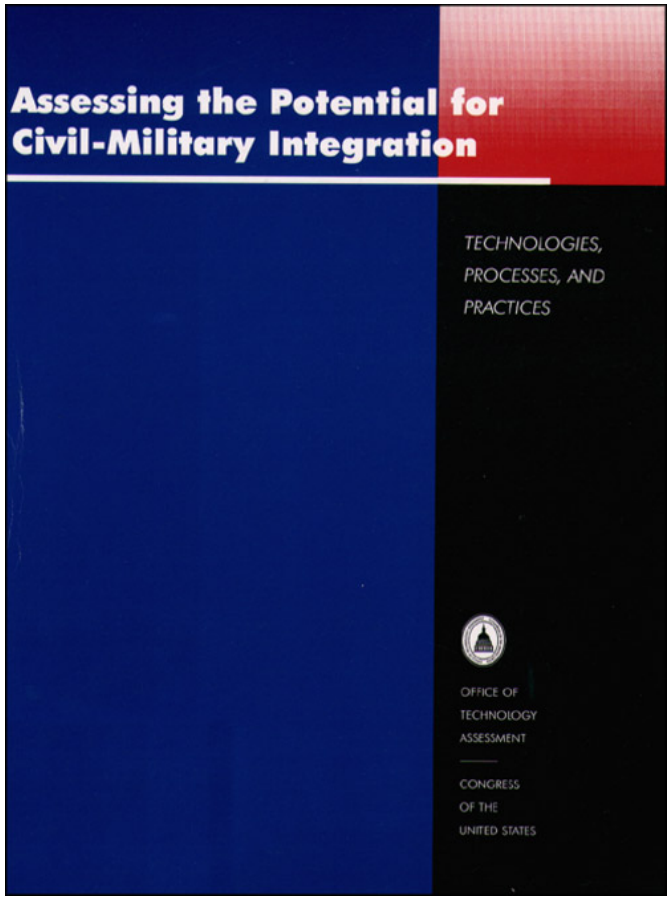
Assessing the Potential for Civil-Military Integration: Technologies, Processes, and Practices

September 1994

OTA-ISS-611
NTIS order #PB95-109666
GPO stock #052-003-01394-1



Recommended Citation: U.S. Congress, Office of Technology Assessment, Assessing *the Potential for Civil-Military Integration: Technologies, Processes, and Practices, OTA-ISS-611* (Washington, DC: U.S. Government Printing Office, September 1994).

For sale by the U.S. Government Printing Office
Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402-9328
ISBN 0-16-045309-7

Foreword

America's national security and economic well-being have long rested on its technological and industrial prowess. Over the four-decade-long Cold War, the Nation's defense technology and industrial base became largely isolated from the commercial base, thus losing some of the benefits of the larger base. This isolation raised the cost of many defense goods and services, reduced defense access to fast-moving commercial technologies, and made it difficult for commercial firms to exploit the results of the Nation's large defense science and technology investments.

Government officials and private sector executives have advocated the integration of the defense and commercial sectors (often termed civil-military integration or CMI). The claimed benefits of CM I include cost savings, increased technology transfer, and an increase in the number of potential defense suppliers. A CM I strategy, however, demands extensive modification of acquisition laws and regulations, and concerns over potential costs and risks of such modifications have hindered change. Although several congressional and administration initiatives have been launched to promote integration, to date, much of the defense base remains isolated and the promised benefits of integration remain elusive.

This assessment found that greater CM I is possible. It confirms the potential for cost savings and increased technology transfer, but analysis indicates such savings are likely to be less, and slower to realize, than many previous studies have suggested. Even so, cost savings of even a few percent of total defense technology and industrial spending would amount to billions of dollars in overall savings that might be used to meet other vital defense needs. The most important benefit of increased CMI may be the preservation of a viable defense technology and industrial capability in an increasingly fiscally constrained environment. Increased CMI appears essential if defense is to take advantage of rapidly developing commercial technologies.

This assessment identified no "silver bullet" policies that might easily achieve CM I goals. Some policies can have broad effects, but in most instances the barriers to increased CMI are sufficiently intertwined to demand a comprehensive (and complex) set of policies if the projected benefits are to be achieved.

In undertaking this assessment, OTA sought information and advice from a broad spectrum of knowledgeable individuals and organizations whose contributions are gratefully acknowledged. As with all OTA studies, the content of this report is the sole responsibility of the Office of Technology" Assessment and does not necessarily represent the views of our advisors and reviewers.

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Note: OTA appreciates and is grateful for the valuable assistance and thoughtful critiques provided by the advisory panel members. The panel does not, however, necessarily approve, disapprove, or endorse this report. OTA assumes full responsibility for the report and the accuracy of its contents.

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Preface

Two recent reports by the congressional Office of Technology Assessment (OTA) examined the nature of the defense technology and industrial base (DTIB) necessary to meet future U.S. national security needs.[1] These reports considered future military force structure alternatives, defense technology and industrial needs associated with these forces, characteristics of a DTIB that could fill those needs, and alternative strategies that might be employed to achieve the desirable DTIB characteristics. One alternative recommended by many industry representatives and government officials is the integration of the defense and commercial industrial bases.

Other recent studies have examined the benefits of and barriers to integration of the DTIB and the commercial technology and industrial bases-often termed civil-military integration (CMI).[2] They also recommended a number of possible actions to increase integration. This assessment builds on their recommendations for possible actions to further integration.

This report responds to requests by the Senate and the House Armed Services Committees to investigate the potential for civil-military integration and the implications of such integration. It is divided into six chapters and five appendices. Three of the supporting case studies (Composite Materials, Flat-Panel Display, and Shipbuilding) are being published in a separate background paper.

Chapter 1 summarizes the principal assessment findings and presents policy options for consideration by Congress. Chapter 2 discusses strategies for implementing increased CMI. Chapter 3 provides a general overview of CMI, including a detailed definition and discussion of integration at several levels; reviews the debate on civil-military integration; provides a framework for considering CMI; and outlines OTA's approach to this issue. Chapter 4 addresses the current level of commercial purchases, the potential for purchasing more commercial goods and services, and the policies necessary to support such a strategy. Chapter 5 examines the current level of process integration in R&D, production, and maintenance, and the potential for greater integration in these activities. It also considers the steps needed to implement such integration, as well as the benefits and risks associated with these steps. Chapter 6 examines policies relating to that portion of the DTIB that is likely to remain segregated. It considers CM I policies that might lower costs and increase the potential for technology transfer in the segregated base.

[1] The Office of Technology Assessment's earlier study of the defense technology and industrial base resulted in two reports: *Redesigning Defense: Planning the Transition to (he Future U.S. Defense Industrial Base,* OTA-ISC-500 (Washington, DC: U.S. Government Printing Office), July 1991 and *Building Future Security: Strategies for Restructuring the Defense Technology and Industrial Base,* OTA-ISC-530 (Washington, DC: U.S. Government Printing Office), June 1992, and three background papers: *Adjusting to a New Security Environment: The Defense Technology and Industrial Base Challenge,* BP-ISC-79 (Washington, DC: U.S. Government Printing Office), February 1991; *American Military Power: Future Needs, Future* Choices, BP-ISC-80 (Washington, DC: U.S. Government Printing Office), October 1991; and *Lessons in Restructuring Defense Industry: The French Experience,* BP-ISC-96 (Washington, DC: U.S. Government Printing Office), June 1992.

[2] These studies include *Use of Commercial Components in Military Equipment,* conducted by the Defense Science Board in 1986 and 1989; The Center for Strategic and International Studies' *Report on Integrating the Commercial and Defense Technologies for National Strength,* in 199 l; a report by the DOD Acquisition Law Advisory Panel, *Streamlining Acquisition Laws, 1993;* and a report by the Defense Science Board Task Force on *Defense Acquisition Reform,* in 1993.

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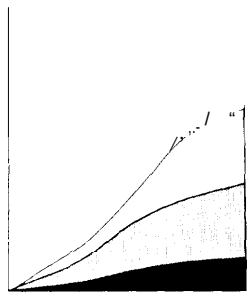
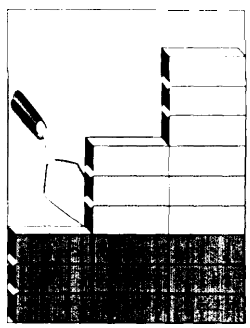
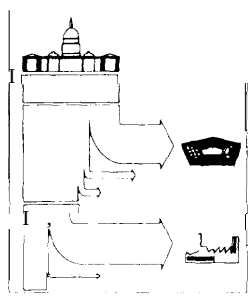


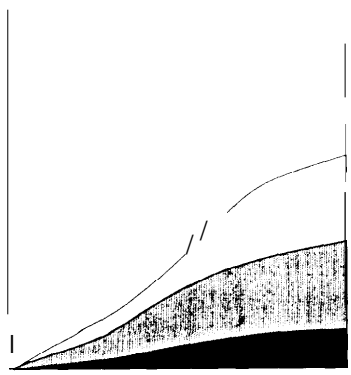




Summary and Findings 1

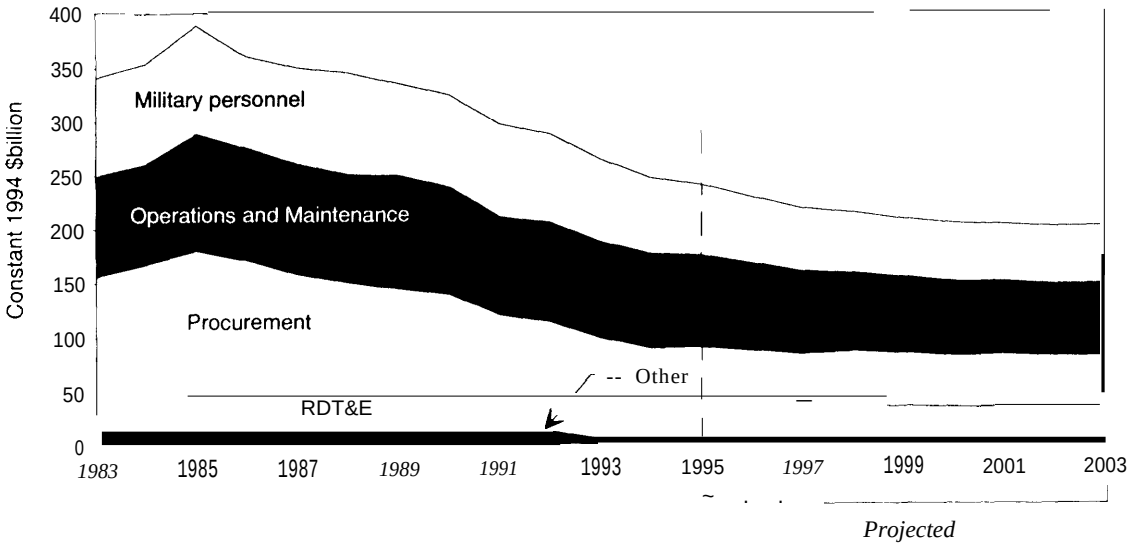
The end of the Cold War has not brought an end to the need to maintain a viable American defense force. Since 1990, the United States has fought a major conflict against a well-armed, if badly led, opponent, and deployed troops to several regional trouble spots. Although the emergence of a new global military threat on the order of that of the former Soviet Union is unlikely in the foreseeable future, demographic changes, border disputes, and the expansionist goals of some regional leaders have fostered the growth of a variety of lesser threats to peace and stability. In the longer term (15 to 20 years), however, the reemergence of a major military threat cannot be discounted. The United States, in concert with its allies, will need to maintain adequate military forces to protect its vital interests against these various contingencies.

These forces must be reconciled with short-term budget constraints. The remarkable changes in the global security situation accompanying the end of the Cold War have resulted in significant and continuing reductions in the U.S. defense budget. Assuming no new global military threat, total U.S. defense budget authority is predicted to fall from a peak of almost $390 billion (constant 1994 dollars) in 1985 to about $200 billion (constant 1994 dollars) in the first decade of the next century. (See figure 1-1.) Confronted with continued fiscal constraints, the defense budget may decline even further.



Spending for research and development, procurement of goods and services, and depot-level maintenance activities necessary to arm and sustain American forces in the field could fall from about $190 billion to between $80 to $100 billion in that same period, measured in constant 1994 dollars.

FIGURE 1-1: DOD Budget Forecast by Category



SOURCE Electronic Industries Association *Ten-Year forecast of Defense, NASA and Related Markets Electronic Opportunities*, October 1993

Confronted with declining budgets, many government officials and private-sector executives advocate the increased use of the commercial technology and industrial base (CTIB) as one strategy for preserving adequate technological and industrial capability to help meet future national security needs. [1] This increased use of the CTIB, dubbed civil-military integration (CMI), can take many forms, including purchasing commercially available goods and services, conducting both defense and commercial research and development in the same facility, manufacturing defense and commercial items on the same production line, and maintaining such items in shared facilities.

CONGRESSIONAL INTEREST

Congress has been very interested in the potential benefits of CMI. But Congress has also been concerned about the potential costs and risks associated with changing acquisition policy to promote such integration. Congressional interest is evident in earlier defense acquisition legislation. The Competition in Contracting Act (CICA) of 1984, for example, requires federal agencies to "promote the use of commercial products wherever practical." [2] And the Defense Procurement Reform Act of 1984 mandated that DOD use "standard or commercial parts" when developing or acquiring militarily unique products "whenev-

[1] This report uses the modifiers "civil," "civilian," and "commercial" interchangeably when discussing the portion of the national technology and industrial base that sells on the open market on the basis of price. The modifier "private." however, when referring to a business or sector. denotes nongovernment ownership.

[2] 10 U.S.C. § 2301 (b)(6).

er such use is technically acceptable and cost effective."[3]

Despite several DOD initiatives to increase commercial purchases and use commercial business practices. many in Congress, industry, and the executive branch noted a slow acceptance of commercial goods and services for defense use and a reluctance to make changes in government practices that would promote CMI.

The 1990, 1991, and 1993 Defense Authorization Acts all contained language promoting CMI. The 1990 Defense Authorization Act directed DOD to streamline regulations governing commercial products and to design and implement a simplified uniform contract for commercial items. The 1991 Defense Authorization Act called on DOD to determine the availability and suitability of nondevelopmental items (including commercial items) prior to contracting for militarily unique products. The 1993 Defense Authorization Act directed DOD to modify its acquisition policy to encourage the integration of the defense technology and industrial base (DTIB) with the CTIB.

Although the Clinton Administration has embraced many of the proposed acquisition reforms designed to increase integration, actual change has been slow. However, DOD has launched a number of new initiatives aimed at increasing CMI, including eliminating the unnecessary use of military specifications and standards. The Department also proposed several pilot acquisition programs to test new ways of doing business. These initiatives hold the promise of producing important change.

As this report goes to press, Congress has passed the Federal Acquisition Streamlining Act (FASA) of 1994. FASA incorporates many of the proposals from the Acquisition Law Advisory Panel commissioned earlier by Congress to recommend changes to acquisition law. and includes a number of provisions that will enhance CMI. Specifically, FASA provides a new definition of commercial items, raises the dollar threshold for simplified acquisition contracts, makes it more difficult for the government to demand rights in technical data, removes some of the requirements for cost and pricing data in the case of commercial products and/or competitive contracting, and increases potential government purchases of commercial items.

FASA is an important step toward increasing CMI, but overall cost savings from its provisions may be limited. They will affect only a portion of DTIB spending (this is considered in more detail in the discussion of CMI strategies in chapter 2), and they may not have an effect on some of the activities where savings might be greatest (e.g., the integration of processes and also in the reduction of government infrastructure as a result of CM I). But even if savings are less than some anticipate. the effect on the long-term preservation of the DTIB could still be significant. The provisions for commercial purchases should increase the potential for gaining access to useful technology in rapidly developing commercial sectors. This access may be crucial in a fiscally constrained environment.

In their requests to OTA to undertake an examination of the potential for CMI, the Senate and House Armed Services Committees noted that despite the studies recommending increased use of commercial industry to support national security objectives, as well as broad verbal support from government and industry, "there have been few changes in the acquisition process to increase civil-military integration." The Committees requested that OTA "focus on the technical potential for civil-military integration."

[3] *Streamlining Defense Acquisition Laws: Report of the Acquisition Law Advisory Panel to the United States Congress*, January 1993, p. 8-3. The Defense Procurement Reform Act is Public Law No. 98-525, § 1202, 98 Stat. 2588 (1984).

SOME CRITICAL QUESTIONS

The glacial pace of change in the face of widespread support raises several questions about the potential for actually accomplishing integration. These questions are important in considering policy alternatives for Congress. They include:

- How much integration currently exists? Where is this integration occurring?
- Are some technologies, industrial sectors, industrial tiers, and activities (e.g., R&D, services) more amenable to CM I than others? Are there identifiable characteristics that enhance the potential for integration? If so, can these characteristics be developed in other technologies, industrial sectors, industrial tiers, and activities?
- What are the benefits of increased CMI? What are the costs and risks? Are the incentives for CMI sufficient to foster integration?
- What are the limitations to CMI in achieving national security objectives? What are the potential implications for weapons design and battlefield performance?

An estimate of the current level of integration and of how and where that integration occurs is absolutely essential in developing policy alternatives for future integration. In the past, there has been no systematic attempt to estimate either the level of integration or the means of that integration. DOD is beginning an estimating process.

OTA conducted a trial industry survey that provided insights on the current and potential levels of integration and suggested an approach to systematic gathering of integration data. A better understanding of what characteristics might make a technology, industry, or activity more amenable to integration could help direct CMI efforts toward areas that might have the greatest potential for change. Past case studies, and the analysis in this assessment, provide some insight into characteristics of amenability. Industry interviews and discussions suggest that amenability to integration might be promoted in various technologies and industrial sectors through conscious efforts to design for dual-use (commercial and defense) rather than for military use alone.

Cost savings and access to technology are frequently cited as reasons to integrate, but savings have been difficult to document or may not necessarily translate beyond a particular case study. Policy development demands a better understanding of the potential benefits and the associated costs. This assessment has attempted to provide more insight on benefits and costs by combining the findings of individual case studies with: data from a survey of selected industry sectors; macroeconomic data on defense spending patterns; and information on the industrial tier structure.

It is clear that the incentives to change the acquisition laws and regulations to enhance CMI have been insufficient in the past. While the falling defense budget appears to be a major new incentive for integration, it too may be insufficient to prompt total change necessary to gain the full benefits of CMI. But a better understanding of the potential benefits and costs of CMI may add sufficient stimulus to promote change.

Most previous studies have focused on the administrative and regulatory barriers to CMI and on the need to adjust these. But integration also confronts technical barriers. Some military specifications are absolutely essential. But determining what is and is not truly essential for military purposes can be difficult. It is clear, however, that greater reliance on commercial technology will have an impact on the nature of weapon systems and on future force operations. These effects will be evident not only in the systems available, but also in the ability of the technology and industrial base to respond to national security requirements.

DEFINING CMI

Definitions are essential—not only for the term "civil-military integration, " but also for the various related act ivities, such as "commercial goods" and "'commercial services." Policy formulation for CMI has been handicapped by the lack of a standard definition of CMI. OTA developed a

working definition of CMI (see chapter 3), and definitions of commercial goods and services (see chapter 4).[4]

In this study, Civil-Military Integration (CMI) is defined as the process of uniting the Defense Technology and Industrial Base (DTIB) and the larger Commercial Technology and Industrial Base (CTIB) into a unified National Technology and Industrial Base (NTIB).[5] Under CMI, common technologies, processes, labor, equipment, material, and/or facilities would be used to meet both defense and commercial needs.

Although most of the analysis and discussion of CMI has been focused on activities at the facility level, in the course of this assessment it became clear that useful integration activities also occur at other levels. This assessment therefore examines integration activities that occur at the level of: 1) the industrial sector within which firms. government organizations, and academia can share product and process technologies, and 2) the firm, where certain corporate resources can be shared (e.g., research, finance) even if the actual defense and commercial work of the firm is segregated.

In estimating the degree of integration that currently exists, or could exist in the future, this assessment used a broader definition of what constitutes integration than has been used in many past studies. During interviews and analysis, R&D, manufacturing, maintenance, and administrative activities were each considered independently. Thus, a firm that integrates R&D and separates production is not considered segregated, but is considered to have one activity segregated and one integrated.

TABLE 1-1: Sources of Segregation

- Acquisition laws, regulations, and culture
- Military specifications and standards.
- Militarily unique technologies or products
- Commercially uneconomical orders
- Emphasis on performance over costs.
- Classified technologies.

SOURCE OTA based on analysis of previous CMI Studies 1994

SOURCES OF SEGREGATION

Previous studies identified a number of sources of segregation, as shown in table 1-1.

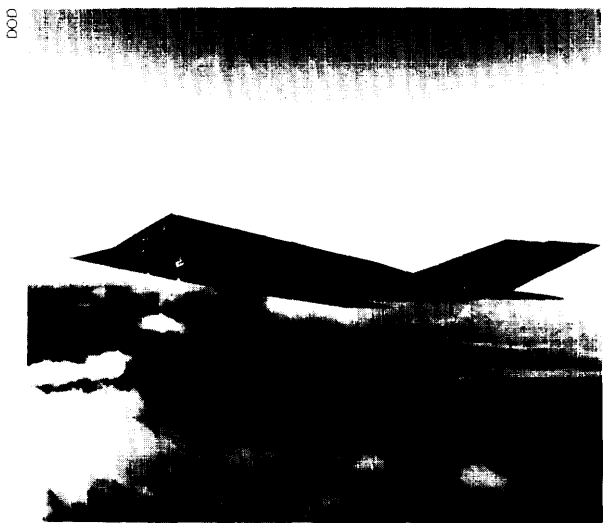
Defense cost accounting rules are the most often cited reason for segregating operations. In actual practice, however, the reasons for segregation appear to vary by technology and product. Still, the current structure of acquisition laws and regulations—and the culture they engender—-provides few incentives to integrate. Furthermore, many of the regulations promote an adversarial relationship between government and private industry and raise product costs. Provisions of FASA address some of these issues.

Beyond the acquisition culture, segregation has also resulted from the use of military specifications and standards in situations where they were not necessary. Full implementation of the new DOD policy on the use of specifications and standards should solve some of these problems.

Segregation flows from the fact that some military products, services, and processes with specialized uses have no commercial market. And while some militarily unique items might benefit

[4] The definition of commercial goods and services used during the assessment is roughly equivalent to the definition contained in the Federal Acquisition Stream] ining Act of 1994.

[5] This national base is understood to be embedded in the larger Global Technology and Industrial Base. Pol icy makers will have to develop DTIB policies in the context of this larger base.



from coproduction on a commercial production line, they are often ordered in volumes that are economically unattractive to commercial manufacturers.

The segregation of the DTIB also stems from the priority placed on developing and producing high-quality and high-performance equipment—a result of decisions to spend money rather than lives to achieve military objectives. This source of segregation was exacerbated by technological trends during much of the Cold War period, when military technology often led its commercial counterpart.

A final factor has been the need to keep some types of technology and information (e.g., design of nuclear weapons) out of the general public domain and away from potentially hostile countries. The desire to preserve superiority in sensitive conventional technologies, such as radar-absorbent materials, by limiting dissemination of information about them is another example.[6]

BENEFITS OF THE CURRENT SYSTEM

Although the policies that created the current acquisition system contributed to the segregation of the DTIB, these policies were implemented to achieve important goals, including: public accountability, mobilization readiness, development of high-quality equipment, and preservation of technology security.

One of the primary objectives of instituting the cost-based acquisition structure was to guard against waste, fraud, and abuse. In addition, the government used the defense budget to attain a number of socioeconomic goals, including support for small and minority-owned businesses.

While the classification of some development programs contributed to segregation, such segregation was also beneficial in limiting the flow of information to adversaries and providing a technological edge on the battlefield. The results were evident in the active combat of Korea, Vietnam, and Iraq, and during the Cold War confrontation with the Soviet Union.

Similarly, the standardization of equipment following World War 11 was both a benefit to logistical support (providing greater reliability and faster repair) and a factor in segregation. Despite the higher costs of equipment, it could be operated and maintained more efficiently than in the past.

The fact that past policies have had both beneficial and harmful effects makes change more difficult.

