types of mobilization are considered. *Full mobilization* refers to mobilization to fill the existing or "program force" structure. *Total mobilization* describes a mobilization effort that expands beyond the existing force structure.

regenerating expanded defense industrial capabilities in a timely manner. The Nation faces some broad strategic choices about the nature of the future defense base, including:

- the degree of national autonomy versus international interdependence,
- reliance on an arsenal system versus civil integration, and
- the allocation of resources to current production versus future potential.

Autonomy v. Interdependence

One strategic choice relates to the extent to which the DTIB is integrated into the world economy. The Nation must choose the degree of defense industrial autonomy that is necessary and possible in an increasingly global technological environment. There are risks both in excessive reliance on foreign sources and in attempting to be fully autonomous. In the former case, the Nation risks losing to offshore competitors both critical capabilities and control over which technologies are pursued; in the latter case, it risks higher procurement costs, protected industries that lack innovative drive, and loss of access to foreign technological developments. The optimal tradeoff between interdependence and autonomy will depend on the industrial and technological sector and the military importance of the technology, as discussed in chapter 5.

Arsenal System v. Civil Integration[10]

A second choice relates to the internal structure of the base. There are two alternatives for dealing with reduced levels of defense procurement. On the one hand, the Nation can rely on arsenals, either government or privately owned, that might be sole-source producers of particular military systems. On the other hand, the Nation could modify its military requirements to conform with what might be available from the commercial sector. Either choice will require changes in government procurement laws and regulations. In the absence of deliberate policies, the DTIB is likely to converge toward an arsenal structure as current procurement laws impede civil-military integration and reduced levels of production eliminate competition. An optimal strategy may be to rely on the civilian industrial base whenever possible, depending on arsenals for those areas of defense development and production having little or no overlap with civilian technology, or where only monopoly producers can survive.

Potential v. Current Capability

A third choice concerns the allocation of resources between maintaining current military capability and future military potential. While current capability is needed for theater requirements (as opposed to global conflict), two factors are shifting the Nation's relative emphasis toward future potential: fiscal constraints are limiting procurement, while the less immediate threat of a major conflict allows more time for development of new systems. While the actual choice of this strategy will depend on the defense industrial sector of interest, an overall approach of emphasizing future military potential will remain prudent as long as any large threat remains remote.

Tactical Decisions

In addition to considering the broad strategic choices outlined above, the Nation will need to make a number of tactical decisions about how best to achieve the desired characteristics of the future DTIB outlined in table 1-2. These tactical decisions are discussed in detail in chapter 5.

Advanced R&D Capability

Maintaining a viable defense R&D base in a constrained fiscal environment will require identifying "core competencies," or areas of technological know-how critical for the development and production of major U.S. weapon systems. Since these core competencies are largely embodied in the skills and knowledge of individuals, the major challenge facing defense R&D policy is to attract and retain key personnel and to develop a system in which they can be most creative. Over the longer term, interesting and meaningful work is thought to be the primary motivator for such people. Thus, while downsizing the base, it will be necessary to maintain R&D funding and to provide challenging tasks for defense R&D personnel, possibly through research contracts and programs not directly tied to production.

[10]Arsenals are usually considered to be government-owned facilities that manufacture military materiel. As discussed in this report, however, an arsenal system is composed of either government facilities such as Watervliet Army Arsenal, or private firms that might be sole-source producers of a particular defense technology. The key point is that an arsenal is a single source that maintains a technology that does not exist in the civil sector.

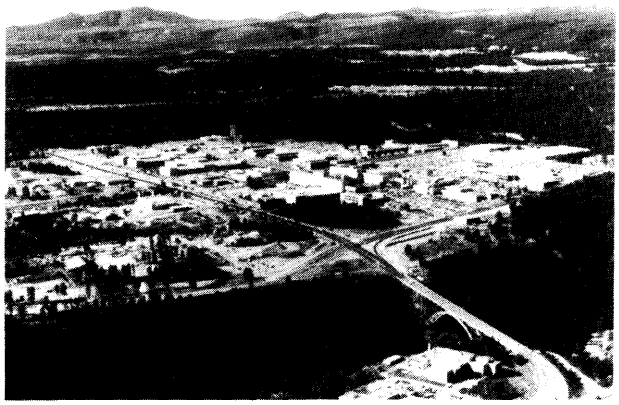


Photo credit: Los Alamos National Laboratory

The Los Alamos National Laboratory, managed by the University of California under contract to the Department of Energy, conducts both nuclear and non-nuclear defense research as well as non-defense R&D.

With less opportunity for traditional competition, new ways must be found to discipline, guide, and evaluate R&D. To this end, new forms of competition might be pursued, such as competing design teams within firms or increased international competition. A teaming or consortium approach involving collaboration among two or more firms may also work in lieu of competition in some cases. The process of prototyping, discussed below, would offer a means of maintaining competitive design and manufacturing capabilities in a severely constrained fiscal environment.

Design and Prototyping

Defense R&D will need to follow a dual-track strategy, emphasizing on one track the development of advanced components and subsystems for upgrading existing weapon platforms, and on the other track, the continuous prototyping of future weapon systems as a hedge against technological surprise. Competitive prototyping would provide information about design concepts and new materials while helping to preserve industrial design teams and innovation in a constrained fiscal environment. Great strides in computer hardware and software have opened up new capabilities for simulation and computer-aided design with enormous potential for future defense R&D, including prototype development.

A prototyping strategy might involve developing several cycles of "technology demonstrators' before one of them suggests a significant new military capability, such as an operational electromagnetic tank gun or improved stealth aircraft (see figure 1-3). A limited production run incorporating the new capability would allow investigation of production processes and field testing of operational concepts. If the system lives up to expectations, a force modernization decision could be made. In addition to testing of operational performance, prototypes should be evaluated by a wide variety of criteria including affordability, relative ease of manufacturing, reliability in the field, and maintainability.