IMPETUS FOR CHANGE

The end of the Cold War has provided an impetus for changing the current structure of the DTIB. Yet even earlier, it was evident that the current level of segregation was unacceptable. The demise of the Soviet Union and the risks it posed to the security of the United States, however, have removed many of the constraints on modifying the defense

[6] See U.S. Congress, Office of Technology Assessment, *Proliferation of Weapons of Mass Destruction: Assessing the Risks*, OTA-ISC-559 (Washington, DC: U.S. Government Printing Office, August 1993).

acquisition system. The current system appears to cost more than the Nation is willing to pay.

Studies show that segregation often increases initial acquisition and life-cycle costs; limits flows of information and technology; and reduces the numbers of firms willing to sell to the government. These studies further suggest that segregation contributes to decreased economic competitiveness due to the inefficient use of national resources.

Many of the studies have attempted to calculate the added costs and other negative effects of the government requirement for cost and pricing data; unique contract clauses; the use of inappropriate or unnecessary military specifications and standards; and disputes over technical data rights. Studies have estimated cost increases of 20 to 60 percent resulting from various government acquisition rules. Some estimates were even more dramatic. A Defense Science Board study on commercial products, for example, reported that the militarily specified version of the STU-III classified telephone cost 10 times more than a commercial version.[7] Although it is difficult to generalize the finding of such case studies, it is clear that the current system has driven up costs and acquisition times.

Part of the added costs are alleged to result from the numbers of personnel in private firms needed to respond to DOD's reporting demands and to interface with the government's oversight personnel. Businesses must retain contract specialists and others to gather and report the information necessary to comply with current government accounting, auditing, and other requirements.

The government oversight complex is costly too. DOD employs more than 178,000 personnel as a part of the acquisition workforce. This runs in excess of $7 billion per year in salaries alone. Added to the expense of these personnel are the expenses of redundancies between private- and

U.S. ARMY

The Anniston Army Depot Tank Rebuild Line is part of the public-sector DTIB.

public-sector capabilities in research, development, testing, and engineering (RDT&E), production, and maintenance—almost 370,000 people work in these functions in public sector facilities (e.g., Service and DOE laboratories and test facilities, DOD and DOE production facilities, and Service maintenance facilities). Allowing for double-counting of some personnel in both the acquisition workforce and the RDT&E effort. the total public sector workforce is estimated between 475,000 to 500,000, costing more than $18 billion per year.

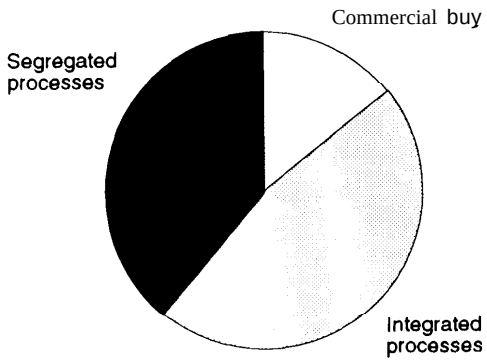
The segregated nature of the DTIB restricts the flow of product and process information and technology between the DTIB and the CTIB, discouraging innovation in both the manufacture of military systems and the substitution of more advanced components in those systems. In some cases, the DTIB does not have access to the full range of technology available in the CTIB.

In sum, studies indicate that the current level of segregation has resulted in inefficiencies and redundancies that have restricted the exploitation of scarce national technology and industrial base resources. The decline in defense funding necessi-

[7] Caution needs to be applied to all cost savings estimates. The commercial alternative STU-III was developed several months after the defense version and contained some less expensive, and better, technology not previously available.

tates greater efficiency in defense acquisition and makes reform of the current system a priority.

FIGURE 1-2: Current Facility-Level CMI Division of the Private DTIB at All Tiers



Key

Commercial buy Procured from private facilities on the basis of a commercial market price

Integrated Processes Procured from private facilities that predominantly use common processes for both defense and commercial goods or services This sharing of processes might occur in R&D, production, maintenance, or administration R might revolve the use of common equipment, labor, management, or inventory

Segregated processes Procured from private facilities that have largely or completely segregated their defense work from any commercial work

SOURCE Industrial survey conducted by the Off Ice of Technology Assessment, 1994

FINDINGS

The assessment resulted in a number of findings related to the questions stated earlier and other aspects of CMI.

Some Integration Currently Exists

The current DTIB appears to have a significant amount of integration already. OTA estimates that many of the goods and services coming from the private-sector portion of the DTIB are already derived from either commercial purchases or firms using integrated processes. Much of the DTIB, nonetheless, appears mired in segregated processes. Figure 1-2 shows an estimate of the current degree of CMI based on the results of OTA's industry survey.[8]

The figure estimates the value added to national security goods and services through 1) commercial purchases, 2) integrated processes, and 3) segregated processes.

These estimates are based on a limited industrial sector survey. Thus, they should be considered suggestive rather than definitive. Nevertheless, they do provide valuable insights on the DTIB.

Increased Integration Appears Possible

The findings of this assessment confirm that it is possible to increase commercial purchases, make greater use of commercial practices, and promote the integration of processes-if changes are made in current government acquisition policy, efforts are made to adapt technologies, and steps are taken to restructure the DTIB. The level of growth of CMI will depend on the extent of policy change.

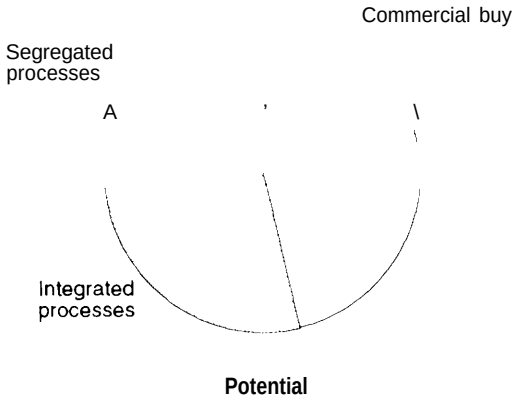
OTA's broad estimates of the potential for increased CMI, based on significant reform, are shown in figure 1-3.[9]

The estimate of potential increase of CMI shown in figure 1-3 does not indicate any particular amount of savings. Estimating cost savings requires considerations of the impact of these policy changes on the base over time. OTA has made some estimates of potential savings, discussed later in this chapter and more extensively in the examination of CMI strategies in chapter 2.

[8] These estimates are based on a Macroeconomic examination of the DTIB and an industry survey. The survey is discussed in chapter 4, box 4-2.

[9] In addition to the industry survey noted earlier, OTA used interviews, case studies, and analyses of selected industrial sectors to validate its estimates. Again, these estimates are based on a limited sample and should be considered suggestive rather than definitive.

FIGURE 1-3: Potential Facility-Level CMI Division of the Private DTIB at All Tiers



SOURCE Industrial survey conducted by the Office of Technology Assessment 1994

Case studies and surveys reviewed for this assessment support the industry survey conclusion that with appropriate policy initiatives, increased integration is possible. But because almost all of these studies considered only individual segments of the DTIB, the case studies provide very limited insight into the impact of a comprehensive CMI policy on the DTIB as a whole. The 1993 report of the Defense Science Board Task Force on Acquisition Reform is an exception. That report attempted to both identify possible increases in CMI within the entire base and quantify potential savings.

The potential for increased integration is enhanced by the fact that both Congress and DOD are actively pursuing CMI initiatives. As noted earlier, Congress has pushed for greater integration in recent legislation, including FASA. DOD has responded with several initiatives. Most recently, Secretary of Defense William Perry issued a directive eliminating the use of many military specifications and standards and placing greater reliance on commercial specifications and standards. In addition, DOD has supported further efforts to simplify contract procedures, and has nominated seven pilot programs for testing alternative acquisition strategies. 10

Developments in technology reinforce the trend toward integration of the DTIB and CTIB. More products and services can meet both defense and commercial needs. The same model personal computer, for example, can be used at the Pentagon or at General Motors Corp. The same ruggedized laptop computer might be used by military forces in the field or by petroleum exploration teams in remote areas. Components of these systems are even more interchangeable. The improved quality of commercial integrated circuits, for example, often make them interchangeable with devices produced according to military specifications and standards. Some even argue that commercial items are often superior.

Developments in process technology are increasingly applicable to defense and commerce. Commercial manufacturing is gaining the capacity to profitably produce small lots of an item. Some observers anticipate that with advances in

DOD

Commercial computers and electronic components can now meet many defense needs

[10] FASA supported the implementation of five DOD pilot programs: the Fire Support Combined Arms Tactical Trainer, Joint Direct Attack Munitions, Joint Primary Aircraft Training System, Commercial-Derivative Aircraft, and Commercial-Derivative Engine.

TABLE 1-2: Characteristics That Make a Defense Good or Service (G/S) More or Less Amenable To Integration

More amenable	Less amenable
Fills a similar defense and commercial need.	Has no related commercial variant (esp. weapons).
Readily customizable from commercial G/S.	—
Processes similar to commercial processes.	Process is specialized for performance or security reasons.
A service.	—
Sourced from lower tier (subcomponent, commodity).	Sourced from a higher tier, especially at the prime integration level.
Economically viable volume/predictable rates.	Noncommercial volume/uneven rates.
Commercial technology leads defense technology.	Defense technology leads commercial technology.

SOURCE Off Ice of Technology Assessment, 1994

manufacturing technology, it will even be possible to produce a single item profitably. Except in time of crisis or war, the defense base has always had to deal with small orders and uneven production runs, making such flexibility particularly attractive.

Improvements in commercial product quality also favor the use of commercial products. Commercial developments in design and development processes using simulations for virtual prototyping, and concurrent engineering to reduce future production risks, are applicable to defense as well. [11]

Integration occurs not only at the facility level, but also at the levels of the industrial sector and the firm. Integration should be promoted at all three. Integration at the **industrial sector level** involves drawing from the same pool of technologies, specialized assets, and processes to meet both defense and commercial needs. Integration at the **firm level** is characterized by the sharing of corporate resources to meet both defense and commercial needs. **Facility level** integration is marked by the sharing of personnel, equipment, and material.

But not all technologies, industrial sectors, or industrial tiers are equally amenable to integration. Complex defense systems requiring high levels of systems integration may not lend themselves to CMI. Tier 1 prime contractors performing such work may therefore be less able to integrate commercial and military practices (although common administrative and management control activities may be possible). Lower tier activities, such as production of components and subcomponents for those systems, appear far more amenable to integration. Surveys indicate that firms at these lower tiers, small or large, may be more likely to be integrated, and the products and processes involved may be more amenable to integration than are those at the prime contractor level. Indeed, many firms at the lowest tiers may not even know they are serving defense needs.

Table 1-2 lists some of the factors that may make a good or service more or less amenable to some form of integration.

Goods and services that have equivalent defense and commercial uses, and that may be sourced from a lower tier, appear to be more amenable to integration-either commercial purchase or integrated processes. Many electronic and aviation components fall into the more amenable categories. The potential for integration is further affected by manufacturing processes. Defense and commercial goods sharing similar production

[11] OTA is currently conducting an assessment of defense modeling and simulation that addresses some of these issues as wellas examining the use of modeling and simulation for military operations.

processes (e.g., integrated circuits) have a better chance of integration than those relying on dissimilar production techniques (e.g.. fabrication of stealthy composite aircraft structures). Security considerations can limit the suitability of certain defense manufacturing processes for integration with commercial production.

Services, which involve the most flexible processes of all, appear particularly amenable to commercial purchases. But there are currently government constraints against exploiting some commercial services.

Identifying those technologies, industries, and tiers that maybe more amenable to integration can aid policy development and help focus efforts on areas with higher potential for success. Figure 1-4 shows an estimate of the amenability of the major procurement categories (e.g., R&D, manufacturing, maintenance and services), and tiers to alternative CM I policies. [12]

Increased CMI Provides Benefits

The findings of this assessment confirm that benefits can be derived from increased CMI. The assessment points to areas of potential cost savings and possibilities for increased technology transfer that might aid both the defense and commercial sectors. More importantly, the assessment indicates that increased CMI may be essential for preservation of a viable future capability to meet U.S. national security needs.

Potential Savings

The implied estimated savings of 20 to **60** percent for some individual case studies and savings of factors of 10 in a few selected cases, do not translate into proportional savings across the entire DTIB. **Potential savings are difficult to quantify. OTA's analysis indicates that savings may be lower than some advocates have claimed, and be more difficult and take longer to achieve than many anticipate. Still, even if the percentage increase of total potential savings from greater CMI is relatively small (2 to 3 percent of the baseline DTIB spending), overall savings would amount to several billion dollars per year.**

Insight into where and how savings might occur can be gained by considering national defense spending patterns. For example, the potential for CMI appears greatest in the lower tiers among activities that are more amenable to integration. Yet savings from these tiers are likely to be limited because many of the products, processes. and services procured at these tiers are already integrated or purchased commercially. Further, the total value added at the lowest tiers accounts for comparatively little defense spending. (See figure 1 -5.)

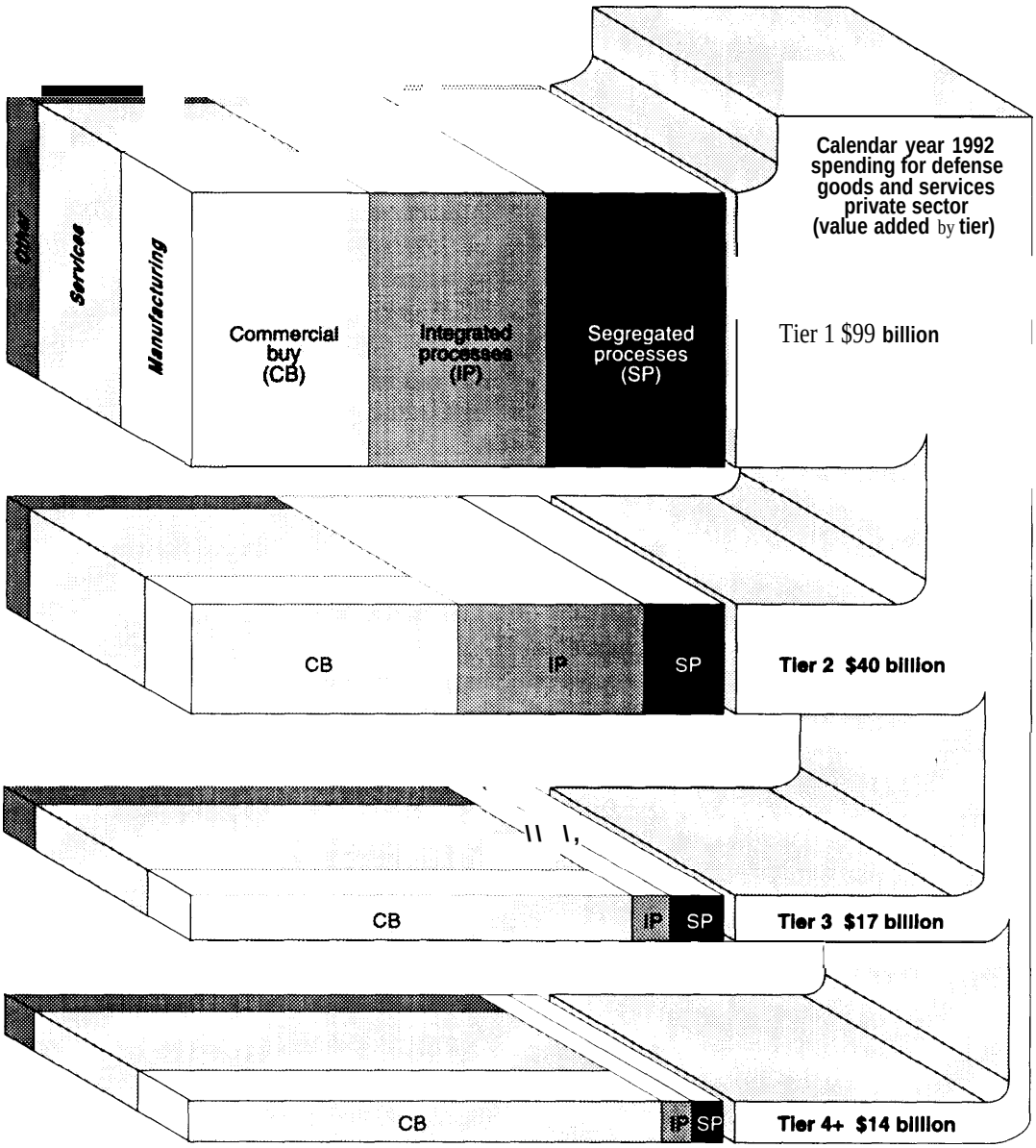
In calendar year 1992, an estimated $180 billion flowed to the U.S. private sector for national security goods and services. [13] OTA estimates that another $18 billion was spent for personnel working in the public sector DTIB.

Prime contractors at tier 1 accounted for the largest single segment of private DTIB value added. Of the estimated $180 billion they received in calendar year 1992, prime contractors are estimated to have contributed some $99 billion in value added to defense goods and services. and transferred some $81 billion to lower tiers through the purchases of goods and services (figure 3-1, chapter 3, illustrates this flow). **Spending at the prime contractor tier in this model includes** not only money going to large defense contractors, such as McDonnell Douglas and General Dynamics, but **all direct government contracts,** includ-

[12] This estimate is based on responses from [he OTA industry survey and the full implementation of the integration policies associated with a Reform Strategy outlined later in this chapter.

[13] This estimate is derived from Bureau of the Census economic data, and is estimated by tier from the Bureau of Economic Analysis input output model. Estimates include not only funds for the Department of Defense, but also for intelligence functions, [he Department of Energy national security programs, and all other national security spending.

FIGURE 1-4: Amenability to CMI



SOURCE Off Ice of Technology Assessment, 1994 Based on data from industrial survey conducted by the Office of Technology Assessment 1994, Bureau of Economic Analysis Data and Bureau of the Census, CY 1992 spending by federal government for national defense (excludes noncomparable Imports and spending for government salaries in the public sector of the DTIB); and Department of Defense, Figure 1 Composition of Defense and Non-Defense Purchases, ' *Projected Defense* Purchases *Detail by Industry and State* Calendar Years *1991* Through *1997*, November {991, p 4 Assumes full Implementation of policies associated with a Reform Strategy discussed in chapter 2

ing those for less exotic activities, such as laundry services and auto leasing. [14] The bulk of the *money going to* the private sector, however, goes to a relatively small number of large contracts. Of the more than 12 million contract actions in 1992, less than 3 percent accounted for more than 90 percent of the money spent. Whether large or small, however, the firms and funds at tier 1 are the most directly affected by the government acquisition process.

OTA developed estimates of potential savings resulting from alternative policies, based on findings from case studies, interviews, and surveys. OTA also conducted some parametric assessments of potential private DTIB savings. Although it is difficult to accurately gauge potential savings—particularly in the out-years—it does appear possible to bound the potential savings and to gain insight into when such savings might accrue.

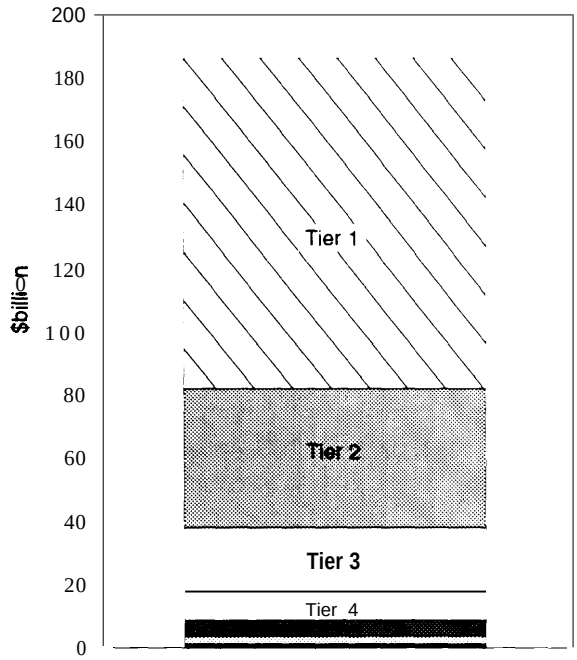
A curve illustrating the possible time phasing of savings from increased CMI associated with the strategies discussed later in this assessment is shown in figure 1-6.

Savings, from increased commercial purchases and buying practices and the elimination of many military specifications and standards, might begin to appear relatively soon after implementation of new policies, but the amount of early savings will be constrained by the fact that many of the items that are initially affected (e.g., clothing, subsistence, and fuel) already are purchased commercially.

Savings from the purchase of commercial components and subcomponents require government and industry to change complex military specifications and standards and retrofit commercially specified parts into existing systems. These savings are, therefore, unlikely to have much of an impact for at least a year or two after program implementation. Savings from new items will take even longer. Given the probable slowdown in new programs, any real savings from new system development will be unlikely to appear sooner than seven to 10 years after implementation.

Savings from increased process integration are derived from more efficient use of available resources. The reduced use of military specifications and standards promises increased process integration—if changes are also made in cost accounting requirements and the rules governing technical data rights. Some process integration savings might begin soon after implementation of changes in the use of military specifications and

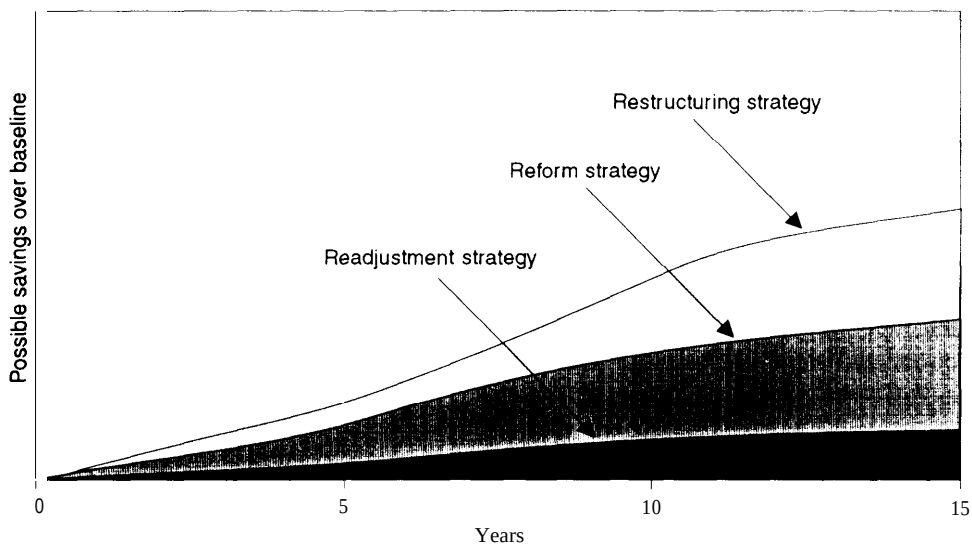
FIGURE 1-5: Estimated Valued Added to Goods and Services by Tier



SOURCE Off Ice of Technology Assessment, 1994 Based on data from Bureau of Economic Analysis Data and Bureau of the Census, CY 1992 spending by federal government for national defense (excludes noncomparable Imports and spending for government salaries in the public sector of the DTIB)

[14] Data used for developing the numbers for these tiers was collected and assembled by commodity rather than by firm, so that the value added by a particular contractor may appear at both the prime contractor level and at lower tiers, depending on the product.

FIGURE 1-6: Phased Impact of CMI Strategies



SOURCE Office of Technology Assessment, 1994

standards-as special testing requirements are eliminated, facilities are consolidated, and the necessary industry workforce reduced. But significant savings here will also depend on changing acquisition rules, eliminating government acquisition oversight personnel, planning products for dual- or multi-use, and designing for manufacturing with commercial processes. These steps will all take time to implement.

OTA's examination of possible savings from increased CMI revealed that gaining significant savings may require major restructuring in the DTIB—for example, eliminating government inventory of commercially purchased parts, adopting long-term (three to five years) service contracts for supply of goods and services, and closing government facilities (e.g., depots and Service R&D facilities) made redundant by such approaches. Savings from such restructuring could be significant, but they are unlikely to begin to appear for five to 10 years after the implementation of change. Even greater CMI benefits might be derived from redesigning forces, as well as weapon systems, to take maximum benefit of CMI.