Responsive Production

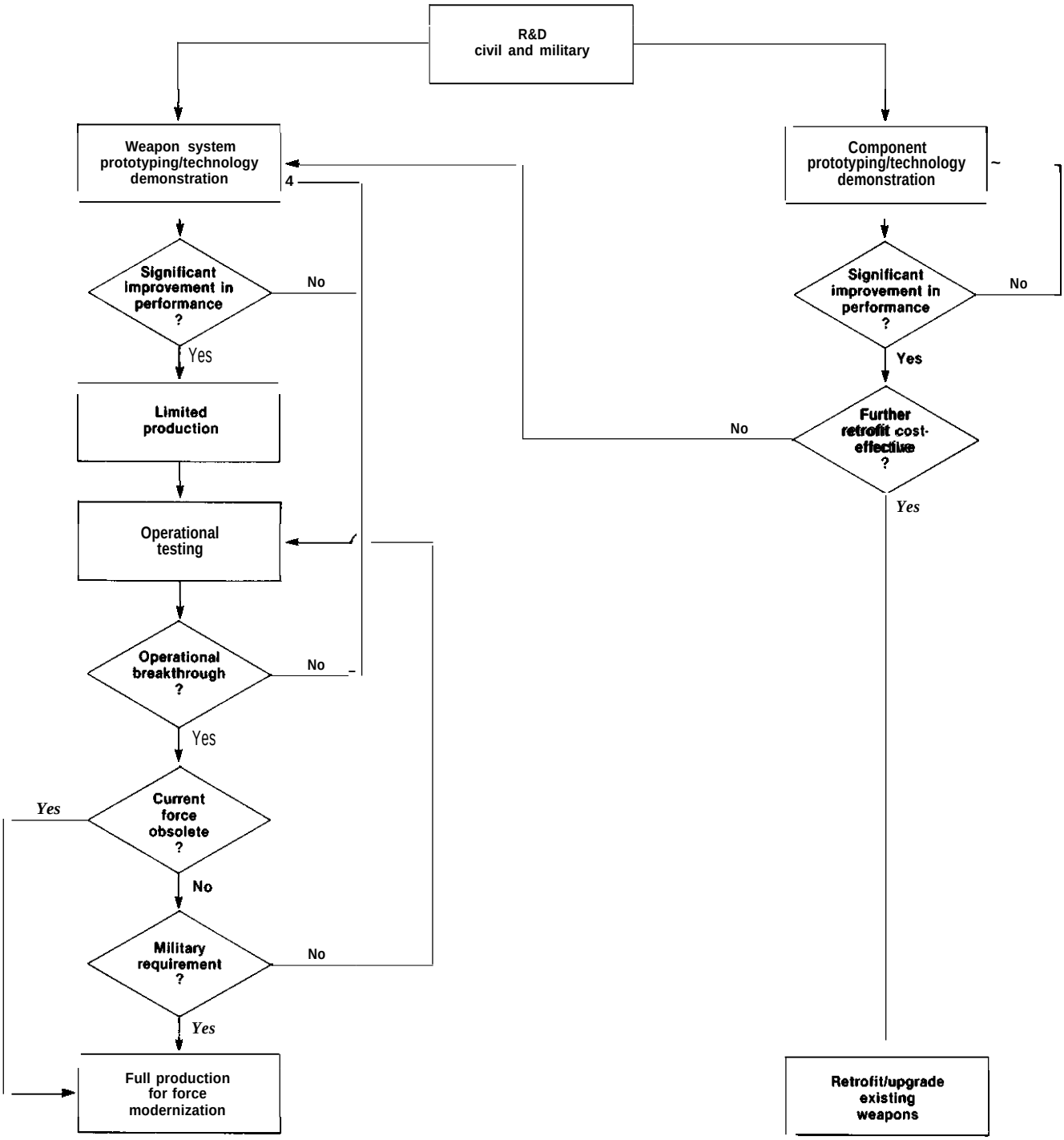
The responsive base that must be capable of surge production can be limited to those consumables, spare parts, and munitions that theater commanders consider critical to their war-fighting needs. Much of this responsive element will probably have to be maintained in a dedicated defense base, although some elements (e.g., clothing and food) can be made to have sufficient commonality with civilian production to allow for greater use of the civilian base. The key to having a responsive base is to develop priorities and provide funding for a surge capability. Industrial preparedness planning requires a coherent management approach that includes maintaining realistic war reserve stocks. Some degree of foreign dependence is unavoidable, but foreign vulnerability can be minimized by identifying multiple foreign suppliers and by stockpiling foreign-sourced parts.

Mobilizable Production Base

While the responsive portion of the DTIB enables the Nation to cope with less challenging but more likely theater-level contingencies, producing military equipment in peacetime at affordable prices requires a much larger industrial base-partly dedicated to defense production and partly in the civil sector. This component of the base would also provide a hedge against a reconstituted Soviet threat or other great-power threat that could arise over a period of years. Since a surge capability in this portion of the base is neither affordable nor necessary, the manufacturing facilities in the mobilizable production base dedicated to defense production (e.g., military aircraft and armored vehicles) should be sized for small, realistic production rates.

Mobilization plans for this larger base might be driven as much by what technologies are

Figure 1-3-Dual-Track Prototyping Strategy



SOURCE: Office of Technology Assessment, 1991.