OTA made its own estimates of savings, as well as considering estimates from other studies. Based on the available data, it appears that total potential cost savings from increasing CMI might range from a few percentage points to as high as 15 to 20 percent of baseline DTIB spending depending on the set of policies implemented. But given the complex range of policies being considered and the time frames within which savings might occur, narrowing the range of possible savings is difficult. Applying the estimates of savings resulting from annual efficiency improvements made by the Defense Science Board Task Force on Acquisition Reform[15] to OTA's estimates of the po-

[15] See U.S. Department of Defense, Office of the Under Secretary of Defense for Acquisition, *Report Of/he Defense Science Board Task Force on Defense Acquisi ion Reform,* July 1993, Table 1. Estimated Potential Annual Efficiency Improvements (After a 5-year Period), p. C-8.

tential for integration derived from OTA's industry survey, gives an overall estimated cost savings in the range of 5 to 10 percent of estimated baseline spending.

Some observers are more skeptical of possible savings than was the DSB Task Force. These observers estimates would be lower. There are sound reasons for caution in estimating high rates of savings. As noted above, additional savings at the lower tiers will be constrained by the amount of ongoing integration and the more limited funds going to those tiers. Savings at the top tier will be constrained by the unique aspect of much of the defense systems integration activity that occurs there. This is likely to remain true even with significant CMI policy changes.

A few observers are even more optimistic than was the Defense Science Board report. Their estimates might approach the upper limit of the range cited above. But regardless of the ultimate size of the savings, any significant savings will take several years to appear. Achieving savings on the high end of the estimated range will demand major restructuring of the DTIB and the likely elimination of much of the government DTIB.

Other Potential Benefits

If CMI is successfully implemented, its most important contribution may not be savings, but instead the preservation of a capability to support future national security objectives, i.e., ensuring the existence of a viable DTIB in the face of significant defense spending reductions. Increases in commercial purchases, for example, might provide the defense community access to important technology in some fast-moving commercial sectors—particularly in electronics, soft ware, and some manufacturing processes-otherwise not available to defense. A properly designed integration strategy may also enhance the commercial viability of a number of industries.

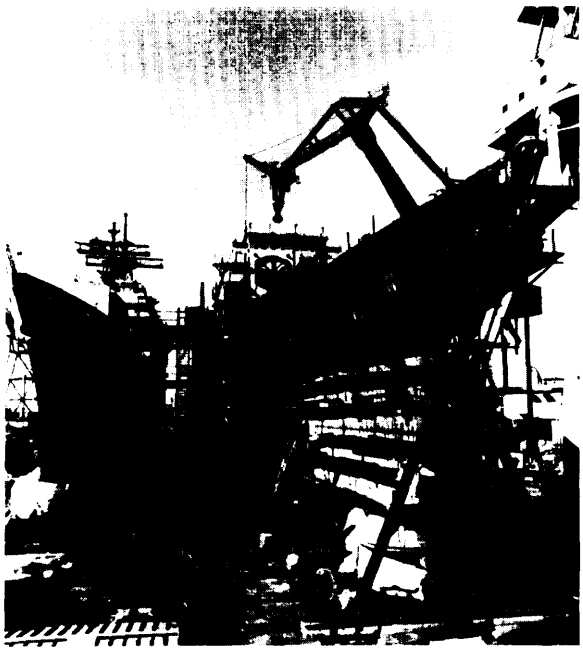
Technology transfer between the defense and commercial bases should also increase as a result of integration, but such increases are even more difficult to quantify than are cost savings. Some studies, however. indicate that significant intrafirm movement of scientific, technical, and engineering personnel occurs in firms doing both commercial and defense work. Integrated facilities should enhance such transfer. Firms should be able to better leverage their investments.

Activities such as the Technology Reinvestment Project (TRP), Cooperative Research and Development Agreements (CRADA), and DOD-funded consortia appear to contribute to technology transfer, but they are unlikely to have much immediate effect on facility-level CMI unless acquisition barriers such as special cost-accounting and rights in technical data are addressed. A number of metrics have been suggested to help evaluate the initiatives aimed at increasing technology transfer. Some of these are discussed in chapter 5.

Implementing Change Will Not Be Easy

The DTIB necessary to provide goods and services for national security is very complex. The base contains a wide range of technologies and industrial sectors, and is composed of large and small prime contractors, with thousands of subtier suppliers of components, manufacturers, research and development organizations, maintenance providers, and service industries.

The complexity of the DTIB and of DOD expenditures demands adoption of a diverse set of policies to increase integration. Some acquisition reforms, such as adopting commercial or performance specifications and standards, affect all levels (industry sector, firm, and facility) and activities. Others are more limited. Operations and Maintenance, for example. may be influenced by policies directed at increased purchases of off-the-shelf commercial items and making greater use of commercial buying practices. R&D, on the other hand. may be far less susceptible to influence 'by such policies. It may respond to adopting research goals that encompass both civilian and defense uses (dual-use technologies), eliminating or changing military specifications and standards, and modifying government requirements for rights in technical data.


INGALLS SHIPBUILDING

Tier 1 systems integrators such as shipyards, aircraft manufacturers, and armored vehicle producers will be difficult to integrate

But, as previously noted, the data essential for shaping policy are sparse. Despite recent DOD efforts, available data on the current use of commercial items by DOD remain insufficient to allow any firm estimates of potential savings from their increased use (thus, OTA's use of an industry survey to gain insights). DOD recently estimated that approximately 6.9 percent of the goods and services are purchased commercially. This estimate, however, comes only from the first and second tiers. DOD is attempting to refine these data.

The lack of data is due, in part, to the absence of any concerted effort by the federal government to track CMI. DOD has not previously gathered such information, partly because of definitional problems (e.g., lack of agreement on what constitutes CMI and what is a commercial item), but also because of a lack of interest. While the Census Bureau gathers information on both the CTIB and DTIB, these data are not collected with CMI in mind, and are highly aggregated. Thus, census data provide general information on industrial sectors, but give little insight into developments at individual plants and enterprises.

DOD has established working groups to gather information in support of acquisition reform policy. Unfortunately, decisions are still too often based on data from studies that concentrated on only a few sectors and the higher tiers, although the 1993 Defense Science Board Task Force Report on Acquisition Reform did consider the entire DTIB. Absent an understanding of overall DTIB operation, the available knowledge remains insufficient to set a comprehensive CMI policy.

While case studies provide useful insights, their findings cannot easily be generalized across the entire DTIB. Indeed, one obvious problem of past studies has been a tendency by some to generalize potential savings for the entire budget based on findings of a particular case study or group of studies. An industry survey conducted by the Center for Strategic and International Studies is currently among the best sources of available data. [16]

OTA's own industry survey estimates are general indicators and not absolute estimates of current integration or firm forecasts of the potential for change. OTA estimates were supported by information derived from more than 100 interviews, site visits, workshops, a random sample of industrial sectors, an examination of 11 other industries, and discussions with industry executives and government personnel responsible for research, development, manufacturing, and maintenance. [17]

The public portion of the DTIB, by definition segregated, is relatively large, costly, and difficult to change. Public sector activities en-

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16 Debra van Opstal, *Integrating Civilian and Military Technologies: An Industrial Survey* (Washington, DC: Center for Strategic and International Studies, April 1993).

17 These sectors included: shipbuilding, aircraft, communications equipment, portable laptop computers, flat-panel display technology. apparel, munitions, circuit breakers, fluid power products, gear manufacturing, and composite materials.

compass the full panoply of defense-related processes, including research, development, engineering and testing, manufacturing. maintenance, and other services. The total number of government employees estimated to be involved in these activities is about 370,000. These laboratories, test centers, arsenals, and maintenance facilities are spread around the country. Any change, with its potential for personnel cuts, therefore, becomes both a local as well as a national issue. Yet the rationalization of the public and private sectors of the DTIB and the elimination of unnecessary redundancies between the two sectors hold promise for cost savings.

There are Potential Costs and Risks

Policies designed to promote integration are neither cost nor risk free. The drawbacks will affect how change is implemented.

One of the most discussed risks, and potentially the most important. is that the goods and services purchased directly from the commercial sector, or conforming to commercial rather than military specifications and standards, will fail in military operations. While this is possible, there is no inherent reason why it must occur. Current proposals for change include provisions for using special specifications and standards where they are necessary to ensure performance.

A second risk is that by relying more on the commercial sector, DOD will become more dependent for off-shore goods and services. While this too is possible, there is no reason to believe that increased foreign sourcing necessarily leads to military vulnerabilities. Further, potential vulnerabilities can be identified and managed.

A third risk involves the potential increase in fraud and abuse that might result from a reduction in oversight, such as elimination of the requirement for cost and pricing data, elimination of the use of special government accounting practice, and the elimination of in-house quality inspectors. While there may be some increased risks, most of the alternatives proposed (e.g., increasing commercial purchases, using commercial quality standards, accepting commercial accounting systems) provide for continued (but different) oversight of government spending.

In addition to these risks, CMI is likely to incur certain costs. at least in the short-term. There are two broad categories of identified costs. The first category is **personnel costs.** This includes both the jobs lost as a result of eliminating redundancies in the private and public sectors of the DTIB, and those likely to be eliminated within the acquisition workforce because of changes in oversight requirements (both public and private sector). Personnel retraining costs are inherent in providing the acquisition workforce with the skills necessary to operate in an integrated environment.

The second category is **activity costs.** This includes activities such as reviewing and eliminating inappropriate military specifications and standards and the expense of participation in standards setting bodies.

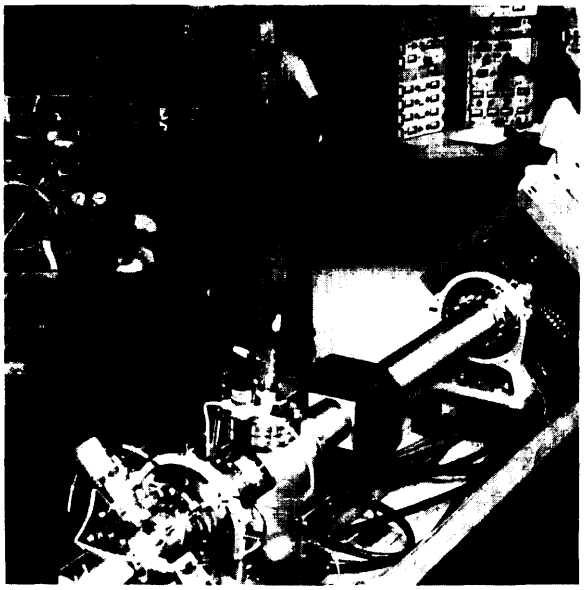
Strategies to Implement CMI

OTA grouped the policies examined in this assessment into three strategies designed to promote CMI. The strategies, termed Readjustment, Reform, and Restructuring, were divided according to the potential difficulty of implementation. The strategies can be viewed as additive. If taken together, the y provide a phased approach to comprehensive CMI.

Strategy 1: Readjustment

A Readjustment Strategy contains three main elements: 1) facilitating commercial procurement, 2) promoting development and diffusion of technology, and 3) leveraging resources and investments. It takes advantage of ongoing, often unrelated activities to promote CMI—including several steps proposed by the Acquisition Law Advisory Panel and adopted in FASA.

Some of the steps necessary to implement this strategy (e.g., eliminating unnecessary military specifications and standards) can be taken by DOD without additional legislative authority. Others require congressional action (e.g., eliminating cost and pricing requirements on commer-



Government facilities often have extensive, specialized facilities that industry can exploit, such as the Ion Beam Material Laboratory at Los Alamos National Laboratory

cial purchases—included in FASA). However, even those steps that can be undertaken by DOD alone cannot succeed without congressional support.

Commercial purchases are facilitated by the elimination of cost and pricing requirements on such purchases, cessation of unique contract clauses, and changes in government requirements on rights in technical data. FASA addresses these issues.

Development and diffusion of technology require a continuing commitment to R&D, including programs to diffuse defense technologies and DOD efforts to access technology developed commercially.

Leveraging investments and sharing resources can occur through the adoption of dual-use technologies to meet defense objectives. DOD participation in TRP, CRADA, and consortia provide mechanisms for technology development and diffusion, as well as leveraging of investments.

The benefits of a Readjustment Strategy include cost reduction, better (and faster) access to essential goods and services, and an increase in the number of available vendors.

The strategy does have some disadvantages. One of its greatest shortcomings is that it leaves the overwhelming amount of DTIB spending under the cost-based acquisition structure, which industry observers argue is one of the most powerful factors in segregation. This situation not only limits its potential savings but, more importantly, may leave firms making defense-unique items or performing defense-unique services at a competitive disadvantage in selling commercial products to DOD—including newly declared commercial products that these firms previously made to military specifications and standards.

Some socioeconomic programs may also be negatively affected, although actions mitigating the negative impact of any change can be taken. For example, FASA reduces the use of unique contract clauses in contracts under the $100,000 Simplified Acquisition Threshold, while reserving these contracts for small business. Of course, actions to protect affected programs can have a negative impact on CMI. A further concern is that the increased use of commercial goods and services could open the door to more foreign sourced goods and services. Whether such an increase presents a real military risk depends on how it is managed.

Strategy 2: Reform

A Reform Strategy builds on the foundation of a Readjustment Strategy (i.e., assumes that Readjustment policies are implemented as a part of a Reform Strategy), and takes a more expansive approach to fostering CMI. The strategy rests on three pillars: further expansion of commercial purchases, integration of processes, and applying CMI lessons to the segregated portion of the DTIB.

Commercial purchases are expanded by: broadening the definition of commercial items; eliminating government cost accounting requirements for all commercial purchases; exempting all commercial purchases from unique contract requirements; limiting government rights in technical data related to these items; and, adopting

commercial buying practices. FASA includes some of these steps.

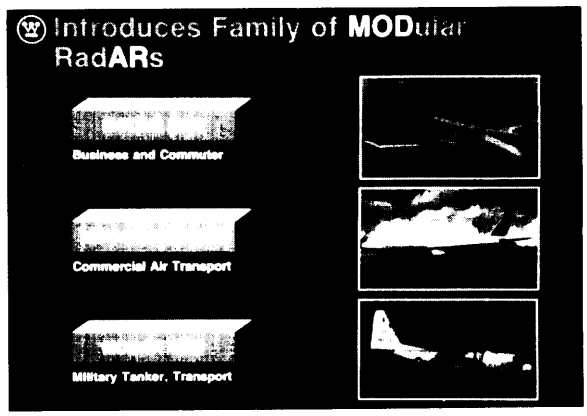
The second pillar of a Reform Strategy is integrating processes. A key step in process integration is to find alternatives to government cost accounting to ensure the government pays a fair price for goods and services that do not have commercial counterparts. Activity-based cost-accounting is one avenue being pursued; facility exemptions is another; government price analysis is a third.

Programs that stress dual-use design for products and manufacturing processes are essential. Increased emphasis can be placed on designs that accommodate commercial components and processes. DOD can foster developments in product and process technologies and help coordinate DOD and commercial acceptance of common technologies through participation in industrial sector organizations and consortia.

A final element of a Reform Strategy directs CM I policies toward that portion of the DTIB that remains segregated. CMI might be a major factor in reducing DTIB redundancies. A Reform Strategy would favor the retention of private firms and contractor-operated facilities (e.g., GOCOs) over government-owned and operated ones (e.g., GOGOs). The elimination, or reduction, of the redundancies between the DTIB and the CTIB would help leverage funds, personnel and facilities. A second objective would be to use commercial products and processes where possible.

A Reform Strategy would produce additional cost savings over a Readjustment Strategy through increased commercial purchases—including large components or systems (e.g., aircraft engines, certain aircraft, and computer networks). The strategy would enhance technology transfer between the DTIB and the CTIB and a larger base would be available to meet defense needs.

A Reform Strategy has some drawbacks. The lessening of oversight might increase the potential for fraud and abuse. Greater use of commercial products might affect the quality of military items. Rationalization of the base would lead to job displacement. There may also be increased prospects for proliferation of militarily relevant technologies to other countries.



The Westinghouse MODAR wind-shear radar is an example of successful dual-use design

Strategy 3: Restructuring

After successfully implementing the Readjustment and Reform strategies, a Restructuring Strategy might be considered. The strategy would not only restructure the DTIB, but would also change military force structure, as well as specific weapon systems, to take advantage of commercial items and services.

The nature of future conflict and technology trends will have a profound impact on future DTIB needs and consequently on this longer term strategy. A Restructuring Strategy will be designed to exploit changes in technology and to accommodate changes in conflict.

A Restructuring Strategy involves three principal elements: restructuring the DTIB aimed at elimination of all redundancies between the public and private sector DTIB, restructuring military forces and weapon systems to take full advantage of CMI benefits and, finally, movement toward complete commercialization.

While some rationalization of public and private R&D, production, and maintenance activities occur under both the Readjustment and Reform strategies, Restructuring pursues rationalization to the maximum degree possible. Some countries—Japan and Germany—rely almost entirely

Tanker aircraft, built around passenger jet airframes, are examples of major dual-use products already in service,

on the private sector to provide for maintenance and support, as well as manufacturing.

Restructuring military forces to fully exploit CMI would be even more controversial than restructuring the DTIB. But there is some precedence for such policies. During the 1970s, for example, the 9th Infantry Division experimented with many commercial pieces of hardware, different ways to employ off-the-shelf equipment, and alternative force structures for employing that equipment. Weapons more amenable to integration—such as rocket artillery launched from tubes commonly available in industry, and standoff-bombers built around commercial airliner airframes—might replace more militarily unique hardware—such as tube artillery or penetration bombers.

Complete commercialization in acquisition would mean that DOD would purchase goods and services like other commercial customers but with one significant advantage: in some areas its purchasing power might give it considerable clout. Such clout might not exist, however, in important areas such as electronics.

A Restructuring Strategy represents a radical departure from DOD's post- World War II acquisition approach. The more radical reforms outlined in this strategy promise major benefits from significant rationalization of the private and public sector bases, better use of the Nation's technology and industrial bases, rapid incorporation of new technologies, and a larger mobilization base.

But restructuring would be costly and involve significant risks, including uncertainties in the ability of weapon systems and forces to meet future performance requirements and the responsiveness of commercial firms to national emergencies.

OPTIONS FOR CONGRESS

This assessment confirms that greater CMI is possible. Benefits include cost-savings, increased technology transfer, and expansion of potential defense suppliers. But the assessment also indicates that cost savings are likely to be lower than some previous studies have suggested. Further, it will take several years after the implementation of CMI policies for major savings to occur. Even so, cost savings of even a few percent of total DTIB spending could produce billions of dollars in savings.

The assessment suggests that the most important benefit of increased CMI might be the preservation of a viable defense technology and industrial capability in a fiscally constrained period. Without increased CMI, the Defense Department may lack adequate access to rapidly developing commercial technologies and pay a premium for commonly available goods and services. Therefore, regardless of the size of the potential savings, some increased CMI appears to be a necessity.

The assessment uncovered no "silver bullets" that might easily achieve CMI goals, However, some policies can have broad effects. The elimination of military specifications and standards is such a policy; relief from supplying cost and pricing data is another. But in most instances the barriers to increased CMI are sufficiently intertwined to demand a comprehensive (and complex) approach if the projected benefits are to be achieved.

DOD can take some actions to facilitate CMI without any new legislation. In addition to the actions recently taken, the Department can also change the incentives for the acquisition workforce. It can move to ensure that cost and ease of

production are major factors in program development, and that acquisition personnel have the necessary skills to make sound technical judgments about commercial products and processes and have the necessary training to conduct a market analysis. DOD might also prohibit the use of certification of cost and pricing data absent clear evidence that a market analysis was attempted first and failed to provide the necessary information.

Congress has an important role to play if the full benefits of CMI are to be achieved. To date, congressional initiatives have been central to developing and pursuing CMI. The three alternative strategies (Readjustment, Reform, and Restructuring) provide a phased approach for considering implementing CMI.

Should Congress wish to promote CMI, while retaining strong oversight over defense expenditures, then it may wish to implement some of the Readjustment policies and stop at that point. A Readjustment Strategy, directed principally at increasing commercial purchases, provides high levels of direct oversight while opening the base to some new vendors and products. Changes in military specifications and standards open the base to additional firms and provide for the introduction into the DTIB of a modest amount of commercial innovation. Since much of the DTIB will be unaffected by these changes, however, benefits (including savings) are likely to be relatively small.

Implementing the DOD policy eliminating many military specifications and standards will require the support of Congress. Implementation will result in the decentralization of many more acquisition decisions. This will pose problems as well as provide benefits. In a system that operates with fewer rules, the price of greater overall efficiency might include some acquisition failures.

While greater benefits (in terms of savings and technology transfer) could follow from a Reform Strategy, it also involves increased risks such as reduced oversight and the potential for weapons performance shortfalls. A successful Reform Strategy involves a close interlinking of policies that must be implemented in concert. Expanding commercial purchases into rapidly developing technologies may require a broader definition--or at least a broader interpretation-of commercial products and services than exists in the Readjustment Strategy (or FASA). Increasing process integration will necessitate further reduction in the demand for cost and pricing data, and fewer government demands for rights in technical data. Congress has important interests in each of these issues.

Increasing process integration also involves changes in system design philosophy that may have an effect on operational performance. Congress may wish to examine the implications of such changes in detail.

Should the Nation wish to make even greater use of the civilian base after implementing a Reform Strategy, a Restructuring Strategy could be pursued. While some actions of such a strategy (e.g., rationalizing the public and private sectors of the DTIB) will have begun as apart of a Reform Strategy, they would be pursued to their limits in a Restructuring Strategy. Other actions, such as restructuring forces, commence under this strategy. These actions pose significant questions that demand more study. Congress may wish to examine possible force restructuring now, in anticipation of changes in the decades ahead.

Immediate Considerations

Congress has the option of going no further with the CMI than it has in its current acquisition streamlining legislation. Combined with DOD's CMI initiatives, FASA provides many of the benefits discussed in a Readjustment Strategy. Even if Congress wishes to pause, however, it may wish to consider steps to assess the effects of current initiatives.

Congress may want to ensure the increases in commercial purchases are monitored and that any savings are properly attributed. Although increased commercial purchases should begin to appear within 12 months. significant savings probably cannot be identified and reported for at least 3 to 5 years. Evaluation of the technology de-

velopment and diffusion results of the TRP, DOD supported consortia, and similar initiatives is also important.

Finally, increased commercial purchases and the use of commercial vendors, if not properly managed, could threaten the long-term viability of the DTIB's design and engineering base. Congress may wish to monitor trends in DOD management and funding of this vital capability. The defense technology and industrial base reports previously requested by Congress will be even more important in this fiscally constrained environment.

The recent congressional and DOD initiatives also provide a solid foundation for a continued expansion of CMI. Should Congress wish to immediately continue to pursue CMI, the alternatives discussed under a Reform Strategy provide options for consideration. With significant legislative action already taken supporting the expansion of commercial goods and services, the initial focus of new efforts might be on the integration of processes. Process integration appears important not only for potential cost savings and increased technology transfer, but also because such integration appears important to retention of the critical defense system design and engineering capabilities. Integrated firms might combine an understanding of militarily unique technologies and operational needs with knowledge of developments in commercial technologies in ways that commercial firms are either unable, or unwilling to match.

For integration to succeed at the facility level, additional effort must be made to deal with the difficult issue of how to allow both commercial and defense activities in facilities while protecting public funds. These objectives are difficult to reconcile. Some firms are experimenting with activity-based cost accounting, Other observers argue that accepting data gathered with current commercial accounting systems should be sufficient to guard against fraud and abuse.

Designing items for dual-use, appears critical to the ultimate ability to integrate processes. DOD's initiative on military specifications and standards can have a positive effect on dual-use design, but ultimately such an approach must confront the way in which military requirements are developed. Congress may wish to consider how requirements are developed and validated.

Because the defense base is so diverse, efforts to integrate processes might initially focus on areas that appear most amenable to integration (e.g., lower tiers, having commonality with commercial requirements, and services). Figure 1-4 shows one estimate of the amenability of tiers and activities (R&D, manufacturing, services, construction) to commercial purchases and process integration.

At the prime level, technologies with many common commercial and defense requirements such as transport aircraft, or aircraft engines might be considered excellent prospects for integration. Technologies with few commercial requirements such as tank guns, might be largely excluded from initial efforts.

A comprehensive CMI strategy must include provisions for preserving those militarily unique capabilities that remain largely segregated. A Reform Strategy includes efforts to incorporate commercial products and processes into the segregated portion of the base. But while this portion of the base can benefit from CMI changes such as purchase of commercial components, special efforts will still need to be made to ensure that these capabilities are preserved. DOD and Congress will need to ensure that these critical activities remain funded at a sufficient level to ensure their viability.

Finally, although there are immediate actions to be taken, successful implementation of CMI will require a long-term commitment. CM] can provide benefits-but most of these benefits will take years to appear. Patience and a steady effort will need to be maintained. Congress will want to evaluate results over time, and make necessary course corrections to achieve the full range of projected benefits of CMI.

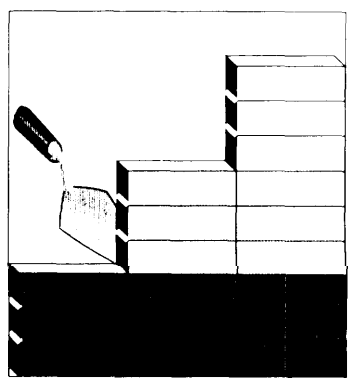
Three CMI Strategies 2

The Office of Technology Assessment has grouped some of the policy options discussed in this assessment into three broad civil-military integration (CMI) strategies that Congress might consider. The three strategies are delineated according to the anticipated difficulty of implementation and their potential impact. They incorporate ongoing government and industry activities as well as possible future actions.

These strategies are not mutually exclusive alternatives: taken together, they might comprise a phased approach to implementing CMI. For this discussion we have named the strategies Readjustment, Reform, and Restructuring.

STRATEGY ONE: READJUSTMENT

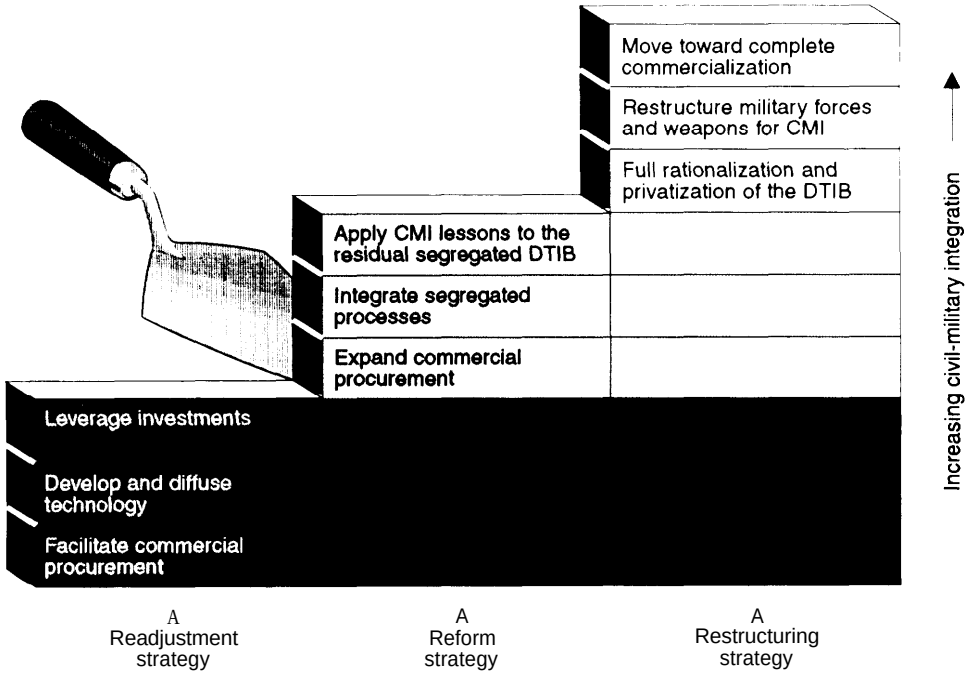
A **Readjustment Strategy** makes incremental changes that enhance the use of commercial goods and services and promote process integration at the industrial sector level. It includes many of the current congressional, Department of Defense (DOD) and industry CMI initiatives (e.g., many of the provisions in the Federal Acquisition Streamlining Act of 1994 (FASA), and DOD initiatives on military specifications and standards). But the strategy may have only a limited effect on process integration at the firm or facility level, and so might be viewed as the first step of a more comprehensive approach to CMI that includes subsequent **Reform** and **Restructuring** (figure 2-1.)



A Readjustment Strategy aims at eliminating some of the barriers to CMI that stem from both the unintended consequences and misapplication of legislation and regulations and from inflation,

DOD can take many of the steps necessary to implement this strategy without additional legislative authority. Other steps,

FIGURE 2-1: Building Blocks of CMI



SOURCE Office of Technology Assessment, 1994

such as raising the simplified acquisition threshold, do require congressional action. Even where DOD can act alone, congressional support may be essential to ensuring success. For example, although DOD has unilaterally begun to eliminate the use of many military specifications and standards, Congress will have to decide the level of support for these initiatives when groups opposing some changes raise their concerns. Further, Congress may need to provide funds to train the acquisition workforce to properly implement the DOD initiatives.

A Readjustment Strategy contains three main components: facilitating commercial procurement, developing and diffusing technology, and leveraging investments and sharing resources.

Facilitate Commercial Procurement

The principal focus of a Readjustment Strategy is increasing the levels of commercial purchases and the use of commercial buying practices. Several ongoing initiatives are directed at this goal.

Adopt Commercial Specifications and Standards

Using commercial specifications and standards in place of military equivalents is one of the most important steps DOD can take unilaterally to increase commercial procurement. But this change will require time to implement fully, and its benefits may take years to be realized.

According to new DOD guidance, military specifications and standards will be used only where no adequate commercial specification or standard is available. Even when a military specification or standard is necessary, that specification will be written in terms of desired performance rather than the physical characteristics or method of production of an item. Performance-driven specifications encourage innovation. They re-

BOX 2-1: Commercial Items and Services in the Persian Gulf War

Commercial items were used extensively during the Persian Gulf War. For example, coalition forces used the Global Positioning System (GPS)—an array of geosynchronous satellites that broadcast positioning Information—to navigate over largely unknown terrain and execute the massive military envelopment from the west that was key to the ground attack. GPS IS a military system, but contains provisions for commercial use with somewhat degraded positioning Information. Lacking sufficient military GPS receivers, DOD purchased and successfully used several thousand less accurate and supposedly less durable commercial receivers

United States and allied forces used imagery provided by the commercial LANDSAT satellite system to plan operations, and leased commercial satellite communications channels to augment the Defense Satellite Communications System.

Other commercial items used included commercial vehicles to haul equipment in the rear areas, and commercial meal packs (called Meals Ordered Ready to Eat—Contingency Test) that substituted for military meals. [1] The United States also drew extensively on commercial shipping and aircraft to transport people and equipment to the theater of operations.

[1] Department of Defense, Conduct *of the Persian Gulf War Final Report to Congress,* April 1992

SOURCE Off Ice of Technology Assessment, 1994

quire, however, knowledgeable government personnel to evaluate them.

Case studies have shown that adopting commercial specifications, standards, and business practices will often produce savings. In some cases, costs were estimated to have been reduced by 20 to 60 percent, or more.[18] DOD has estimated that adopting performance specifications might save $550 million over the initial two years of the program.[19] That estimate appears overly optimistic, if for no other reason than implementation is likely to take longer than anticipated. Further, there are some in DOD who question moving "too rapidly" toward reliance on commercial specifications and standards. Their concerns are likely to slow the process.

DOD has also moved to adopt commercial standards such as ISO 9000 in lieu of DOD standards.[20] Proponents argue that accepting ISO 9000 is critical for increasing the international competitiveness of U.S. firms. But use of ISO 9000 is not without controversy. Some government quality-control personnel oppose the change. So do some U.S. firms.

Indeed, there is concern about moving too hastily toward reliance on commercial specifications and standards. Some commercial items were used successfully during the Persian Gulf War. (See box 2-l.) But not every commercial item proved successful. Some chocolate candies melted in soldiers' hands rather than their mouths. Some com-

18 In the case of the STU-III secure telephone, an estimated 10-fold reduction was achieved.

19 Estimate by the DOD Process Action Team for Specifications and Standards.

20 ISO 9000 is shorthand for International Standards Organization 9000-9004, a series of documents on quality assurance pub] ished by the Geneva-based ISO. The five documents outline standards for developing Total Quality Management and a Quality Improvement Process. ISO 9000 consists of guidelines for the selection and use of quality systems contained in 9001-9003. ISO 900 I outlines a model for quality assurance in design, development, production, installation, and servicing. ISO 9002 outlines a model for quality assurance in production and installation. ISO 9003 outlines a model for quality assurance for final inspection and testing. ISO 9004 is not a standard, but contains guidelines for quality management and quality system elements.

This commercially available Rockwell "Plugger" GPS receiver is being purchased by the U S Army.

mercial laptop computers were fouled by the fine sand. None of the commercially available boots measured up to the Commander-in-Chief's requirements. Thus, commercial goods and services, while useful, are not a panacea.

In implementing change, DOD will need to overcome internal resistance, and work closely with industry in determining which commercial specifications and standards to accept, and which military specifications and standards remain essential. DOD involvement in setting commercial specifications and standards will be essential to ensure that defense interests are advanced. Since DOD accounts for only a small part of the overall business in most industrial sectors, it may have to compromise some performance requirements (thus increasing concerns over possible future mission failures) or fund special technological developments when commercial items do not meet a need.

Eliminate Cost-Accounting and Pricing Requirements

Industry representatives have repeatedly identified cost-accounting and pricing requirements for commercial goods and services as one of the greatest deterrents to doing business with the government. Actions taken in a Readjustment Strategy conform with recommendations of the Acquisition Law Advisory Panel to eliminate cost and pricing data requirements for all contracts below $500,000.[21] The DOD requirement that firms certify that the government is getting the best price offered any customer—said to be derived from the Truth-In-Negotiations Act (TINA)--would be eliminated. Steps must also be taken to preclude cost or pricing data from being used in competitive, fixed-price contracts.[22]

Adopt a New Definition of Commercial Items and Services

The lack of a good, common definition of a commercial item has contributed to the misap-

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21 As this report goes to press, the Federal Acquisition streamlining Act of 1994 (FASA) has eliminated cost and pricing requirements not only for contracts below $500,000 (included in the Readjustment Strategy), but also for all commercial purchases (an action included in the following Reform Strategy).

22 This raises the issue of how legislation is implemented. TINA is intended to ensure that the price of products sold to the government is fair and reasonable. While TINA provides exemptions for contracts with adequate price competition or catalog or market prices on commercial products, in practice "competition" and "commercial" have often been misapplied, requiring cost and pricing data in competitive markets and even for some commercial products. Further, TINA allows for price analysis as an alternative to cost analysis-but, reportedly, because DOD contracting officers are often not trained to perform such analysis, they instead opt to require certification by the contractor that the government has received the most favored customer price. A major problem thus arises less from legislation than from lack of training and experience.

plication of cost and pricing data. Acceptance of a definition such as that in the Federal Acquisition Streamlining Act of 1994 (FASA) will eliminate some cost and pricing problems and expand the usc of commercial products. This definition, however, might still exclude items with little or no commercial market if those items have not evolved from a product that is on the market. The FASA definition might thus preclude DOD from rapidly acquiring some leading-edge technologies that have not yet established a commercial market.

Reduce Requests for Rights in Technical Data

DOD could promote the development of technology by limiting its requests for rights in technical data. This would encourage vendors to provide their best product technologies. DOD could, for example, expand on practices in the Technology Reinvestment Project (TRP) and the Department of Commerce Advanced Technology Program (ATP), allowing firms to retain rights to technology developed partly at government expense.[23] FASA provides for the presumption of commercial ownership of data on commercial products, thus placing the burden of proof of ownership on the government. But this change is insufficient to answer many industry concerns. Anticipated DOD changes, in response to recommendations from the government/industry technical data committee established under Section 807 of the 1992 Defense Authorization Act, may eliminate many of the disputes over rights in technical data between DOD and industry.

Develop and Diffuse Technology

A second major component of a Readjustment Strategy is the collective development of technologies by the defense and civilian sectors for defense and commercial use.

The source of new technology is unpredictable. It may emerge from defense or commercial research, or result from the development of a particular weapon or commercial product. Therefore, ensuring effective technology transfer may depend on a variety of approaches. Further, an effective plan to promote development and diffusion of technology requires mechanisms to measure the returns on investment.

Rationalize Research Funding

With fewer available resources, DOD might choose to direct more of its funds into research that is not strictly defense-related, but holds promise of producing dual-use technology. Through the Advanced Research Projects Agency (ARPA), DOD already funds general research. Such research may become more important in the face of reduced defense budgets. Previous modifications to the law governing independent research and development (IR&D) should also promote the exploration of nondefense technologies.

But it is essential to identify technology areas in which DOD support of dual-use technology development in the private sector can make a difference. Resources for research in areas that are thought to be militarily unique may be scarce, so every effort will need to be made to avoid funding duplication.

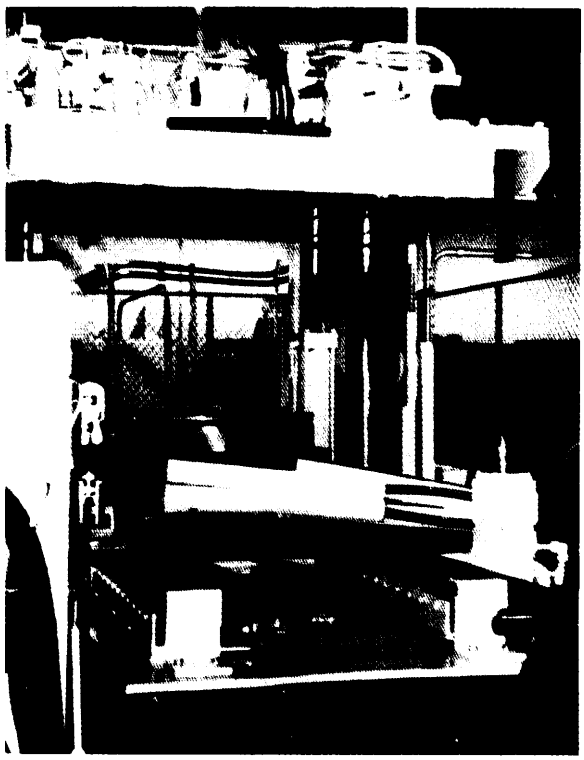
Exploit Individual Programs

DOD might make better use of efforts within specific programs to develop and diffuse technology. The Manufacturing Operations Development and Integration Laboratories (MODIL) developed by the Strategic Defense Initiative Office (SDIO) is an example. In this program, SDIO used small amounts of seed money to fund joint efforts among companies, universities, and laboratories directed at developing space optics.

Use Current Diffusion Programs

Cooperative Research and Development Agreements (CRADAs). originally designed to transfer

[23] The government does have the right to use the data and, in some cases, to promote its commercialization if the developing firm does not bring a product to market.



This hydraulic clamp is available for use by clients at the Great Lakes Composites Consortium for limited production runs or prototyping

technology out of the federal laboratory system, are now viewed as a means to facilitate two-way transfer, helping government laboratories gain access to commercial technologies.

The TRP program allows firms to keep data rights as an enticement in technology development. This approach may enhance technology development, but not diffusion. The TRP's Manufacturing Extension Partnership Program, on the other hand, might promote technology diffusion. So too might DOD participation in regional manufacturing centers and consortia that perform research of interest to both defense and commerce. The Great Lakes Composites Consortium and SEMATECH are examples.

Support for many of these activities is decentralized, with organizations vying for funding from the Office of the Secretary of Defense (OSD), the Services, and defense agencies. The Navy, for example, supports five Centers of Excellence in manufacturing in the private sector. The Army lists 12 university science and technology centers in 7 different research areas (including electronics, rotor craft, mathematics, high performance computing research, and others). DOD is attempting to bring order into its science and technology process. Readjustment would include stronger coordination of programs.

While efforts such as the TRP, CRADA, and consortia can positively affect development and diffusion of technology, in the aggregate they account for a small portion of defense technology and industrial base (DTIB) spending. In the longer term, development and diffusion of common technologies depend on acquisition reforms that allow businesses to integrate firms and facilities profitably.

Leverage Investments/Share Resources

A third component of a Readjustment Strategy is leveraging investments in technology and industry to derive the maximum benefit from public and private spending. Some of this sharing will come from selecting common technologies for defense and commercial exploitation. Some CRADA and TRP projects that include government laboratories, manufacturing centers, and other government facilities already do this.

Other high-cost resources, such as R&D and test facilities, could also be shared. Commercial use of the Navy's David Taylor Model Basin for design of ships is an oft-cited possibility. Unique government computer capabilities could be made available. Los Alamos National Laboratory and other DOE laboratories, for example, provide support to industry on a fee basis. The Army's National Automotive Center plans to draw industry and government researchers together to develop new dual-use product and process technologies.

While sharing resources makes great sense on paper, there can be problems in practice. Industry managers, for example, worry about timely availability of test facilities. More importantly, many in industry question whether the government has much to offer. The proof, however, is probably in

act ions rather than words. Private-sector representatives are reportedly making more approaches to government facilities.

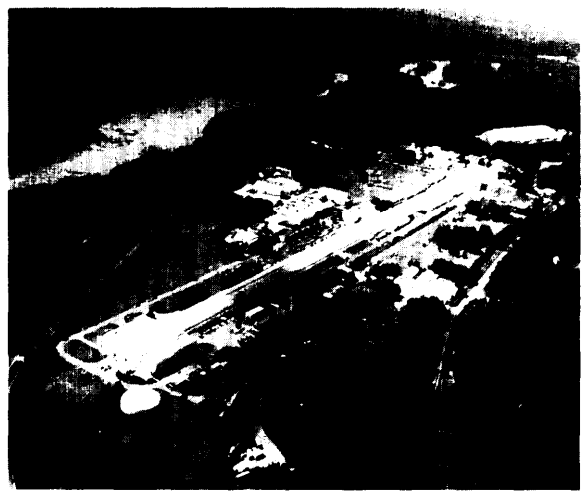
Benefits of Readjustment

Actions taken as part of a Readjustment Strategy should reduce some costs, provide better (and faster) access to essential goods and services, and increase the number of available vendors. For example, a relatively simple reform, the Defense Logistics Agency's use of commercial air-delivery of medicine to U.S. forces in Alaska, has lowered medicine costs, eliminated waste associated with excess inventory, and reduced transportation and handling expenses. But savings may be diminished by the limited nature of the changes a Readjustment Strategy makes in cost accounting and pricing requirements, rights to technical data, and the DTIB structure.

Actions taken in the Readjustment Strategy can affect a large percentage of the total contract actions (estimated over 98 percent), but not the majority of the DTIB budget. If commercialization were to reduce the number of government oversight and processing personnel handling these millions of actions, however, there might be significant savings. The 1993 Defense Science Board Task Force on Acquisition Reform estimated a $4 billion annual savings from a reduction of about 45,000 government acquisition personnel alone. This savings estimate appears high, based on cost figures supplied to OTA by the DOD Comptroller, but $1.5 to $2 billion in annual savings may be possible. Greater government personnel reductions (and more savings) could occur under both the Reform and Restructuring Strategies.

Figure 2-2 illustrates how the potential savings from a Readjustment Strategy might phase in over time.

Exact savings are impossible to determine, but case studies and surveys provide the basis for estimates of how much and when savings might occur. Savings could result from changes in the specifications and standards themselves (e.g., certain required military quality tests might be eliminated) and from increased competition as



CARDEROCK DIVISION, NAVAL SURFACE WARFARE CENTER

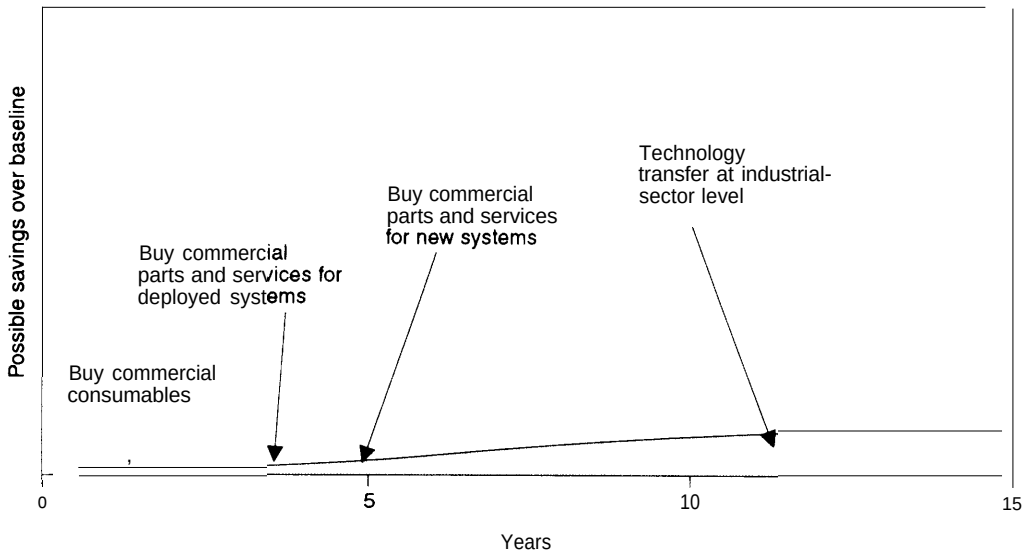
The David *Taylor Model Basin, the long building* **in** *the center, is an example of* a government facility that has excellent dual-use possibilities.

commercial firms bid for defense business. Other savings may result from changes in contracting. Further in the future, savings might be derived from manufacturing technology transfer, which could drive down production costs. Some of the case studies reviewed suggest relatively high savings for particular items. DOD's earlier commercial products program for purchasing, however, is estimated to have produced an approximate average cost saving of about 10 percent on commercial items.

The elimination of military specifications and standards will probably have their initial effect on the purchase of consumables—food, paper, motor oil, and services that are purchased regular] y. Savings could appear within months of the implementation. But many consumables and serviccs are already purchased commercially—so initial savings might be quite small.

Savings derived from the purchase of component parts may take more time—possibly beginning to be felt 12 to 18 months after the initiation of new procedures, when orders are made. Retrofitting parts specified to commercial standards in deployed systems is possible, but there may be constraints. It may take time to gain acceptance of such changes by system operators and producers. Firms may question whether the use of commer-

FIGURE 2-2: Phased Impact of a Readjustment Strategy



SOURCE Off Ice of Technology Assessment, 1994

cial specifications and standards will increase their legal liability. And the nature of the limited modification of the laws governing technical data rights under a Readjustment Strategy may lead some firms to continue to refuse government business, particularly in the case of commercial items that are adopted for government use.

It may take 8 to 10 years after the implementation of a Readjustment Strategy until new systems incorporating commercial items and built to commercial standards are developed. Fiscal constraints are likely to limit new starts and associated savings.

Finally, technology investment programs, such as the TRP, manufacturing centers, and consortia, should promote acceptance of common technologies, affect new product and process technology, and even further reduce costs in the longer term—10 to 15 years. If these savings amount to an additional one percent,[24] total annual cost savings over the projected baseline might fall between 3 to 5 percent of total DTIB spending.

There may be some additional savings related to any reduction in personnel processing contracts and engaged in oversight. These savings could begin in the first year, but the maximum effect is not likely to occur for 5 to 10 years after a Readjustment Strategy is implemented.

Of course, cost savings are not the only benefit of pursuing a Readjustment Strategy. Increased purchase of commercial items provides defense access to rapidly moving commercial technologies. And with the defense market open to more potential vendors, a more responsive DTIB might be available in times of crisis.

[24] Studies attempting to identify the returns on commercial R&D investments provide a wide range of potential effects. However, the totals spent in these activities area relatively small proportion of the DOD budget—any future savings derived from these investments are likely to be correspondingly small.