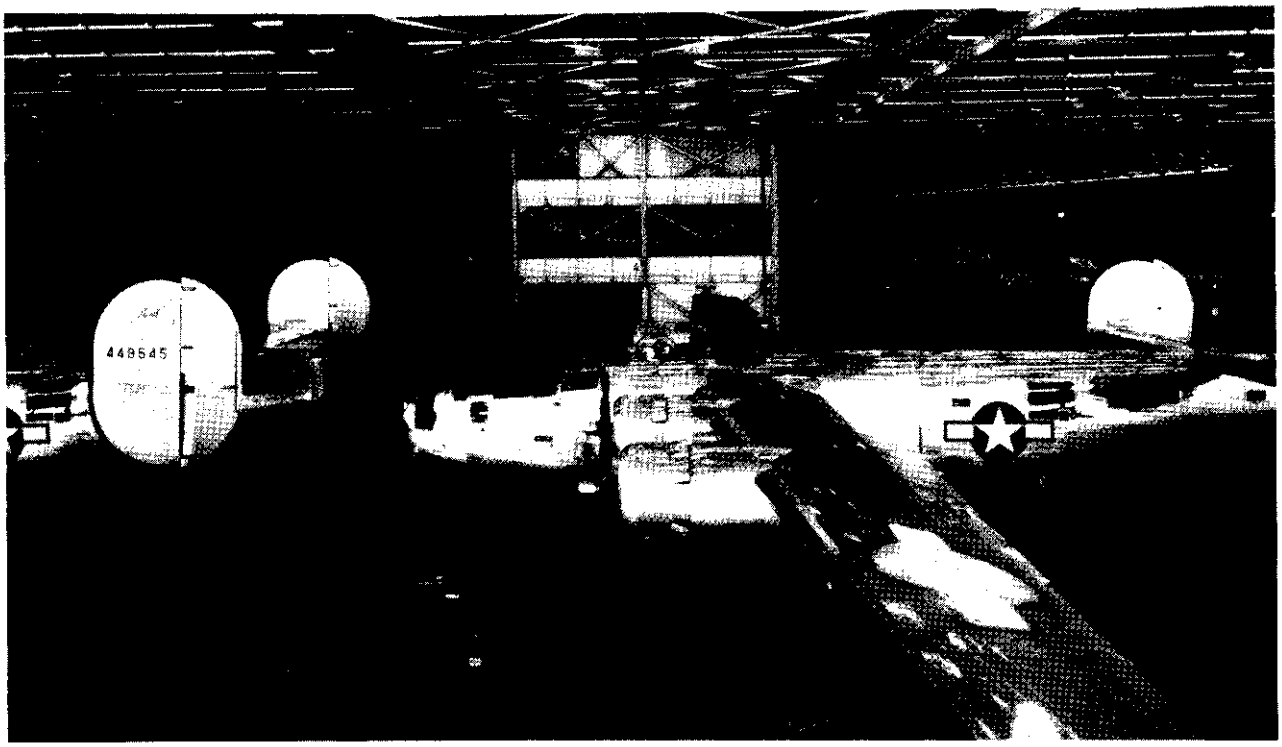


Photo credit: Ford Motor Co. Archives

The mobilization of civilian industry will always be required to meet large-scale threats. During World War II, Ford's Willow Run aircraft factory was the world's largest industrial structure under one roof and turned out 428 bombers a month.

commercially available as by the desire to maximize military performance. If the Department of Defense (DoD) is to make more effective use of the broader civilian base, it will require better data about the commercial availability of dual-use products so that it can identify the industrial sectors in which civilian and defense production can be integrated most effectively. Moreover, since the mobilizable component of the defense base is embedded in the larger civilian base, the ability to mobilize will rely on a strong, competitive U.S. economy. The transition strategy for this component of the DTIB might therefore be shaped by policies to improve the international competitiveness of the broader U.S. industrial base. Policies must also consider the change in corporate culture that must occur if defense firms are to work effectively in a civilian environment. Many of the steps argued to be necessary for strengthening the broader base, such as tax reform and improved technical education, are outside the purview of DoD and the other national-security agencies of the Federal Government.

A recent OTA assessment of international arms cooperation noted that foreign defense firms in Europe and Japan are structured to make much more use of their civilian capabilities.[11] This structure has resulted, at least in part, from different approaches to acquisition and accountability. An essential step in the transition to the future DTIB is a major review of the defense acquisition laws to identify changes that allow greater integration of the civilian and defense sectors. Some of these specific changes are discussed in chapter 5.

Maintenance and Overhaul

The expected longer service life of deployed systems will ultimately increase the importance of maintenance and overhaul capability. Traditionally, this activity has been performed mainly by the military services, but a growing number of manufacturing firms are interested in maintenance, remanu-

[11] U.S. Congress, Office of Technology Assessment, *Global Arms Trade: Commerce in Advanced* Military *Technology and Weapons,* OTA-ISC-460 (Washington DC: U.S. Government Printing Office, June 1991).