Disadvantages of a Readjustment Strategy

There appear to be few disadvantages to a Readjustment Strategy. A major disadvantage is that the strategy leaves much of DTIB spending untouched and the current cost-based acquisition structure would remain in force for much of the base. This situation not only limits savings, but, more importantly, it may also leave some defense firms at a distinct disadvantage in competing for sales of commercial products, because they will be required to maintain government cost-accounting for their militarily unique products. Since these firms may contain the key design and engineering teams essential for developing new military systems (said to be the "core" of the DTIB), some provision must be made to ensure the survival of such teams.

Some socioeconomic goals may be undermined, although steps can be taken to avoid this. For example, FASA reserves contracts under the $100.000 threshold for small business. Job losses are probably also inevitable, but the y will be offset at least in part by new jobs in the commercial marketplace.

Training costs may rise as a result of the elimination of the established military specification and standards system. Further, the increased use of commercial goods and services might open the door to foreign competitors. But foreign sourcing need not be a vulnerability. Proper management should reduce any problems.

STRATEGY TWO: REFORM

The second major strategy—Reform—builds on the foundation of a Readjustment Strategy and takes a more aggressive and expansive approach to fostering CMI. But to achieve greater benefits, Reform presents more difficult choices.

A Reform Strategy rests on three pillars: further expansion of commercial purchases: integration of R&D. manufacturing, maintenance, and services; and application of CMI policies and practices to the segregated DTIB where possible. For this more comprehensive strategy to succeed. however. a concentrated effort to acquire better data is crucial.

Current CMI information relies heavily on anecdotal evidence and a limited number of case studies, and is difficult to apply to the DTIB as a whole. Future data collection for CM I needs to be more systematic. It requires interagency cooperation and needs to be collected in ways that allow the findings to be applied to the DTIB as a whole. OTA conducted a trial industrial survey (outlined in box 4-2 in chapter 4) that illustrates how such data might be collected. The Census Bureau might perform a more detailed industrial survey to obtain better data.[25]

Expand Commercial Purchases

Commercial purchases in a Readjustment Strategy may be constrained by requirements for rights in technical data; by continued demand for cost and pricing information, requiring government cost accounting; by insufficient change in government buying practices: and by an acquisition workforce not used to buying commercial products. A Reform Strategy would seek to remove these hurdles.

Buy Commercially

FASA eliminates government cost and pric ing requirements for all commercial purchases. This is essential to further increase commercial goods and services. There is, however, some skepticism about whether contracting officers will demand pricing information that might continue to make special accounting necessary.

Exempting all commercial purchases from socioeconomic-related contracting requirements. is another alternative for increasing commercial procurements. The objectives of these unique contract requirements might be met in other ways. FASA makes a start. but implementation of FASA requires DOD to conduct a waiver process. The

[25] Observations on selecting a representative industrial sample and gathering data are presented in appendices C and D

Acquisition Law Advisory Panel concluded that where DOD contract requirements duplicate existing federal, state, and local laws, these laws could be applied instead. Where special government efforts are considered essential to achieve a desirable socioeconomic objective, the actual requirement might be implemented differently—possibly as a part of a "best value" contract evaluation rather than within a contract clause. The idea is to establish the desired socioeconomic objective as an industry norm rather than an additional individual contract requirement.

DOD can further facilitate greater commercial purchasing by revamping its bid and proposal process to be more flexible and timely. The use of electronic transactions with commercial vendors is a useful start to the process. Giving procurement officials the same authority enjoyed by commercial buyers would speed acquisition.

Develop a Trained Workforce

The expansion of commercial purchases requires a highly trained, high-quality acquisition workforce. A new acquisition corps of "smart buyers" should have training in market research, the technical competence to evaluate purchases, and the authority to act on their findings. The current acquisition corps might be retrained or—if it proves to be too deeply entrenched in its old ways—DOD might gradually replace the corps through attrition or early outs.

A critical change in promoting commercial buying practices is to modify the current incentive structure. The new system must include the development of new measures for judging and rewarding the performance of procurement officials.

Integrate Processes

The second main element of a Reform Strategy involves policies designed to integrate R&D, manufacturing, maintenance, and service processes. Process integration eliminates redundancies within firms and facilities, generating economies of scale and allowing the government to piggyback on commercial operations. It would yield direct, facility-level technology transfer between the commercial technology and industrial base (CTIB) and DTIB.

A Reform Strategy might reap these benefits through implementation of the following policy options:

Change Cost-Accounting Requirements

Perhaps the most important step to integrating processes at the facility level is finding alternative means to assure that the government is paying a fair price for militarily unique goods and services.

The least intrusive but possibly most risky option is for DOD to rely solely on internal DOD price and cost analyses. This option places DOD in the same position as commercial buyers seeking to purchase unique items. Some goods and services lend themselves to this form of cost estimation, notably those involving tasks and products that are well understood and have known material costs.

DOD might also accept the data generated by the contracting firm's own cost accounting system. Some firms are moving toward an activity based cost-accounting system that might provide much of the data requested by DOD without adding unnecessary overhead to the firm's commercial activities.

Change Contracting Approach

Unique contract requirements or unnecessary demands for rights in data stifle process integration in much the same way they stifle commercial procurements. Focusing DOD contracts solely on the products and not the process would help foster process integration.

"Form, fit, and function" specifications detail the general type of product, how it should interact with neighboring components, and how it should perform. Their use in place of detailed "how to" standards may open numerous opportunities for using commercial goods and services. They would also facilitate quick incorporation of new commercial technologies into defense goods. The

new DOD directive on military specifications and standards appears to address these issues.

While FASA makes some changes on rights in technical data, these changes do not appear to address concerns firms have over the possible loss of privately developed manufacturing technology in integrated facilities. Government's demand for rights in technical data might be further restricted in a Reform Strategy. Where obtaining rights is critical, the technical data might be protected in escrow or compensated through licensing arrangements. As noted in the Readjustment Strategy, new DOD data rights procedures are expected as a result of recommendations by the Section 807 committee.

Change Acquisition Philosophy

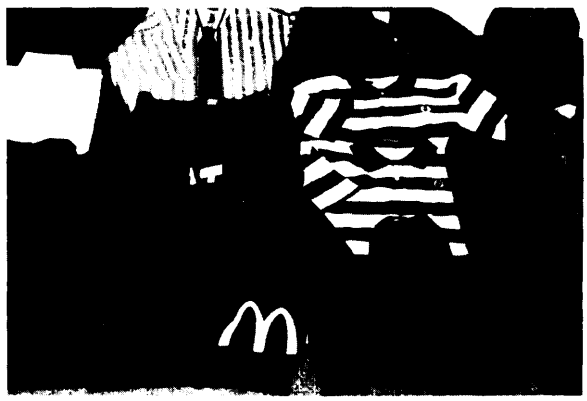
CMI studies on process integration have argued for a concerted effort to change DOD design philosophy to use more dual- or multi-use technologies. DOD military specifications and standards initiative addresses this issue. The design of equipment upgrades should include more commercial components and subcomponents.

New systems specifications should emphasize designs that accommodate commercial components and processes. This could be achieved by making the cost of a system a more important design criterion than in the past. Designing for commercial processes might allow a militarily unique item to be manufactured or maintained in a commercial facility rather than at a segregated site.

Streamlining Oversight

DOD can use alternatives to current visual inspections by residential government personnel to ensure quality. Such changes are implicit in the changes in military specifications and standards—if fully implemented.

The commercial market provides quality information as well as pricing data. Buyers research and track the quality of products. Firms inspect suppliers' quality and sometimes have a representative at a supplier facility. Firms also rely on statistical process controls and other means of quality monitoring. The government could apply



TERRY MANUFACTURING/DEFENSE LOGISTICS AGENCY

Terry Manufacturing produces uniforms for both the U S Army and McDonald's in the same *facility wlth the* same *workforce*

all of these approaches. If still unsatisfied, DOD could do inhouse testing of a statistically significant sample of the product. FASA directs DOD to rely on standard commercial product warranties.

Preserve the Base

DOD will need to foster development of product and process technologies to help preserve the base. Participation in industrial-sector organizations and consortia, as discussed in the Readjustment Strategy, can help coordinate DOD and commercial efforts. In some cases, it might be in DOD's interest to promote particular technologies of clear benefit to the military.

Similarly, DOD has a role in fostering process technologies. Trends towards increased flexibility y in manufacturing could permit commercial plants to accommodate defense needs even with historically uneconomical production volumes.

Finally, the government may need to make a special effort to help defense firms be competitive despite the shift toward commercial procurement. Absent substantial reorganization, many of these firms are unlikely to be able to compete. Moreover, defense firms may now find themselves in the position of producing recently redefined commercial items and militarily unique items in the same facility and facing cost accounting and oversight rules not applicable to commercial firms. Since these are the firms that maintain the design and engineering teams essential to future weapons

development, the government may wish to help them by treating their products preferentially for a limited time. They might also be exempted from certain requirements (e.g., defense cost accounting) so that their commercial ventures are not unduly burdened by continuing defense work.

Apply CMI Lessons to the Segregated DTIB

Policies directed at the segregated segment of the DTIB are a final aspect of a Reform Strategy. These private and public entities develop, produce, and maintain goods and services that are highly unique, complex, and/or classified.

Use CMI as a Criterion for the Elimination of Redundancies

The segregated DTIB, like the rest of the DTIB, is currently undergoing significant downsizing and restructuring. DOD might leverage limited funds by eliminating redundancies within the segregated DTIB as well as by shifting work to the integrated base.

If policy makers decide to emphasize private over public organizations, they may also want to strengthen these segregated industries to ensure their survival during downsizing. Ensuring that antitrust barriers to business mergers in critical industrial sectors do not preclude rational downsizing might help protect core competencies that would otherwise be lost, and could help achieve more economical production volumes as well.

Apply Commercial Buying Practices

Under a Reform Strategy, the segregated portions of the DTIB will continue to operate according to different rules than much of the rest of the DTIB. But it should be encouraged to procure goods and services from commercial firms and companies with integrated processes to the maximum possible extent. DOD can promote such procurement by shifting the incentive structure toward the use of the commercial and integrated markets.

Encourage Technology Transfer

Technology transfer with the segregated DTIB must be encouraged, Intra-firm technology transfer in companies that conduct both commercial and defense operations can be promoted by facilitating sharing of labor, management, research centers, and other resources.

Firms and public sector organizations that do only defense work, are probably limited to industrial sector-level technology transfer, via consortia, standards bodies, shared test facilities, etc.

Benefits of a Reform Strategy

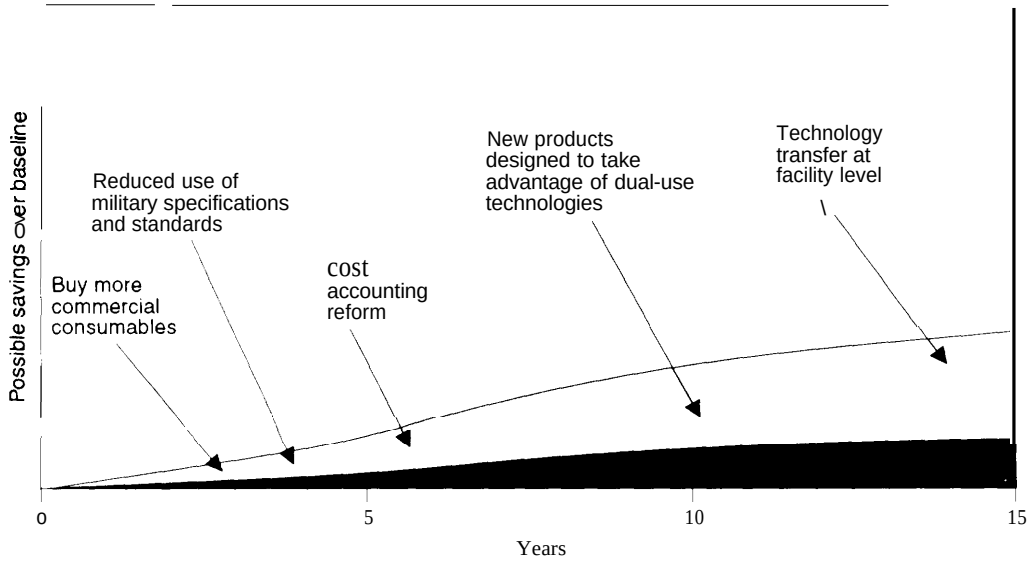
The policies outlined above have a number of potential benefits, including cost savings, technology transfer, and crisis responsiveness.

Reform Strategy savings will come from increased use of commercial products, lower overhead costs in integrated and segregated facilities, higher production volumes in integrated firms, expanded adoption of commercial buying practices, and a further reduction in numbers of" government DTIB personnel.

Savings from increased commercial purchases, just as in the Readjustment Strategy, will not be immediately evident. (See figure 2-3.) Commercial purchases may increase gradually over the first several years after implementation, although because of the increased volume, savings should be more immediate than under a Readjustment Strategy. Development of dual-use technology and systems may begin to influence savings in the mid-term (3-5 years). Integration of processes and redesigning with cost and manufacturability as key criteria are likely to further reduce costs in the medium term. But any savings related to new programs are like] y to begin only in the longer term (8- 10 years) and can be affected by the expected reduction in new starts.

OTA developed a table of possible savings in the private sector DTIB based on assumptions about the potential savings related to CM I policies discussed in chapters 4,5, and 6 and the estimated change in total CM] derived from OTA's industry

FIGURE 2-3: Phased Impact of a Reform Strategy



SOURCE Off Ice of Technology Assessment, 1994

survey. The proposed policies used for the survey correspond to those in a Reform Strategy. While the table does not provide a definite estimate of savings, it does bound the range of potential savings. Combined with other information, it can be used to better define likely savings. The data from the table are shown graphically in figure 2-4.

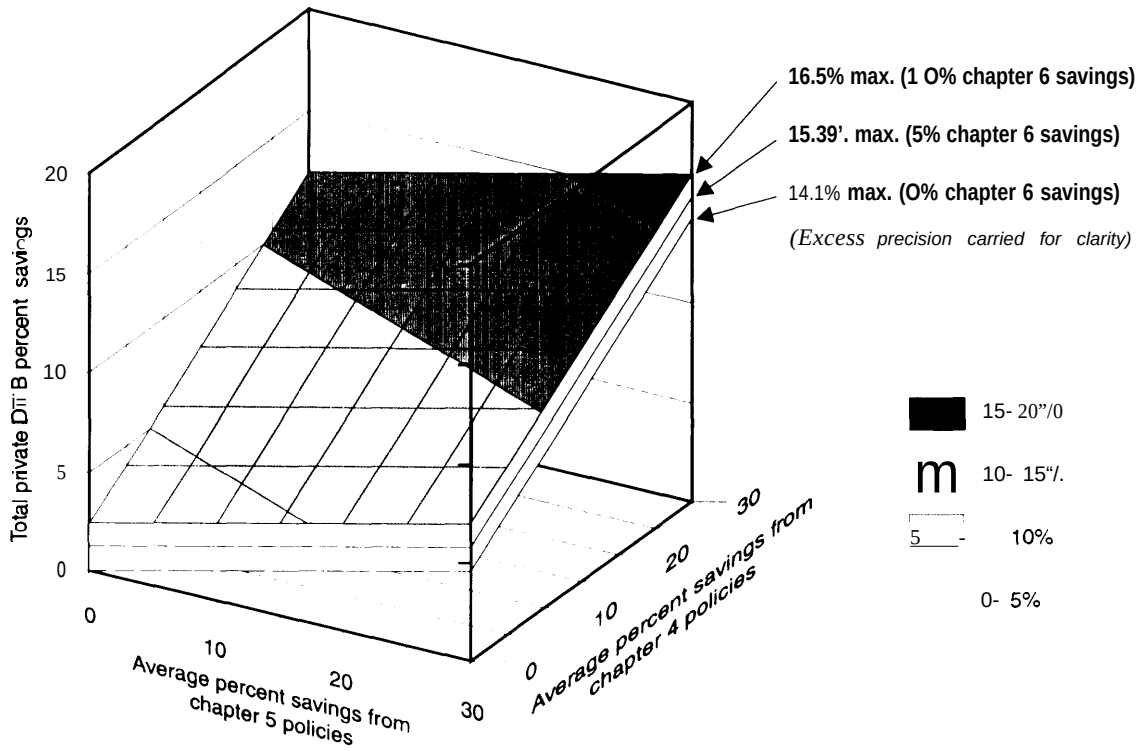
Overall, savings from a Reform Strategy (including those private sector savings derived from the Readjustment Strategy) might yield private DTIB savings ranging from O to about 17 percent. a range we believe shows the limits of the potential returns from the policies discussed. While it is possible that savings in the segregated portion of the base might exceed 10 percent, average savings from past commercial purchases are estimated by some in DOD to be closer to 10 than 30 percent, Thus, even with far greater expected savings from the segregated base, total estimated savings from the private sector DTIB are likely to stay well within the boundaries described in figure 2-4.

Applying DOD estimates of a possible IO-percent average savings on commercial purchases, a 15- to 20-percent average savings from integrated processes (a figure that many observers believe is too high), and a 10-percent savings in the segregated portion of the base might provide overall savings of 5 to 10 percent of private sector DTIB spending. In the future base such estimates might produce savings of $5 to $10 billion per year. Less optimistic estimates would, of course, result in lower estimates.

Additional savings not included in figure 2-4 might come from reductions in personnel, resulting from reduced oversight requirements. Another $1.5 to $2 billion in savings might be possible over the long term.

Further personnel savings might be achieved by eliminating redundancies between the private and public sectors of the DTIB, e.g., closing government research, development, testing, and engineering, and maintenance facilities. These reductions might begin 2 to 3 years after implementation, but could take 8 to 12 years or longer to complete. Congress has been reluctant in the past to close public facilities.

FIGURE 2-4: Potential Total Private DTIB Savings at the Facility Level



SOURCE Office of Technology Assessment, 1994

Other Benefits

A Reform Strategy should expand direct technology transfer at the firm and facility levels between the DTIB and the CTIB. At a minimum, opportunities will grow for spin-on from the CTIB to the DTIB and spin-off from the DTIB to the CTIB. Broadening the use of business-like approaches and technology transfer as part of a Reform Strategy could also strengthen producers of militarily unique goods and services.

A Reform Strategy is likely to result in a larger —perhaps global—mobilization base, given the increased number of firms that engage in defense-related production. Promotion of flexible and agile manufacturing would further expand the number of potential defense suppliers.

Finally, a Reform Strategy could enhance U.S. global economy competitiveness. Integrating the entire NTIB means that the benefits of research and development in manufacturing, information management, and specific product technologies are widely shared across U.S. industry. Elimination or reduction of the redundancies between the DTIB and the CTIB will leverage funds, resources, facilities, and highly trained personnel.

Disadvantages of a Reform Strategy

Together with significant benefits, a Reform Strategy has some drawbacks. These include the cost of training and/or recruiting new acquisition personnel; increased costs for some products or services; greater risk of fraud and abuse of public funds; potentially lower quality for some military items; the possibility of job loss; and risks of proliferation of defense technologies to other countries.

OTA did not attempt to quantify the costs and risks. While they are real, they appear to be far lower than are the potential benefits of pursuing a Reform Strategy.

The possibility of lower quality items and a resulting combat failure is the most worrisome, but those advocating change argue that commercial specifications and standards should only be used in cases where they meet performance requirements. Adherence to this standard should avoid this problem.

The potential for greater fraud and abuse of DOD funds, for example, is difficult to estimate. Many observers argue that the current system is not particularly protective of government funds. Since it was imposed, in part, in reaction to egregious cases of fraud and abuse, however, removal of such controls may lead to more such cases.

Reform policies will likely result in a shift in employment away from traditional defense companies and public facilities and toward commercial firms. Some defense firms will not be able to make the transition. The ongoing consolidation within the defense industry would suggest that the private sector is already taking actions to cope with the changing environment.

Socioeconomic programs may be negatively affected if efforts are not made to find less intrusive ways to promote these goals.

Finally, new policies might increase proliferation of advanced technologies to third parties. If weapon technology is merged with commercial technologies, then exports of advanced commercial technologies could offer other states access to U.S. weapon technology.

STRATEGY THREE: RESTRUCTURING

The third CMI strategy, **Restructuring,** might achieve an even higher level of CMI. This strategy would not only restructure the DTIB, but would also change military force structure and weapon systems to take advantage of developments in the CTIB. Due to its encompassing nature, a Restructuring Strategy carries a greater degree of risk.

A Restructuring Strategy assumes that the policies associated with Readjustment and Reform have been implemented. A Restructuring Strategy involves extensive rationalization and privatization of the public and private sector DTIB, changing requirements for military systems forces, and progress toward what might be termed complete commercialization of the base.

Which Future?

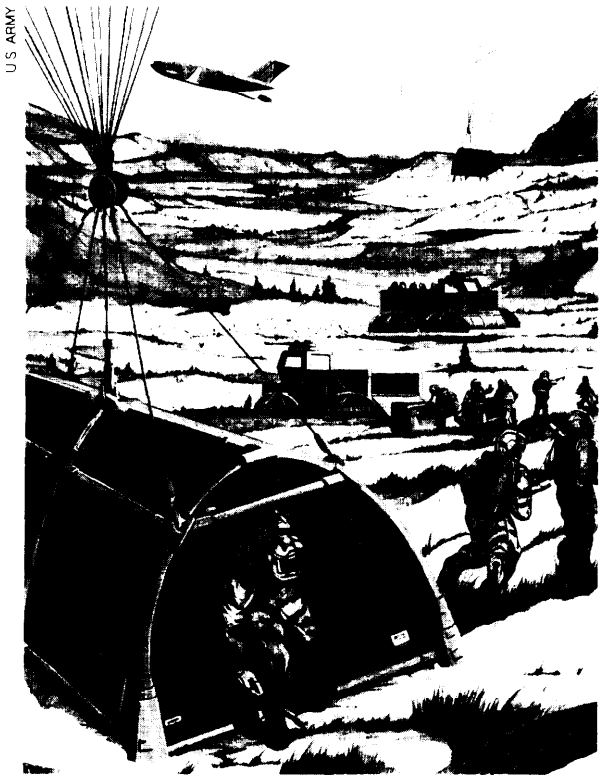
The changing nature of warfare will influence the use of the DTIB to support military requirements, and the nature of any Restructuring Strategy. If future security threats are similar to those of the past (e.g., direct military threats from nation states), then there may be fewer opportunities to radically alter either the shape of the DTIB or military requirements. DOD might, however, still benefit from further CM I as a means of extending scarce dollars.

Alternatively, a decline in major military threats to U.S. interests could promote a fundamental reorientation of military forces away from traditional war-fighting and toward different missions, including peacekeeping and humanitarian assistance. Under such a reorientation, the armed forces might need to be differently equipped, organized, and trained. Light, versatile capabilities might take precedence over heavy, durable, sustainable ones. The requisite DTIB might then be materially different and, possibly, more similar to its commercial counterpart.

Between these two extremes lies a variety of potential futures, requiring a DTIB with varying amenability to CMI.

Tighter restrictions on conventional arms exports could have a significant impact on an industrial base that now depends on overseas sales to sustain important capabilities. The denial of such markets might even precipitate changes in requirements and increase CMI.

Concepts of future military operations also have implications for our industrial posture. Reducing human presence on the battlefield, for example, suggests a concentrated pursuit of such technologies as autonomous vehicles, robotics, and extended-range smart munitions.



Future military operations, such as those depicted here, will probably mix new and old military equipment. A strong CMI strategy might have a significant effect on the nature of that equipment

Technology trends and choices will also have a significant effect on the nature of future conflict and the DTIB. Technological advances and diffusion are likely to accelerate in the future, with potentially profound effects on the technology life cycle—from concept origination to product obsolescence. Process technologies, for example, will increasing y accommodate integrated processes.

Rationalize and Privatize the DTIB

Some rationalization of public and private R&D, production, and maintenance activities occurs under both the Readjustment and Reform Strategies. A Restructuring Strategy would pursue rationalization to the maximum extent possible, with the goal of relying on private-sector capabilities.

Some countries, Japan and Germany for example, depend almost entirely on the private sector for maintenance and support. Japan turns to the private sector for R&D. The United States might adopt this position.