Table 1-3—Options for Change in the DTIB

		Tiers of the base				Ownership
		Prime	Subcontractor	Supplier	Private	GOCO[a]
R&D	Current base	Emphasis on systems development for production	Subsystem R&D funded through production contracts from primes	R&D generally driven by civil requirements	scaling back on investment in R&D	Isolation from civil sector
	Desired future base	Emphasis on technology demonstration, prototyping, and potential production	Subsystem R&D funded through government or commercial development	Same as above	Explicit government funding of military-unique R&D; greater access to dual-use technologies	More integration of commercial technologies and technology transfer to the civil sector
Production	Current base	Excess capacity, rapid production to field new systems and minimize unit costs	Respond to subsystem requirements from primes for new platforms	Extensive integration with civilian base, concern over increasing internationalization of the supplier base	Largest element; operates competitively in a relatively high-risk environment	Limited Competition and reduced capital requirements; government moderates risk by providing some facilities and tools and gains efficiency of private management
	Desired future base	Reduced overall capacity, low rates of production to maintain warm base and personnel skills	Respond to subsystem requirements for retrofit of current platforms and new platforms	Rationalize supplier base to protect against potential vulnerabilities	Reduced risk through multi-year contracting and more rational application of competition	Relatively more reliance on GOCOs as a result of reduced peacetime production requirement and to meet surge targets for theater conflict
Maintenance	Current base	Essential but limited involvement in maintenance	Maintenance of subsystems	Not applicable	Essential but limited involvement in maintenance	Maintenance of nuclear weapons primarily
	Desired future base	Increased involvement in maintenance	Same as above	Not applicable	Increased involvement in maintenance to maintain production capability	Increase use of GOCOs to reduce business risk, provide greater management efficiency

a Government-owned/Contractor-operated.
b Government-owned/Government-operated

SOURCE: Office of Technology Assessment, 1991.

facturing, and retrofitting systems as a means of surviving in a period of reduced production. As noted above, however, the dual-track approach to prototyping may help to maintain key design and systems engineering capabilities. The Services are also wary of placing too much reliance for maintenance on private firms. Allocating maintenance contracts between Service depots and private firms should therefore be aimed at preserving a reliable in-house capability while helping to support the commercial production base.

Good, Integrated Management

During the period of rapidly increasing defense budgets in the 1980's, defense procurement laws and regulations were developed to provide wide access to government funds through mandated competition and to ensure accountability in the use of those funds through extensive auditing procedures. Some of these laws and regulations now appear inappropriate for dealing with the transition to a smaller future DTIB. An improved management strategy would modify these laws and regulations, would attempt to make funding more predictable (e.g., through greater use of multiyear procurement contracts or adoption of multiyear defense budgets), would link defense industrial policies explicitly to operational plans, and would take steps to improve the quality of personnel involved in managing the DTIB.

ISSUES FOR CONGRESS

Congress will play an important role in defining the nature of the Nation's future defense technology

Table 1-3—Options for Change in the DTIB—Continued

	Industrial sectors				
GOCO[b]	Defense electronics	Combat vehicles	Shipbuilding	Aerospace	Ordnance
Fragmented lab structure, lack of R&D strategy	Commercial sector dominates	Military-unique, geared toward production	Defense sector dominates, commercial sector not competitive	Robust, but largely focused on system development for production	Military-unique, geared toward production
Consolidate tabs to become world-class developers of specific military technologies	Greater use of commercial developments	Greater use of prototype development that may or may not lead to production	Same as above	Shift in emphasis toward a more deliberate development strategy and use of technology demonstrators	Greater use of prototype development that may or may not lead to production
Preserve unique military technologies that would be too costly or risky to produce in the private sector	Strict military requirements and specifications have isolated defense from civil sector	Tremendous over-capacity, anticipated trough in production	Inadequate demand to maintain competition among shipyards	Overcapacity, anticipated trough in production	Overcapacity, including mothballed munitions plants, yet questionable surge capability in many systems
Same as above	Modified requirements and changed procurement procedures to allow increased use of civil sector	Size plants for smaller, more realistic production rates	increased reliance on single sources for production of warships and submarines	Less frequent modernization, with retrofits and upgrades of existing platforms	Reduced capacity, improved surge capability for selected items
Major element of maintenance base, now undergoing consolidation	Maintenance performed mainly by Services	Maintenance performed mainly in Service depots	Maintenance performed in both public and private shipyards	Maintenance performed mainly in Service depots	Maintenance performed mainly by Services
Relatively reduced use, with sufficient depots to maintain core capabilities	New designs decrease maintenance requests	Competition between Service depots and private sector	More private sector maintenance	Increased competition between Service depots and private sector	Same as above