DOD could promote the consolidation of the defense support infrastructure around private, rather than public, entities. Less controversial within the military, but perhaps more so in Congress, would be the elimination of most of the public sector military support infrastructure and its replacement by private contractors. The most obvious savings might come from privately run maintenance depots and air logistics centers, but there are numerous other services that might be spun off from DOD, including transportation and inventory control.

At the extreme, DOD could contract with a private company to handle defense procurement. While on its face this seems a questionable approach, the Nation has done precisely this with much of the U.S. nuclear arsenal. The Department of Energy has provided overall funding and general guidance for the national laboratories, and relied on the laboratories to design, develop, and produce the Nation's nuclear weapons. Indeed, it is the laboratory director, and not a government official, who certifies the reliability of nuclear weapons and the nuclear stockpile.[26]

One advantage of having a private contractor fulfill this role is the private sector's ability to attract the best and the brightest of America's talent through its flexibility in management, personnel practices and pay. A private contractor is better positioned than a government agency to size itself efficiently according to the workload.

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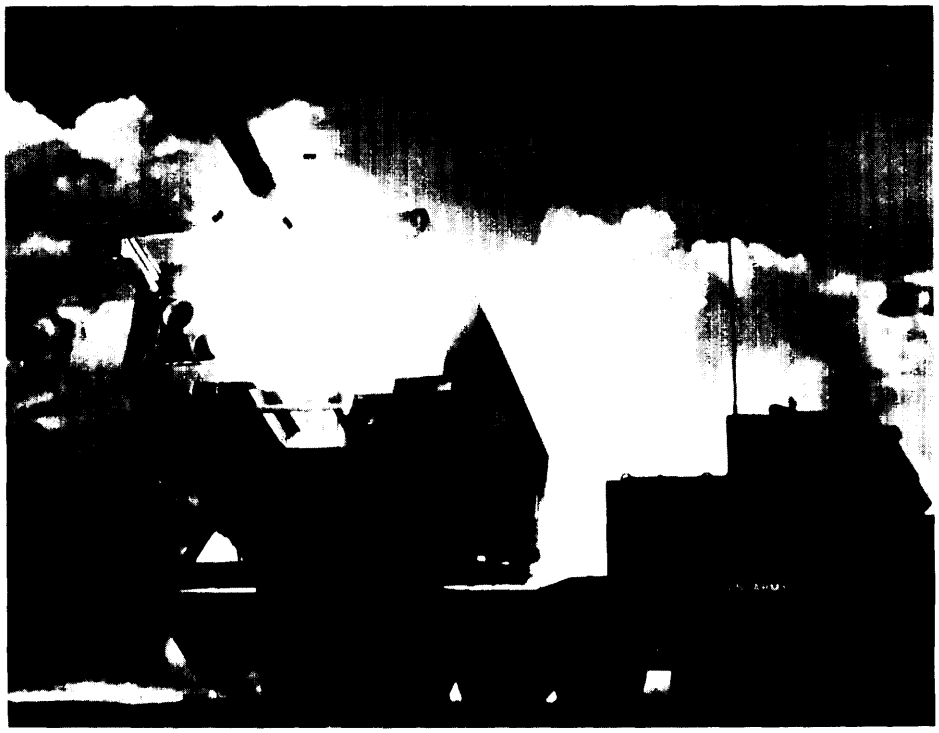
26 It should be noted that this approach appears to have worked well with regard to the development of the nuclear stockpile, but possibly less well with regard to the overall running of the laboratories and their full range of missions.



Rocket artillery is widely used by the United States and other nations

Restructure the Military Forces and Weapons

Restructuring portions of the military itself would provide opportunities to increase CMI dramatically. Some of these changes would be relatively minor and easily acceptable. Others would be far--reaching and extremely controversial.

Just as individual weapon systems can be designed to take advantage of commercial or integrated components, parts, hardware, or services. the armed forces themselves could be configured to take maximum advantage of commercial goods and services. During the 1970s, the Army's 9th Infantry Division experimented with many commercial products (e.g., dune buggies with mounted anti-tank weapons) and examined alternative ways to employ off-the-shelf equipment. New weapons that are more amenable to integration (e.g., rocket artillery launched from tubes commonly available in industry, or standoff bombers built around commercial airlines airframes) might replace more militarily unique hardware (e.g., tube artillery or penetration bombers).

The opportunities for such shifts in force structure will increase in coming years as older weapon systems and equipment become obsolete and need to be replaced. Replacement decisions could be heavily influenced by an understanding of the commercial market. DOD already requires procurement officers to examine alternative tactics and nondevelopmental items (including commercial items) before initiating a new militarily unique development project. Similarly, DOD planners might use CMI as one factor when reallocating roles and missions among the Services.

Move Toward Complete Commercialization

Finally. the acquisition process might be completely redirected by abandoning efforts to apply special rules to defense contracts. (See box 2-2.) Instead, DOD's procurement agency (whatever form it might take) would buy its goods and ser-

BOX 2-2: Alternative Acquisition Approaches: the French and Japanese

The French and Japanese defense acquisition systems differ significantly from that of the United States. France possesses one of the five largest defense industries in the world. It is the only European power currently producing the full range of advanced military weapon systems from fighter aircraft to nuclear-armed and -powered submarines. Japan, too, has a substantial arms industry that produces advanced weapon systems. The Japanese effort is supported by the world's second largest economy and a technologically sophisticated, consumer-oriented industrial base.

The French Ministry of Defense obtains its defense goods and services via a centralized procurement agency, the General Delegation for Armaments (DGA). The French government owns directly or indirectly nearly four-fifths of its defense industry. The French DTIB is consolidated: the manufacture of fighter aircraft, armored fighting vehicles, and aircraft engines are each the responsibility of a single company, Dassault Aviation, GIAT Industries, and SNECMA, respectively. Government ownership provides these industries with a degree of multiyear funding stability not found in the commercial market or in the U.S. defense market. In fact, the Ministry of Defense has virtually carte blanche in the allocation of resources, as the French Parliament has no line-item authority over the defense budget,

The Japan Defense Agency (JDA) procures its weapons entirely from Japanese private corporations, whose main focus is commercial, Unlike the French, or even the United States, there are few government-owned or operated facilities, and no government-owned weapon manufacturers. There is, however, considerable concentration within the DTIB. Defense production is almost entirely in the hands of the largest Japanese *keiretsu* (conglomerates), including Mitsubishi Heavy Industries and Mitsubishi Electric Corp. Firms specialize, and often expect to be awarded certain contracts.

Procurements are managed by a central procurement authority. Procurement requests for equipment come from the JDA, with the blessings of both the Ministries of Finance and of International Trade and Industry. Priorities in Japanese defense production are determined and influenced at least as much by the agendas of the Ministry of International Trade and Industry (MITI), individual corporations, and the powerful Japanese Federation of Economic Organizations (Keidanren), as by the JDA. These organizations are gen-

vices like any other large commercial customer. Many large commercial customers manage to operate effectively, despite having little direct insight into the cost accounting of their vendors. DOD could observe these businesses, see how they determine the relative value of specialized items with little or no available market price information, and apply these lessons to its own procurement activities.

Benefits of a Restructuring Strategy

A Restructuring Strategy represents a significant departure from DOD's acquisition approach since the end of the Second World War. The more radical elements in this strategy hold the promise of major savings and benefits. In particular, it may be possible to derive savings from heightened efficiencies within the newly privatized portions of the DTIB, from increased use of commercial goods and services within DOD itself, and from use of CMI as a factor in the requirements process.

Cost savings derived from the Restructuring policy options depend on the mix applied. A 60-percent reduction in the public sector R&D, production, and maintenance workforce might result in an estimated $9 billion in yearly savings—some significant portion of which might be due to CMI. Savings over time are illustrated in figure 2-5.

Disadvantages of a Restructuring Strategy

Restructuring the DTIB would be costly and entail risks of failure in implementing these radical al-

BOX 2-2 continued: Alternative Acquisition Approaches: the French and Japanese

erally more Interested in the development and commercial exploitation of new technologies than in developing advanced weapons A major focus of Japanese defense procurement is thought to be the utilization of defense contracts as a means of facilitating the development of advanced technologies, particularly those with commercial or dual uses

Both France and Japan accord other priorities to their arms industries beyond the production of the most advanced weapons possible, For the French, ensuring that the French arms industry remains viable, primarily through the development of weapons that are affordable for both the French military and the international arms market, is a high priority In the Japanese case, the interest is in the development of high technology The attendant manufacturing processes appear to have as much Importance as the creation of advanced military capabilities.

In general, neither the French nor the Japanese DTIB possess the array of regulatory and legislative barriers that compel the segregation of the U.S. DTIB from the CTIB. Commercial processes, technologies, components, and practices are applied to defense goods, and commercial and defense goods are often developed and, where possible, produced side-by-side. But the DGA and the JDA often rely on administrative means rather than competition, to control cost and quality. These measures include fixed price and cost-plus contracts for militarily unique systems. In contrast with the United States, both the French and Japanese armaments industries enjoy close relations with their governmental customers, Indeed, in neither France nor Japan do government and industry engage in the same degree of adversarial relations that have marked the United States' government-industry relationship.

SOURCES George K Krikorian American Defense Preparedness Association, *Analysis of the Weapons Acquisition Process of Selected Foreign Governments (France, United Kingdom, Germany, Israel)* for the Acquisition Law Advisory Panel (Washington, DC Department of Defense Systems Management College,1992); U S Congress, Off Ice of Technology Assessment, Lessons *in Restructuring Defense Industry The French Experience,* OTA-BP-ISC-96 (Washington, DC U S Government Printing Off Ice, June 1992), U S Congress Office of Technology Assessment, *Integrating De fense and Commercial Industry. The Chinese and Japanese Experience* (Washington DC U S Government Printing Office), forthcoming

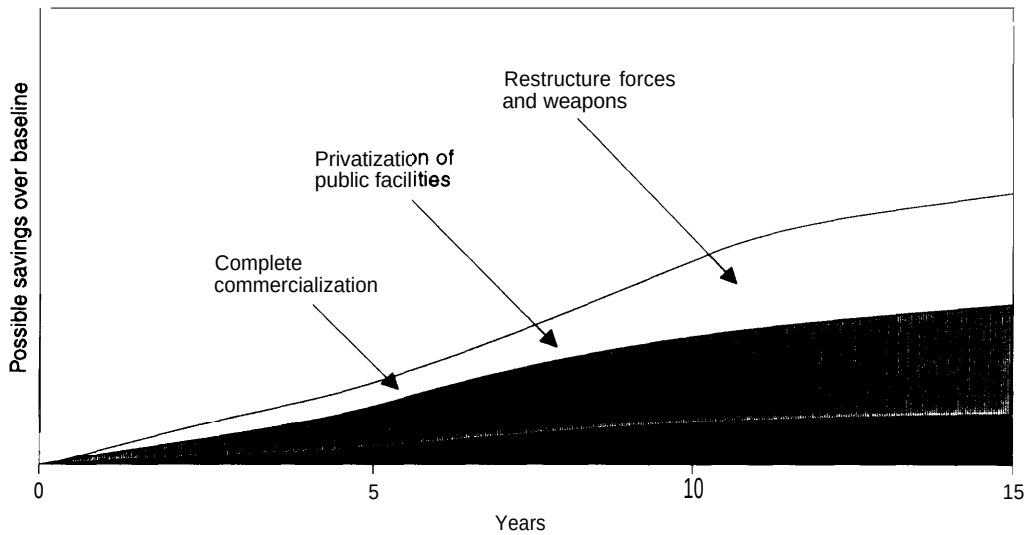
ternatives. There are threats to the effectiveness of U.S. forces in the field, the viability of the mobilization base, potentially greater vulnerability to foreign embargoes, and the possibility of proliferation of sensitive technologies.

The most serious risk is that commercially available weapons and restructured forces may not meet the challenge of future conflicts. A restructured DTIB may no longer give forces the same qualitative edge they now enjoy. The current acquisition process pushes the edge of the technological envelope, although at significant cost. Restructuring the armed services to take maximum advantage of CMI may well gain economic efficiency at the price of technological superiority.

Second, privatization of purchasing may eliminate controls needed to avert waste, fraud, and abuse of public funds. Third, eliminating all redundancies between the private and public sectors may leave DOD with insufficient expertise to be a smart buyer. Fourth, closing bases and terminating personnel will not be cost-free. Further, while the size of the mobilization base may expand with commercialization, the mobilization base may become more fragile. If key components, products, or processes must be sourced abroad, they may be inaccessible to the United States in a crisis.

Finally, even more than in the Reform Strategy, the Restructuring Strategy holds the possibility of increased proliferation of advanced technologies to potentially hostile countries and organizations. While this may not be a problem with regard to controlled technologies (e.g., nuclear weapons

FIGURE 2-5: Phased Impact of a Restructuring Strategy



SOURCE Off Ice of Technology Assessment, 1994.

design), it may become a real threat in the case of dual-use items. Relatively advanced--and previously limited—technologies, such as miniaturized electronics and hardened guidance systems, might become available to pariah or unstable states. U.S. forces could find themselves opposed by forces equipped at an equivalent technological level.

Integrating the Technology and Industrial Base: Overview 3

This chapter reviews the debate on civil-military integration (CMI). It explains what CMI means, discusses the sources of segregation, presents the arguments for and against increased integration, and summarizes the findings of past studies. The chapter provides a framework for examining CMI, outlining OTA's approach to this issue, establishing the context for CMI policy alternatives, and presenting some preliminary findings.

DEFINITION OF CIVIL-MILITARY INTEGRATION

There is no single definition of CMI. The term encompasses a number of different activities, each of which is viewed as an element of integration. For example, those advocating the increased use of nondevelopmental items, including commercial off-the-shelf items, consider such use to be CMI. Analysts recommending changes in government acquisition laws to promote combined R&D, or production of civilian and defense products on a single assembly line, consider such changes to be CMI. Others maintain that CMI involves increased cooperation between government research facilities and the private sector, in both R&D and manufacturing technologies. Still others claim that the rationalization of private and public depot-level maintenance facilities (e. g., transferring jet aircraft engine maintenance and overhaul from military facilities to existing private sector facilities) is a component of CMI.

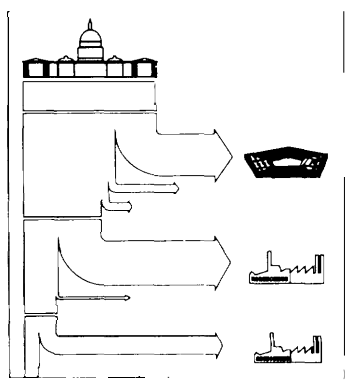


TABLE 3-1: Important Commissions and Studies

- Hoover Commission on Business Organization of the DOD (1955).
- Blue Ribbon Defense Panel (1970).
- Commission on Government Procurement (1972).
- Defense Science Board Report on Specifications and Standards (1 977),
- Grace Commission Office of the Secretary of Defense Task Force (1 983),
- Packard Commission (1986).
- Defense Science Board Studies on the Use of Commercial Components in Military Equipment (1986, 1989)
- Bolstering Defense Industrial Competitiveness (1988),
- CSIS Report on Integrating the Commercial and Defense Base (1 991).
- Report of the Acquisition Law Advisory Panel (1993)
- CSIS Report on Military Specifications and Standards (1993)
- Defense Science Board Task Force on Defense Acquisition Reform (1 993)

SOURCE Off Ice of Technology Assessment, 1994

These definitions are not mutually exclusive. Accordingly, OTA has incorporated all these elements in its definition of CMI as:

> The process of merging the Defense Technology and Industrial Base (DTIB) and the larger Commercial Technology and Industrial Base (CTIB) into a unified National Technology and Industrial Base (NTIB).[1]

More specifically, in an integrated base, common technologies, processes, labor, equipment, material, and/or facilities would be used to meet both defense and commercial needs. Decisions on how to use integrated resources would be based on the same technical, legal, and economic reasoning that commercial firms use when servicing global markets.

Degrees of Integration

Much of the current DTIB is isolated from the CTIB, but the degree of isolation is a matter of debate. The perception of isolation is often affected by the definitions of CMI used. Previous studies have indicated that changes in acquisition laws and regulation could increase integration. A highly integrated base might ultimately require radical changes in acquisition laws and regulations, and in force structure and military requirements.

A fully integrated base, however, is likely to exist only in theory. The defense market is a monopsony, characterized by a single dominant customer—the DOD. Unique defense requirements for goods and services (including security), and the need to ensure the proper use of government funds, shape this market,[2] and to some degree will limit the amount of integration.

BACKGROUND

For over 40 years, government commissions, as well as government and private sector studies, have examined ways to adopt the products and practices of the commercial sector to meet defense needs. Some of the most important commissions and studies with CMI relevance are listed in table 3-1.3 Although most of these reports did not specifically concentrate on CMI, they nonetheless provided insights into the sources of DTIB segregation, the rationales for promoting CMI, and some of the risks and costs of CMI.

Sources of Segregation

The isolation of the DTIB is rooted in the extended nature of the Cold War, the magnitude of the military threat the nation faced, and the structure of our society and government. The sources

[1] The NTIB includes other, noncommercial elements, such as public utilities and other non-DOD government procurements. The national base is also embedded in the larger Global Technology and Industrial Base.

[2] See Jacques S. Gansler, Th *Defense* /n&o-v (Cambridge, MA: MIT Press, 1980), for a discussion Of the underlying economic factors of the defense industrial base.

[3] A more complete listing of study findings and recommendations can be found in appendix B.

TABLE 3-2: Sources of Segregation

- Acquisition laws, regulations, and culture,
- Militarily unique technologies or products.
- Commercially uneconomical orders.
- Military specifications and standards.
- Classified technologies
- Emphasis on performance over costs,
- Initial military use

SOURCE Off Ice of Techno ogy Assessment, 1994

of segregation have been well documented in previous studies and are only briefly discussed here. (See table 3-2.)

Acquisition Laws, Regulations, and Culture

One source of the current isolation is the elaborate defense acquisition system developed over the four decades of Cold War. This system was designed to assure open competition among all qualified bidders, proper accounting of public funds, quality control of defense products, protection of critical national industrial capabilities, and advancement of social and economic goals.

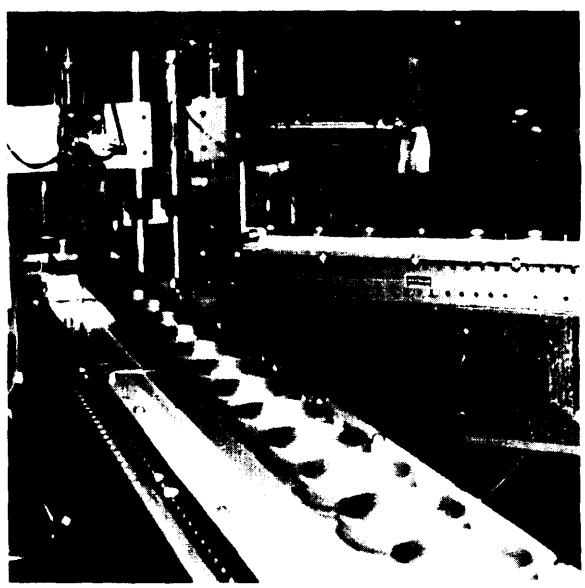
Compliance with acquisition laws and regulations raised defense firms' overhead costs and made their commercial product lines less competitive. Moreover, the laws and regulations provided few incentives to incorporate new processes. Compliance with DOD contracting rules required actions that were totally unnecessary for commercial sales. The firms therefore frequently chose to separate their commercial and defense activities,

The adversarial relationship between DOD and business-caused partly by a government acquisition structure that provided few incentives for contractors to reduce costs and placed great stress on government oversight—has exacerbated this situation. The situation was made still worse by centralized government decisionmaking, a lack of expertise among some procurement personnel, and the criminalization of the procurement process in response to some cases of financial abuses.

Militarily Unique Technologies or Products

Some military products and their attendant technologies may have little or no counterpart in the commercial market and involve manufacturing processes that overlap little with those employed in commercial production. Among the most defense-oriented industries (e.g., ammunition, tanks, shipbuilding, and guided missiles), there are few, if any, sales to the civilian sector.[4] Moreover, defense products often differ significantly from their commercial counterparts (e.g., naval combatants versus commercial transport ships in the shipbuilding industry).

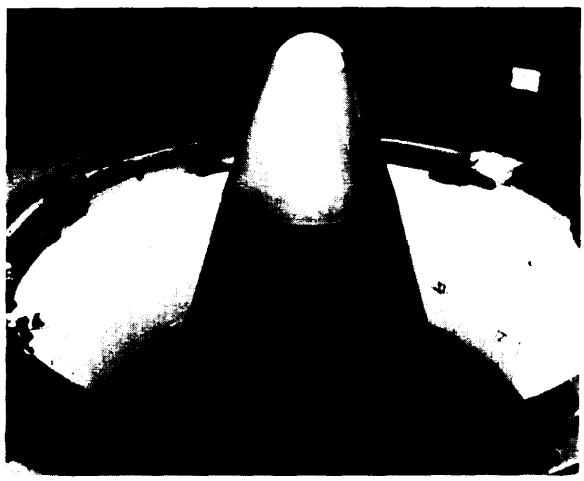
But while final assembly of some of these systems might be militarily unique, many weapon-system components could be commercial. Fur-



TALLEY DEFENSE SYSTEMS

Military unique production lines, such as this one for 155mm shells, are unlikely to have many commercial customers for their products, even with increased CMI.

[4] There are so-called "commercial" sales in these sectors to foreign militaries, but these are not the commercial sales of main interest to this report. Data from Bureau of Economic Analyses, 1987 *Annual Input-Output Tables,* unpublished.



Some defense industries, such as those that produce nuclear weapons and missile warheads, will almost certainty remain highly classified and therefore segregated

ther, both the components and the systems might be built using commercial processes.

Commercially Uneconomical Orders

Even when defense goods and services are not unique, commercial firms may avoid defense production if DOD orders are uneconomical. For example, the production volumes for some specialized defense computer chips are too small to justify even a commercial test-run, much less a production line.

Moreover, given that defense budgets and purchases of goods and services can fluctuate unpredictably, some firms are unwilling or unable to make the investments necessary to maintain facilities or retain a skilled cadre for military equipment.

Military Specifications and Standards

Many of these militarily unique technologies and products have been defined by military specifications that describe their shape, composition, and function, and military standards that determine the manner in which they are produced.[5] While such specifications and standards are often useful in defin ing performance or nature of the product to be procured, they are criticized as being misapplied in cases where commercial equivalents exist. Other criticisms of current specifications and standards include that they are out-of-date and applied by fiat or in a contradictory manner. "How to" standards are often criticized for limiting manufacturing innovation and increasing costs.

Although some commercial products are defined by military specifications and standards, often the difference between commercial and defense specifications and standards can eliminate any economies of scale to be gained from using the same production line or even the same facility. In other cases, the special processes and oversight required by DOD may raise overhead costs and lead firms to segregate defense and commercial work to remain commercially competitive.

The changes in the use of military specifications and standards directed by Secretary of Defense William Perry in June 1994, may eliminate many of these problems.[6]

Classified Technologies

DOD aims to develop products and processes that provide it with a military advantage over its adversaries. The Department is naturally reluctant to release such technologies to the commercial market, where they might be exploited by potential adver-

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5 More specifically, *military specifications* are complete descriptions of products that are either intrinsically military in character or signifi cantly modified commercial products requiring special features, design, packaging, or quality assurance to satisfy military needs. *Military standards* are used to describe engineering and management processes, methods, design criteria, data generating requirements, testing techniques, and definitions. U.S. Department of Defense, Office of the Under Secretary of Defense for Research and Engineering, *An Overview of the Defense Standardization and Specification Program (DSSP)*, Standardization Document SD-8, May 1, 1983.

6 William *pew, Memorandum for the Secretaries of the Military Departments, Subject: Specifications and Standards—A New Way of Doing Business*, June 29, 1994.

saries. This is particularly true for technologies such as nuclear weapons and their delivery systems.

Emphasis on Performance Over Costs

During the Cold War, the United States stressed the need for technological advantages to compensate for the enemy's quantitative superiority. Furthermore, American values demanded that U.S. troops be provided with the best equipment in order to minimize their casualties. The result was an acquisition philosophy that valued product performance (e.g., speed, range, durability, and reliability) far more than cost. By contrast, in the commercial base, while quality and performance are important, products are much more cost-sensitive.