and industrial base. The desirable DTIB characteristics developed in this report provide a point of departure for congressional debate. These characteristics imply fundamental changes in the way the U.S. Government acquires military materiel and applies its technological and industrial strength to national security. Table 1-3 outlines options for change in the DTIB in terms of four perspectives discussed in chapter 3: functional area (R&D/production/maintenance), size of firm (prime/subtier/supplier), ownership (private/government-owned), and industrial sector (e.g., ammunition or shipbuilding).

The research and development effort, for example, is characterized in the current DTIB by emphasis on systems development for production but would change in the future base to place more emphasis on technology demonstration, prototyping, and ***potential*** production, as outlined in chapter 5. This shift in the orientation of defense R&D away from assumed production of a future system has many implications that require congressional consideration. One particularly difficult issue arises from the fact that considerable component research and development is currently embedded in freed-price contracts that flow from prime contractors to the subcontractors who actually produce subsystems. These subcontractors, many of whom survive by virture of proprietary technical data that gives them a competitive edge, are reluctant to take direct R&D contracts because of concern over loss of technical data lights to the prime contractor and the government. Congress may wish to take action to limit

government rights to technical data, thereby making it easier to incorporate commercial technology into defense systems. Unless this concern is addressed adequately, many more subcontractors may leave the defense business. Table 1-3 contains a number of other similar issues that could lead to legislative action.

Congress will shape the ultimate choices the Nation makes with regard to the broad strategies outlined earlier, all of which involve tradeoffs between national risks and benefits. As noted above, the choice between national autonomy and interdependence involves balancing the risks of relying on other nations for critical defense goods against the benefits of access to the growing number of technologies developed abroad and the synergies that arise from cooperation with economically strong allies. The choice between arsenals and civilian integration involves balancing the risk of losing key military technologies against the benefits of access to a broad range of useful civilian technologies and a greater latent mobilization capacity. The choice between military potential and current capability involves balancing the risk of being inadequately prepared to meet near-term threats against the benefit of developing more effective future weapons. None of these broad strategies is likely to be pursued in absolute terms, and the application of any given strategy will be tailored according to ownership, tier of the base, functional area, and industrial sector.

Congress will have a deciding role in which tactics to pursue to achieve and maintain the desired characteristics of the future DTIB. First, congressional action will be required for the explicit full funding of R&D previously supported by production. Since the government's calculation of past R&D costs have often not included the money that firms have spent from profits, the explicit R&D funding requirements may appear high. Second, Congress will want to examine new forms of competition that are more amenable to a fiscally constrained environment, such as competitive prototyping or encouraging radically different approaches to achieving a given military objective instead of competitions between similar platforms. Third, Congress will want to consider the tactic of using foreign sales to maintain production lines, including an assessment of the long-term national security implications of the proliferation of advanced conventional weapons.[12]

Obstacles to redesigning the DTIB arise from incentives in both government and the private sector to maintain current capabilities rather than to restructure the base to emphasize future military potential. In addition, anticipating changes in the base involves asking both industry and DoD to make decisions that entail definite short-term costs in the interest of obtaining uncertain long-term benefits. To cut through these constraints, the Nation needs a long-term defense technology and industrial strategy that provides a predictable planning environment for government organizations and fins. The strategies and tactics laid out in this report could provide the basic elements of such a planning environment.