Thus, even in areas where similar technology could be applied to meet both defense and civili an needs (e.g., aviation, electronics, and land vehicles), military performance requirements often obviated the likelihood of integrated production.

Initial Military Use

Finally, the initial development of some technologies is driven by military needs. The technologies develop commercial appeal only later. Computers and communications satellites are examples. Consequently, military specifications sometimes predate, or even constitute the basis of, civilian specifications. This is especially the case of aviation parts and equipment. Many products sold on the global commercial market are designed and manufactured to U.S. military specifications and standards—and are often so advertised.

As a further complication, combining government and private funds in new product development can lead to disputes between government and industry over the rights to the results of research and development. Concern about potential disputes can further isolate defense activity.

Rationale for Integration

Key arguments for increasing CMI are listed in table 3-3 and are detailed below.

TABLE 3-3: Rationale for CMI

- Lower initial acquisition costs and development risks to government.
- Greater access to new technologies
- Lower life-cycle costs
- Reduced acquisition time
- Larger available base
- Greater U S economic competitiveness

SOURCE Off Ice of Technology Assessment 1994

Lower Initial Acquisition Costs and Development Risks to Government

Proponents of CMI argue that purchasing commercial goods and services will reduce the government's development risks and time, reduce tooling and facility costs, and eliminate the expense of government oversight. Integrating the manufacturing and maintenance processes promotes economies of scale and thus lowers costs. Integrating R&D facilitates maximum use of commercial products and processes and ultimately facilitates integrated manufacturing.

Greater Access to New Technologies

Increased integration would also ease the transfer of product and process technology from commercial to defense—and vice versa. For example, commercial advances in key technologies such as electronic memory devices and fiber optics have military application, while military advances in the use of composite materials have application in commercial aviation.

Lower Life-Cycle Costs

In addition to cutting initial acquisition costs, CMI might also reduce the cost of operations and maintenance. The sources of these savings include lower costs for commercially available spare parts, a reduced need for government inventory, and increased competition among potential maintenance providers.

Reduced Acquisition Time

The purchase of commercial goods (whether end items, components, or parts) and services, should

TABLE 3-4: Risks and Costs of CMI*

- Inadequate government oversight
- Degradation of wartime performance.
- Negative impact on socioeconomic goals.
- Increased foreign dependence.
- Loss of technological superiority.
- Implementation costs.
- Job displacement.

*Not ranked

SOURCE Off Ice of Technology Assessment, 1994

shorten the acquisition cycle, allowing for faster acquisition in peacetime, and potentially easing mobilization in crisis or war.

Larger Available Base

Studies by the Defense Science Board and others have concluded that one consequence of government acquisition laws and regulations is an unwillingness on the part of some firms to do business with the Department of Defense.[7] Acquisition reform might expand both the numbers of firms providing goods and services to the government, and the size of the potential technological and industrial base available to meet crisis or conflict situations.

Greater U.S. Economic Competitiveness

Finally, CMI proponents argue that integration will promote economic competitiveness. Reasons cited include:

- Reduced defense acquisition and life-cycle costs will release resources for private or government competitiveness programs.
- Resources spent on the inefficient duplication of processes, equipment, facilities, and accounting systems may be freed for more productive uses.
- Technology transfer will facilitate rapid commercialization of defense technologies.
- Economies of scale can work in both directions.
- Incorporating commercial items in defense goods will help make otherwise nonexistent or nascent commercial goods viable.
- Employing advanced commercial technologies in defense products could make these technologies more competitive in the global defense market.

Risks and Costs of CMI

While there is general agreement that increased integration of the DTIB and CTIB will have some positive benefits, there is less agreement about the extent of these benefits. Further, a number of concerns about the risks and the potential costs of integration have been raised. Some of these are listed in table 3-4 and are discussed below.

Inadequate Government Oversight

Critics of increased CMI worry that the risk of waste, fraud, and abuse will increase if laws and regulations are eased to promote integration (e.g., changes in cost accounting requirements, changes in auditing requirements, and reduced government presence in defense plants). Moreover, these critics question whether DOD will be able to negotiate acceptable prices for goods and services that were formerly procured under DOD cost accounting rules.

Degradation of Wartime Performance

Critics are also concerned that the use of commercial products and processes may lead to reduced system performance and reliability. They worry that commercial items will not be tested as rigorously or built to the tolerances and standards currently achieved by the military system.

Moreover, some contend that commercially procured services may be less responsive and de-

[7] See, for example, OUSD(A), Defense Science Board, *Use of Commercial Components in Military Equipment* (Washington, DC: Department of Defense, June 1989), p. 1.

pendable in wartime than dedicated government support and maintenance personnel. There is always the risk that commercial service enterprises will be preoccupied with other customers, have a different political view of the ongoing conflict, or suffer from bankruptcy or strikes and be unable to support the military effort.[8]

Negative Impact on Socioeconomic Goals

Critics note that CMI proponents wish to eliminate some special contract clauses that promote affirmative action, bolster small business, and support other national social and economic goals.

These critics contend that DOD continues to represent a high percentage of direct government spending on goods and services and that special contract clauses remain essential.

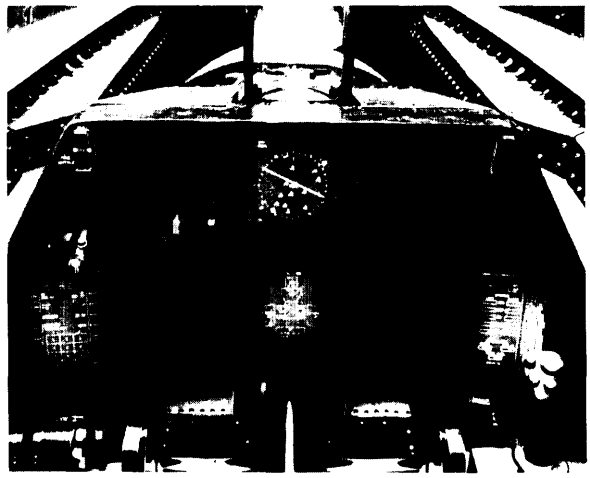
Increased Foreign Dependence

Another potential problem of increased CMI is greater foreign dependence, since the CTIB is itself increasingly a part of the global technology and industrial base. Such dependence could: 1) make U.S. forces vulnerable to a foreign cutoff of spare parts, components, etc.; 2) promote job creation abroad rather than at home; and 3) strengthen foreign commercial competitors, ultimately jeopardizing U.S. industries and future U.S. technological leadership.

Loss of Technological Superiority

Increased reliance on commercial products and processes could ultimately reduce the technological superiority of the U.S. military over potential adversaries having access to much of the same technology.

The use of commercial Global Positioning System (GPS) receivers during the Persian Gulf conflict is a case in point. The United States and its allies were equipped with commercial GPS receivers with attenuated capabilities, as well as more accurate military ones. Had the Iraqis had commercial GPS receivers, they would have had access to navigation data that played a decisive role in the allied victory.[9]


LOCKHEED

To ensure future availability, DOD has started several initiatives aimed at developing and supporting an American fiat-panel display industry.

Implementation Costs

Integration is not cost free. For example, reviewing, changing, or eliminating the more than 38,000 military specifications and standards alone—a process already underway—may require substantial resources from both government and industry.[10] Restructuring the acquisition and oversight functions will also incur significant front-end costs (e.g., closing facilities, moving and reducing government workers, retraining the acquisition workforce). Furthermore, DOD may already be procuring some goods and services at below commercial market prices. Reliance on the

[8] For a further discussion of these views as they relate to commercial maintenance services, see U.S. Congress, Office of Technology Assessment, *Building Future Security: Strategies for Restructuring the Defense Technology and Industrial Base*, OTA-ISC-530 (Washington, DC: U.S. Government Printing Office, June 1992), pp. 130-133.

[9] *Final Report to Congress: Conduct of the Persian Gulf War*, pp. T-227-T-228, April 1992, Washington DC.

[10] Of course, such periodic reviews are essential, so in fact we are merely paying for something we have too long deferred. Indeed there now are five-year reviews, but critics argue these are (oo often "rubber-stamps" of the current specification and or standard.

commercial market may therefore increase the cost to the government of some goods and services.

Job Displacement

Finally, increased CMI will place traditional defense firms into competition with commercial vendors. Though it is not a foregone conclusion that the defense firms will lose in the competition, they will face major hurdles to become competitive, including learning commercial marketing techniques in lieu of defense bid and proposal procedures. Further, as noted above, firms with continuing defense business—and associated government oversight and overhead costs—may be noncompetitive when bidding against commercial firms unencumbered by these government requirements.

Loss of work to commercial firms will result in displacement of defense workers although some defense workers are likely to find positions with commercial companies. The magnitude of this displacement will depend on the degree of competition in a particular product niche, the agility of defense firms in adopting commercial practices, and changes in government procurement policy.

CURRENT STATE OF THE DEBATE

Congress has initiated much of the recent CMI debate. In 1991, it established the Acquisition Law Advisory Panel, which reviewed DOD acquisition laws and suggested changes that would facilitate the purchase of commercial goods.11 Congress also passed CMI measures in recent defense authorization bills:

- The 1990 Defense Authorization Act directs DOD to issue streamlined regulations governing the purchase of commercial products and to design and implement a simplified uniform contract for commercial items. [12]
- The 1991 Defense Authorization Act directs DOD to determine the availability and suitability of nondevelopmental items to meet its needs, prior to making a contract for DOD-unique items. [13]
- In a clear statement of support for CMI, the 1993 Defense Authorization Act directs DOD to modify its acquisition policy to encourage integration of the civilian and military industrial bases. [14]

While the Bush Administration acknowledged the importance of CMI, it was reluctant to intervene directly to support the defense industry, and was very wary of actions that might have been interpreted as "industrial policy." The Administration was particularly concerned that by its actions it could in effect be picking commercial winners and losers in a way that was contrary to the tendencies of the market.

In its 1991 industrial base report to Congress, for example, DOD argued that "the ability of the base to meet future DOD needs will depend in large measure on the ability of individual companies to shift from defense to commercial production and then back again, when required."] [5]DOD, however, took few steps to support such flexibility.

The Clinton Administration, by contrast, appears to favor a more activist approach to CMI. The Administration's $21.6 billion defense re-

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11 Some of the Panel's findings and recommendations are discussed in more detail in chapter 4.

12 National Defense Authorization Act for Fiscal Years 1990, P.L. No. 101-189, Sec. 824.

13 National Security Act for Fiscal Year 1991, P.L. No. 101-510, Sec. 814.

14 Public Law No. 102-484, $4211, *106* Stat. 2315, 2662 (1992), enacting 10 U.S.C. Sec. 2501 (c).

15 Undersecretary of Defense (Acquisition), Assistant Secretary of Defense (Production and Logistics), *Report to Congress on the Defense Industrial Base*, November 1991, p. ES-7.

investment and conversion plan is focused on commercial developments and the transfer of defense technology to the private sector via research partnerships. [16]

In an April 1993 speech in Mountain View, California. President Clinton noted that DOD could and should use more commercial products to meet its needs, and argued that DOD procurement laws and regulations must be reformed to make it possible to do so. [17]

Similarly, Secretary of Defense William Perry has cited defense acquisition reform as a top priority. Previously. as the Co-Chairman of the Defense Science Board Task Force on Commercial Components, he coauthored the 1986 and 1989 reports on the use of commercial components in military equipment. As Chair of a 1990 Carnegie Commission study that resulted in a report entitled New *Thinking and American Defense Technology,,* he argued that "efficient acquisition of high-technology defense systems requires a vigorous defense technology base that is strongly tied into the large and fast-moving commercial technology base. "[18] More recently, Secretary Perry announced his determination to attack barriers: "contracting procedures, our military specifications, and our security procedures, . . . that keep the defense industrial base separated from the rest of the national base."[19]

In February 1994, DOD published a white paper entitled *Acquisition Reform: A Mandate for Change,* outlining its vision of future defense acquisition. This vision incorporated many elements of a CM I strategy. including increased commercial purchases: greater use of commercial specifications and standards; reduced administrative burdens on providers of defense goods and services: and the adoption of some commercial business practices by the DOD procurement bureaucracy. In early March, DOD released its first report measuring progress in the acquisition of commercial and nondevelopmental items.[20] In June, the Secretary of Defense issued a directive changing the use of military specifications and standards.[21]

Additional acquisition reform legislation was introduced in 1993. The Federal Acquisition Streamlining Act of 1994 (FASA) was passed as this report went to press. The FASA incorporates many of the acquisition law reforms proposed by the Acquisition Law Advisory Panel. The Act specifically y addresses the purchase of commerc ial items and services; provides a clearer definition of commercial items and services for use by the contracting community; eliminates the requirement for cost and pricing data on commercial items; and makes it more difficult for the government to demand rights in technical data for items developed with private funds.

In addition, the Act addresses a number of other reforms that should make it easier for commercial firms to do business with DOD (e.g., raises the Simplified Acquisition Threshold, reduces the use of unique socioeconomic clauses in certain categories of government contracts). The Act represents an important step in increasing CMI.

16 The TRp is included in this program, which has grown from the original estimate of over $19 billion for defense reinvestment and economic growth initiatives (between 1993 and 1997) that President Clinton initially announced.

17 F. Peter Wigginton, "President Plan\ Change\ in DOD Procurement Policy," American Forces Information Service. Apr. 5. 1993.

18 William J. Perry et al., *New Thinking and American Defense Technology] '." A Report of the Carnegie Commission on Science, Technology, and Government* (Washington, DC: Carnegie Commission on Science Technology and Government, August 1990), p. 14.

19 Lucy Reilly, "Meet Mr. Procurement Reform: Washington Technology Interview with William Perry," *Nash hington Technology>*, May 6, 1993, pp. 9-10.

20 R. Noel Longuemore, "Memorandum for Deputy Secretary of Defense: Measuring DOD Progress in Acquisition of Commercial and Other Nondevelopmental Items," Mar. 4, 1994.

21 Perry, op. cit., footnote 6.

While most defense industry associations support legislative changes that increase the procurement of commercial goods and services, some firms have expressed concerns about how these changes might be implemented and whether the changes might be unfair to firms operating under current acquisition rules.[22] Furthermore, many in industry argue that some of the most visible recent programs described in the new policy statements (e.g., the Technology Reinvestment Project) will have little impact on integrating the defense and commercial bases at the level of the factory floor unless administrative and regulatory acquisition barriers are also removed.[23]

Nevertheless, consensus is growing among Congress, the Executive Branch, and industry that something must be done to promote CMI. Implementation, however, is still a matter of substantial disagreement.

FRAMING THE ISSUE

The lack of a common framework for discussing CMI is a problem underlying the debate. Since CMI is such a broad and diffuse topic, people debating CMI are often addressing very different notions of integration. This situation is compounded by a lack of good data on the current degree of CMI or CMI trends. Until recently, DOD saw little reason to invest time and resources to track or study CMI. Most of the studies and commissions cited earlier focused on other topics and address CMI only tangentially. More recent studies—such as those conducted by the Defense Science Board, the Center for Strategic and International Studies (CSIS)----found that data on CMI were scarce. A CSIS survey of government prime contractors added some very useful information on CMI,[24] but the survey base was limited by the voluntary nature of the study.

This data situation may improve. The March 1994 DOD report on measuring progress in acquisition of commercial and other nondevelopmental items, for example, reported that 6.9 percent of the Army, Navy, and Air Force funds examined were spent for commercial items, as were 18.3 percent of the Defense Logistics Agency funds examined.[25]

Data: Getting Beyond the Limitation of Earlier Studies

Findings on CMI by earlier studies and commissions relied primarily on expert opinion and anecdotal evidence from case studies of the aerospace and electronic industrial sectors—sectors that have been seen as more amenable to CMI than most others. Less attention was paid to other, more mundane sectors, such as truck and tank manufacturers, and shipbuilding industries that are arguably less amenable to CMI (key case studies are listed in table 3-5).

The studies have found that the various approaches to integration, including the purchase of commercial items for military use, integrated manufacturing and R&D, and the adoption of

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22 One expressed concern already noted is that DOD will initiate changes promoting the purchase of commercial items, but will continue to demand that defense firms labor under unique auditing rules (thus driving up the costs) while not requiring the same of new commercial entries into the defense market.

23 George Leopold, "DOD Hawks Technology Plan," *Defense News*, April 12, 1993; and the Electronic Industries Association report *Dual-Use—Fool's Gold or Mother Lode,* briefing at EIA 22d annual spring Technology and Budget Conference, Washington, DC, Mar. 31,1993, argued that "Technology is not the Problem," Unique DOD/Govemment Procurement Policy, Practice, Culture and Politics are the Major Problem."

24 Debra van Opstal, *Integrating Civilian and Military Technologies: An Industrial Survey* (Washington, DC: Center for Strategic and International Studies, April 1993).

25 OTA did not have access to these DOD data during most of the assessment. Their existence does little to change the conclusion that data are scarce. The reports focused on research, development, test and engineering, and procurement for high dollar value items and was further limited to the major component level of first-tier subsystems. This is better than anything available in the past, but short of a comprehensive v iew of the base.

TABLE 3-5: Selected Previous Civil-Military Integration Case Studies

Case	Company	Study	Aerospace	Electronics	Other
Greater Use of Commercial Products and Buying Practices					
MI L-VAX	Raytheon DEC	CSIS, 1993 DSB	SB	✓	
KC- I 35 Engines	GE	CSIS	✓		
Frequency Agile Signal Simulator	Hewlett-Packard	CSIS, 1993 DSB	SB	✓	
Microwave Semiconductors	Hewlett-Packard	CSIS		✓	
Semiconductors	Intel	CSIS		✓	
Machine Tools	Sterling Hobe Corp.	CSIS			✓
Future Service Voice System	Motorola	CSIS		✓	
Integrated Circuits (1)		1986 DSB		✓	
Avionlcs	—	Section 800800 Panel	✓	✓	
GPS Ground Receiver	—	OSD		✓	
'Shipboard Copiers		1986 DSSP		✓	
Underway Replenishment Winches		1986 DSSP			✓
Shielded Cable	—	1986 DSSP		✓	
Communication Satellite		'Rand	✓		
Commodities		C-Cap, DOD			✓
Non-Developmental Items	—	OSD			✓
Computers and Software (1)		1986 DSB		✓	
Commercial Utility Cargo /Vehicle (1)	—	KSG			✓
Military Clothing	—	KSG			d
250-C30R Helicopter Engine	Allison	1993 DSB	✓		
Government v Commercial Practice	DSMC	Commercial Practices Guidebook			✓

(continued on next page)

commercial cost accounting practices, have had positive results. These studies provided insights into the barriers to integration previously discussed and policies to reduce or eliminate these barriers. They further indicated that some activities, technologies, or industrial sectors might be more amenable to integration than others. But, the studies suffered from a significant drawback: they often lacked sufficient empirical evidence to validate their conclusions. Where data were available, they were not necessarily generalizable across the entire national security budget.

There are additional problems. While identifying technologies and industrial sectors that are amenable to CMI is useful in effectively targeting reforms in these sectors, basing CMI analysis entirely on the most CMI-amenable industrial sectors may not help find solutions to the DTIB as a whole. For example, while studies might help DOD obtain 30-percent savings on the production

TABLE 3-5 continued: Selected Previous Civil-Military Integration Case Studies

Case	Company	Study	Aerospace	Electronics	Other
Integration of Commercial and Military R&D					
Lithography	Los Alamos	CSIS		✓	
Supercomputing	Los Alamos	CSIS			
Superconductivity	HP, DuPont	CSIS		✓	
Optical Fiber Coating	HP	CSIS		✓	
Specialty Metals	Sandia	CSIS			✓
Communications Satellites	Hughes	Beyond Spinoff	✓		
Modular Avionics Radar	Westinghouse	EIA	✓		
Integration of Production and/or Maintenance Facilities					
Avionlcs Processors	IBM	CSIS	✓		
Fiber Optics	Alcatel	CSIS		✓	
Inertial Navigation Systems	Litton	CSIS	✓	✓	
Satellite Technologies	Hughes	CSIS	✓		
Jet Technologies	UTC	CSIS	✓		
Aircraft	Boeing	CSIS	✓		
Microelectronics	TRW, Motorola	CSIS		✓	

(1) Also under Integration of ProductIon and/or Maintenance Facilities

SOURCES

CSIS Center for Strategic and International Studies, *Integrating Commercial and Military Technologies for National Strength*, 1991

1993 DSB *Report of the Defense Science Board Task Force on Acquisition Reform*

1986 DSB Report of the Defense Science Board on the Use *of Commercial Components in Military Equipment*

Section 800 Panel Report of the Acquisition Law Advisory Panel to the United States Congress, *Streamlining Defense Acquisition Laws* January 1993

OSD Off Ice of the Secretary of Defense selected case studies.

RAND *Commercial and Military Communications Satellite Acquisition Practices, 1985*

DSMC Defense Systems Management College, *Commercial Practices for Defense Acquisition Guide Book*

KSG Kennedy School of Government

Beyond Spin-off John Alic, et al , *Beyond Spinoff" Military and Commercial Technologies in a Changing World*, 1992

of a particular electronic component, such savings may not be transferable to other components, to say nothing of the entire industrial sector. Similarly, lessons learned in one sector may have little relevance to reforms in another sector. Unfortunately, such extrapolations have been used in the CMI debate.

OTA was unable to fully overcome the lack of good data on CMI. OTA did, however, fill in some gaps in case studies—using interviews (including indepth surveys of selected industrial sectors), directed case studies (including the shipbuilding industry, flat panel displays, composite materials, and several shorter studies), and a limited industrial sector survey (see box 4-3 in ch. 4). Further, OTA assessed available macroeconomics data for insights on defense activities within industrial sectors and differences between industrial tiers.

By combining macroeconomic data with findings from case studies and interviews, OTA was

BOX 3-1: Data Collection and Reporting and OTA's Data Collection Methodology

OTA found the available data on CM I to be largely anecdotal and not generalizable to the entire DTIB There are a number of alternative methods that might be used to gather information

The Utility of Case Studies

Case studies have been, and continue to be, essential to the study of CMI. Case studies can serve any or all of three purposes

1 Cases are useful as anecdotes, to illustrate degrees or varieties of CM I or barriers to CMI,

2 Cases can provide essential Information and insights on critical firms or sectors, and

3 Randomly selected cases can be used to represent the larger population of companies, contracts, or programs from which they were drawn,

The Utility of Macroeconomics Analyses

Case studies are very time consuming, and many must be done to provide good Insight into the base Examination of available macroeconomic data or larger surveys are useful to providing additional CMI information The DOD or the Census Bureau could make better use of available Industrial base data and could also conduct Industrial surveys In addition to determining the current degree of CMI, such surveys could address the critical barriers to Integration and assess why some commercial businesses avoid defense work While surveys have the benefit of reaching an under-studied population, they 1) demand extensive private sector time, 2) provide far less detailed information than that obtained from case studies, and 3) are expensive to conduct. Appendix D suggests an approach to gathering data.

OTA's Approach

Previous case studies on CMI have served the first two purposes noted above. OTA conducted case studies directed at the first two purposes and also conducted randomly selected industrial sector case studies Appendix C outlines one method for picking a representative sample of industrial sectors. Box 4-2, in chapter 4, discusses how OTA conducted its trial survey of randomly selected industrial sectors and how it used the survey to form rough estimates of the current and potential degree of CMI,

SOURCE Off Ice of Technology Assessment, 1994

able to obtain a better understanding of the possible effects of CMI policy options. The data also allowed OTA to make rough estimates of the current degree of CMI and the possible impact of CMI policies on cost savings, as outlined in chapters 4, 5, and 6. Box 3-1 summarizes CMI data collection in general and OTA's approach in particular.

A Framework for Understanding CMI

The following sections lay out a framework for understanding the complexities of CMI. First, it details how the federal government spends money on national defense goods and services and how these funds flow from prime contractor to subcontractors. Tracking this disbursement flow reveals nuances in the DTIB structure that are not evident when one focuses solely on total DTIB spending or on DTIB payments to prime contractors.

Second, previous studies and OTA's own analysis indicate characteristics that make particular defense goods and services more amenable to CMI than others. Some goods and services appear relatively easy to commercialize (e.g., food or photocopying), whereas others may never have a viable commercial market (e.g., main battle tank final assembly or advanced armored technology).