All of these policy options demand fundamental reexamination of, and specific changes in, procurement laws, regulations, and specifications. The current procurement process discourages many qualified firms from bidding on defense contracts because of the large amounts of paperwork involved and military specifications that are often excessively demanding. Another problem stems from the twin objectives of access and accountability, which have driven the competitive approach to defense procurement. Numerous Federal laws and regulations have been designed to ensure access to DoD contracts by the maximum number of firms, as well as accountability of government funds by those winning such contracts.

Congress has viewed competition as an ideal way of reducing costs, increasing access to new fins, and stimulating innovation. These goals are embodied in statutes mandating competition for defense contracts, such as the Competition in Contracting Act (CICA) and laws that require "setting aside" certain percentages of defense contracts for small and disadvantaged businesses. Unfortunately, as discussed in chapter 4, competition as currently practiced often ends up increasing overall procurement costs while doing little to foster innovation. Although the law allows exemptions from competition where it is inappropriate, in practice the exemptions are rarely exercised because of a lack of bureaucratic incentives for doing so. Competition is thus an important management tool that should be

[12] OTA, *Global Arms Trade*, ibid, addresses the proliferation issue in detail.

structured differently in the future. One way maybe to emphasize competitive design and prototyping, as discussed in chapter 5.

The principle of accountability also warrants a new look by Congress. Large increases in defense expenditures in the early 1980's and revelations of criminal conduct by some defense contractors led to growing congressional concern with ensuring the proper use of government funds. While accountability is clearly essential, there are indications that the current approach is counterproductive. Government and company auditors consume large amounts of time and money contesting what is or is not allowable, and the criminal sanctions associated with violations of many defense-procurement laws cause contractors to fear that honest mistakes could lead to prosecution and possible prison terms. Under these conditions, companies have a strong incentive to err on the side of caution, even if this means taking measures that increase procurement costs considerably. Moreover, the government's special auditing requirements have the unintended effect of isolating the defense industry from the civilian sector. Given budgetary constraints, Congress may wish to reform the current approach to ensuring accountability by moving more in the direction of commercial business practices.

Finally, U.S. procurement law in the 1980's stressed competition and accountability in a way that transferred more risks to the defense industry. Since defense spending was increasing rapidly and the overall economy was engaged in a national borrowing spree, companies were generally willing to build new manufacturing facilities and to accept small near-term profits in the expectation that future sales based on projected production would amortize the investment. Yet the sharp downturn in defense spending is now confronting the industry with financial problems that may well result in the loss of critical elements of the DTIB. Congress may therefore wish to examine new ways of rationalizing the base so that the Nation retains a sound defense industrial capability and not simply a collection of lucky survivors.

SUMMARY

This report provides the framework for congressional debate over the transition to a downsized but still robust DTIB. In the aftermath of the cold war, the Nation no longer faces a single predominant threat to its security and global interests but rather an array of lesser, ambiguous threats. Dramatic changes in the security environment-the dissolution of the Warsaw Pact, the withdrawal of Soviet forces from East-Central Europe, and the growing turmoil within the Soviet Union-combined with increased fiscal constraints in the United States, are resulting in significant cuts in U.S. defense spending.

The decline in budget authority since 1985 and the expected sharp drop in procurement contracts over the next 5 years has already affected the DTIB. Defense contractors, both prime and subtier, are adapting to a shrinking market by diversifying or leaving the defense business altogether. At the same time, procurement laws relating to military specifications, competition, and accountability, many of them written during a period of rising military budgets, now create serious obstacles to the rationalization of the base and the greater integration of civilian and defense production. If this ad hoc restructuring process is allowed to proceed, it could jeopardize the Nation's future ability to develop affordable, high-performance weapon systems and to mobilize its defense industrial capacity in crisis and wartime.

A rational transition to a downsized but viable DTIB will entail preserving critical, long-lead-time design and production capabilities. This task will in turn require Congress to demonstrate leadership by taking a broad strategic approach to the Nation's future national security needs, even at the expense of some immediate political and economic concerns on the part of States and congressional districts.