Not surprisingly, defense goods and services that have similar characteristics benefit from CMI policies. OTA found that defense goods and ser-

vices could be comfortably divided into three CM] policy groups:

1. those that are or could be procured commercially (many commodities, electronic subcomponents);
2. those that are noncommercial, but are or could be sourced from highly integrated facilities (integrated circuits); and
3. those that are or must be purchased from primarily segregated facilities (submarines, tanks).

Finally, OTA found that useful integration might occur at three different levels—the facility, the firm, and the industrial sector. Each of these levels has its own peculiarities and is affected by different sets of policy tools.

Where DTIB Money is Spent

The OTA assessment team used Department of Commerce data and an input-output model to trace federal government DTIB spending and to derive spending estimates at various tiers (figure 3-1).26 The figure shows the flow of funds through the private sector defense base and the value added at each tier of the base.[27]

Of the almost $314 billion the federal government spent on national defense outlays in calendar year 1992, about 37 percent was spent within the federal government. Of that, an estimated $18 billion was directed at the federal portion of the DTIB, which includes both government providers of defense goods and services (e.g., the national laboratories, military depots, and government arsenals) and acquisition personnel.[28] Potential CMI savings derived from government personnel reductions will be bound by this figure.

The remaining 63 percent of the national defense budget in 1992 was spent on goods and services from the private sector. About half of this money went to domestic prime contractors.[29]

In the private sector, prime contractors—-those firms directly contracting with the government to provide goods and services and most subject to its rules and regulations—represent the single greatest segment of value added in the DTIB. In this chart, however, they are not limited to the large prime assemblers of major weapon systems usually discussed, but include all firms with direct government contracts, such as manufacturers of government-furnished equipment (e.g., aircraft engines), and small firms with direct service contracts to the government (e.g., a $25,000 contract for laundry services in the Gambia). This $99 billion represents the value added by all firms having direct government contracts for defense goods and service. While there are many small contracts (in 1992, for example, 11.8 million of approximately 12.1 million total contracts at the first tier were

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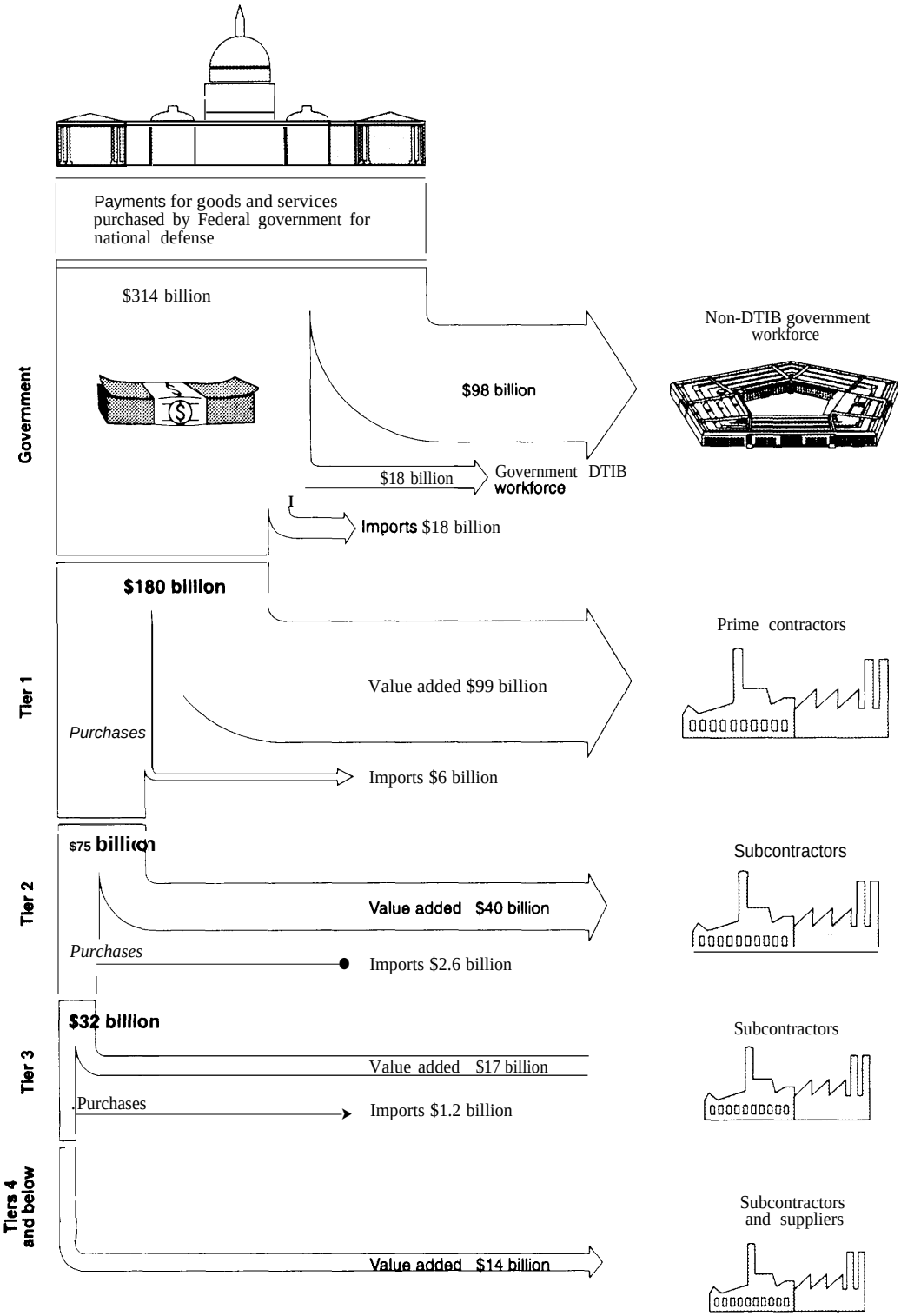
26 The total calendar year 1992 spending of $313.8 billion (current dollars, here rounded to $314 billion) was estimated by the Department of Commerce's Bureau of Economic Analysis (BEA). The fractions spent in various tiers were estimated by OTA on the basis of round-by-round analysis of BEA's unpublished 1987 annual input-output tables, which BEA provided to OTA for this research. These tables were the latest BEA estimates available at the "6-digit" level of detail (i.e., for 6-digit input-output account numbers, which include 541 interindustry sectors). These estimates were found to be generally more accurate than extrapolated data from previous years. Other data came from U.S. Department of Commerce, Economics and Statistics Administration, Bureau of Economic Analysis, National Income and Wealth Division and Government Division, "National Income and Product Account Tables," *Survey Of Current Business,* August 1993, pp. 52- 119; esp. table 3. 10-National Defense Purchases on p. 76; R.E. Miller and P.D. Blair, *Input-Output Analysis: Foundations and Extensions* (Englewood Cliffs, NJ: Prentice-Hall, Inc., 1985).

27 Value added represents the amount of money retained at each tier for providing goods and services. Thus although the prime contractors received a total of $180 billion, they are estimated to have passed on about 45 percent of this to lower tiers.

28 OTA estimates that approximately 475,000 federal employees are involved in acquisition and public sector aspects of the DTIB.

29 About $18 billion was estimated to have been spent on imports. OTA does not have good visibility into defense imports. One deficiency Of using an input-output model for breaking down defense spending is that the DTIB has some different constraints than commercial industry. For example, defense imports are probably overcounted by such a model, because the model does not take into account DOD "Buy America" restrictions. Moreover, OTA was unable to determine the American content of components and subcomponents of foreign goods.

FIGURE 3-1: Estimated Calendar Year 1992 Compensation Flow for Defense Goods and Services



SOURCE Bureau of Economic Analysis Data and Bureau of the Census CY 1992 spending by the federal government for national defense

TABLE 3-6: Characteristics That Make a Defense Good or Service (G/S) More or Less Amenable to Integration

More amenable	Less amenable
Equivalent or nearly equivalent to commercial G/S.	Has no related commercial variant (esp weapons),
Readily customizable from commercial G/S,	—
Processes similar to commercial processes,	Process IS specialized for performance or security reasons.
A service.	—
Sourced from lower tier (subcomponent, commodity)	Sourced from a higher tier, especially at the prime integration level,
Economically viable volume/predictable rates,	Noncommercial volume/uneven rates,
Commercial technology leads defense technology.	Defense technology leads commercial technology

SOURCE Off Ice of Technology Assessment, 1994

worth less than $25,000), large contract actions dominate monetarily, accounting for over 90 percent of the $99 billion consumed at this tier.

Beyond the first tier, there are second, third, fourth, and lower tiers that provide goods and services to the tiers above them. Understanding the flow of funds and the value added at these tiers can improve CMI analysis.

For example, a transport aircraft may have special military requirements that prevent it from being produced alongside commercial jets. If one looks only at first-tier spending, policy makers would see little potential for CMI savings on such a plane. The prime contractor for the aircraft, however, may contribute only 40 to 50 percent of the actual value of the aircraft, relying on lower tier firms for components and parts. The technologies employed by these subcontractors may be amenable to CMI. But such firms are also more difficult to assess than prime contractors. Indeed, at the lowest tiers, firms may be largely integrated and unaware that they supply a defense customer.

Amenability to CMI

Having outlined the flow of defense spending, the next step is assessing the appropriateness of defense goods and services to CMI. The OTA assessment team used past studies, supplemented with interview data, to develop a profile of technologies, products, and services that might be most amenable to integration. These characteristics, summarized in table 3-6, can influence the effectiveness of CMI policies.

The similarity of a defense good or service to a commercial counterpart clearly eases its susceptibility for integration. The difference between the proverbial military fruitcake and one received as a holiday gift is negligible. Alternatively, there is seldom any commercial demand for a large weapon system.

The potential for integration also appears to be affected by manufacturing processes. Defense and commercial goods sharing similar production processes, regardless of the difference in end product (e.g., integrated circuits), may make integration easier than products relying on dissimilar production techniques. The security classification of certain defense manufacturing processes may block their integration with commercial production.

Services, which involve the most flexible processes of all, appear particularly amenable to integration. But the OTA assessment team was surprised at the degree of separation in services re-

ported by participants in the OTA industry sector survey. There should be little difference between how a commercial painter does his actual work and how a defense painter does hers. But service sectors report many of the same acquisition barriers that exist in manufacturing. Services, however, account for a smaller share of both direct and indirect purchases for national defense (see figure 3-2) than in the broader commercial sector.

The reasons for greater amenability to integration of lower tier firms over higher tier firms are less apparent. However, the higher tier firms, especially the prime contractors dealing directly with the government and its auditors, are subject to the government regulations that segregate the base and are more likely to be producing items that are militarily unique than are lower tier firms.

Lower tier firms (subcontractors and suppliers of subassemblies, components, parts, and basic materials) are shielded from government regulations—although government requirements frequently flow down to them—and make products that are often common to both defense and commercial systems. But many defense firms tend to be prime contractors on one contract and subcontractors on another. Such firms are affected by the government's rules even when a particular product may be exempt from those rules. At the lower tier levels, however, case studies and surveys indicate that firms may be naturally integrated in product development and production.

Defense goods are often produced in volumes that have been too small to be attractive to commercial enterprises. Defense goods procured in commercially viable numbers create opportunities for integration. Similarly, DOD's unpredictable procurement patterns may make defense goods and services an unattractive business. Trends in manufacturing technology maybe movin$_g$ toward greater flexibility in production volumes and rates, permitting the manufacture of low and high volume orders on the same production line and thus achieving economies of scale at lower production volume.

Rapid commercial developments may also provide a strong motivation for DOD to integrate within that sector, and thus reduce self-imposed barriers. If, however, DOD enjoys a technological advantage in a given sector, it might want to preserve that advantage and may see little benefit in sharing the technology with the commercial world. One way to remain strong technologically and maintain competitive advantage may be to exploit dual use.

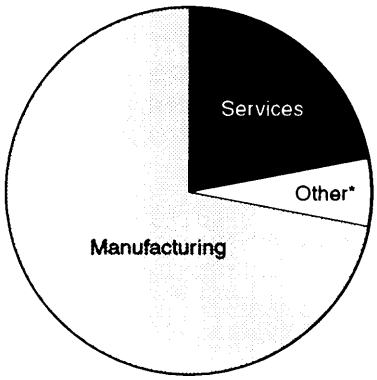
CMI at Different Industrial Levels

Integration should be analyzed not just at the facility level, but at three separate levels—the technology or industrial sector, the firm, and the facility. Each presents its own unique set of policy challenges.

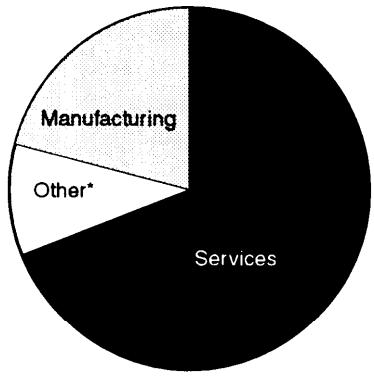
Integration at the technology or industrial sector level is characterized by the DTIB and CTIB sharing common technologies, processes. and specialized assets (e. g., unique test stands, wind tunnels, and industrial research centers). An industrial sector can be said to be integrated if its defense goods or services are drawn from the same pool of technologies, specialized assets, and processes (and, by extension, standards) as are commercial goods or services. However, while integration at the sector level aids the development of common products, it does not assure that defense and commercial products will be the same, that they will be produced in the same facilities, or that they will be less expensive.

Integration at the firm level is characterized by the sharing of corporate resources to meet both defense and commercial needs. These resources include management, workers, research centers, equipment, stocks, and common facilities. A corporation that readily moves staff between defense and commercial work and transfers manufacturing and product technologies back and forth can be considered integrated at the firm level, even though it may separate its operating divisions along commercial and defense lines.

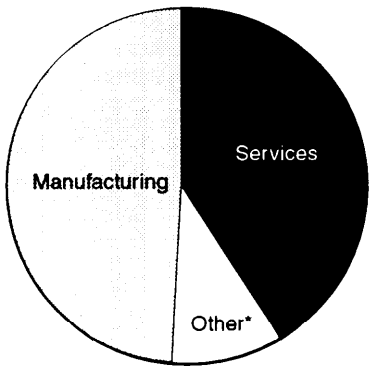
FIGURE 3-2: Composition of Defense and Nondefense Purchases



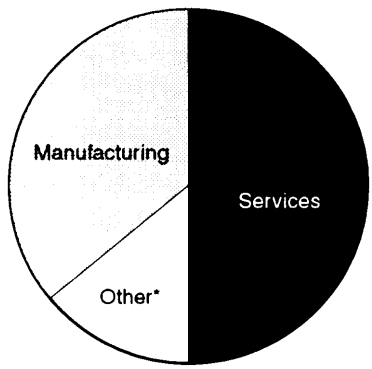
Defense final purchase



Nondefense final purchase

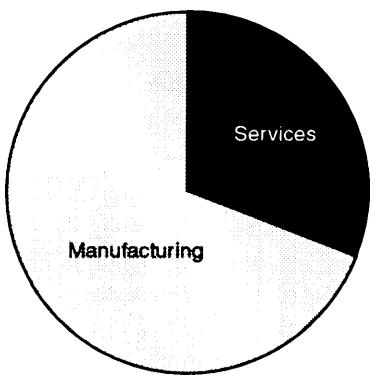


Indirect or lower tier defense purchases



Indirect or lower tier nondefense purchases

● *Other includes construction, agriculture, and mining*



Composition of OTA industrial survey sample (combined direct and indirect)

SOURCE Department of Defense, "Figure 1 Composition of Defense and Non-Defense Purchases, " *Projected Defense Purchases Detail by Industry and State Calendar Years 1991 Through 1997,* November 1991, p 4, with data from an industrial survey conducted by the Off Ice of Technology Assessment, 1994

TABLE 3-7: Levels of CMI

Level of integration	What might be integrated	Examples of integration at this level	Examples of barriers to further CMI	Rationale for further CMI
Industrial sector	All activities in an industrial sector, including companies, Industry groups, standards bodies, government labs, defense acquisition officials, and academia	Use of common technologies, processes, and specialized assets (e g , unique test stands, wind tunnels, and industrial research centers) within an industrial sector.	Differing commercial and military product and process requirements, separate specification and standard systems go-it-alone attitude in businesses or the DOD, classification	Product and process technology transfer reduced costs by avoiding duplication Increased competitiveness, leverage limited R&D funds
Firm	Corporate management, divisions, branches, and assets of an individual company or corporation	Sharing of corporate vision and resources, Including management, workers, research centers, accounting and data systems, equipment, stocks, and facilities	Need to shield commercial work from DOD oversight and added overhead costs, different accounting/data systems, different management and marketing environments, classification.	Internal technology transfer, maintenance of capabilities in commercial or defense downturns, economies of scale Increased long-term stability due to diversification, capital availability.
Facility	R&D, production, maintenance and/or administrative processes within a single facility.	Sharing of personnel, equipment, material and administration within a single facility, joint defense and commercial activity on a production line, in a work group cell, or at an R&D lab bench	Need to shield commercial work from DOD oversight and added overhead costs, different accounting/data/supply systems, military uniqueness, use of military specifications and standards limits on uses of government equipment, classification	Source of cost savings, economies of scale, reduction of redundancies, lower capital investments and overhead costs. less worker retraln-ing, direct process technology transfer, job retention

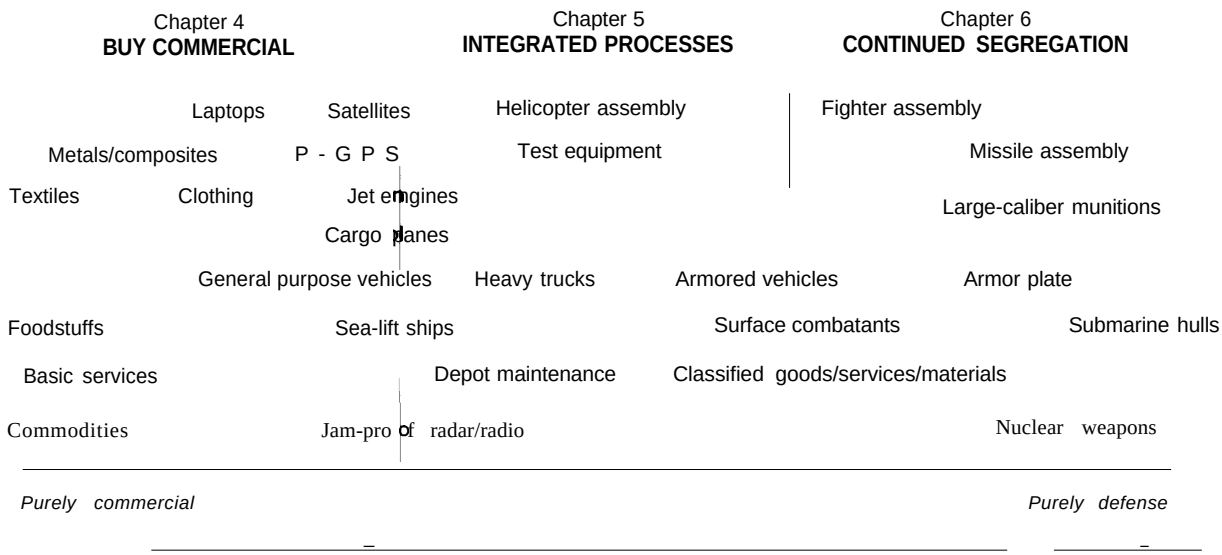
SOURCE Off Ice of Technology Assessment, 1994

The third and deepest level of integration is at the facility level. Integration at this level is characterized by the sharing of personnel, equipment, and stocks within a single facility. In an integrated facility, defense and commercial goods would be manufactured side by side, with differences in production processes and parts dictated solely by product function. Table 3-7 illustrates some of the difference among these three levels of integration.

Approaches to CM]: An Assessment Overview

As noted, defense goods and services that have similar characteristics may benefit the most from similar CM I policies. OTA's analyses indicate that integration policy options might be divided into three broad categories. To facilitate its assessment, OTA has characterized defense goods and

FIGURE 3-3: Sample of Products, Subcomponents, Supplies, and Services Distributed Among Policy Option Groups



SOURCE Off Ice of Technology Assessment, 1994

services accordingly, while recognizing there is some overlap across categories. These categories correspond to how defense goods and services are currently procured and how they might be procured in the future:

- defense goods and services bought commercially;
- noncommercial defense goods and services created with integrated processes (R&D, production, and maintenance); and
- defense goods and services procured largely from a segregated defense base.

These categories serve as the subjects for chapters 4, 5, and 6, respectively, of this report.

Figure 3-3 suggests how some defense goods and services might be distributed across the three broad categories. The figure is intended to be illustrative rather than definitive of the types of goods and services discussed in chapters 4, 5, and 6.

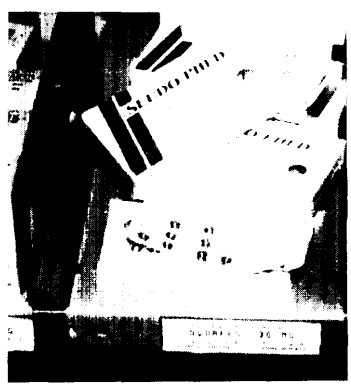
Buying Commercial Goods and Services

4

Commercial goods and services have been an essential element of defense procurement since the founding of the Republic. Prior to World War II, the majority of non-weapon defense materiel was purchased commercially. During the war, commercial industry often used civilian facilities and methods for war production. The use of commercial, non-standard products and parts, however, created logistical difficulties. After the war, the military shifted towards the standardization of products built to military specifications and standards. This not only served to streamline logistical support, it also helped open DOD contracts to more bidders.

But, this approach contributed to the segregation of the defense technology and industrial base (DTIB) from the commercial technology and industrial base (CTIB). The segregation was exacerbated by the complex rules developed to protect tax dollars. ensure fairness in contracting, and pursue national socioeconomic goals. The level of separation is now deemed unacceptable, given reduced defense spending and economic change. Greater reliance on commercial products and services and greater use of commercial buying practices are seen as critical elements of reintegration.

This chapter analyzes policies designed to increase the use of commercial goods and services to meet defense needs.



BACKGROUND

Over the past two decades, studies and commissions hare advocated making increased use of commercial products and practices to meet defense needs, resulting in legislative and executive branch efforts to promote their use.

Congressional Initiatives

Legislative support for the use of commercial products dates back at least to the Competition in Contracting Act (CICA) of 1984.[1] CICA called on federal agencies to "promote the use of commercial products whenever possible."[2]

That same year, Congress also enacted the Defense Procurement Reform Act, which mandated that DOD use "standard or commercial parts" when developing or acquiring defense-specific products "whenever such use is technically acceptable and cost effective."[3]

In 1986, Congress instructed DOD to redefine its military requirements so that they could be more easily met with nondevelopmental items (NDIs), a category including both commercial items and previously developed military equipment. Congress directed DOD to undertake market research to determine if available NDIs could meet the anticipated requirements, perhaps with modification.

In 1989, Congress directed DOD to streamline regulations governing commercial products, rescind conflicting and inconsistent regulations, and design and employ a simplified commercial contract. Congress further prescribed that inspection and warranty clauses be consistent with commercial practices.[4] The fiscal year 1993 National Defense Act called for the reduction of federal government barriers to the use of commercial products, processes, and standards.[5]

Legislative initiatives introduced in 1994 (the Federal Acquisition Improvement Act of 1994-House of Representatives 2238, and the Federal Acquisition Streamlining Act—Senate 1587) contained a number of provisions aimed at increasing the amount of commercial goods and services used by DOD. Congress passed the Federal Acquisition Streamlining Act of 1994 (FASA), incorporating elements of both bills, as this report went to press.

DOD Programs

Since at least 1976-when the Office of Federal Procurement Policy issued the first of a series of memoranda governing procurement of commercial products—increasing the use of commercial products has been a formal part of DOD policy. Subsequently, in 1978, DOD initiated the Acquisition and Distribution of Commercial Products Program (ADCP), designed to facilitate the acquisition of commercial products by eliminating government specifications and contract clauses that did not reflect commercial practices.[6]

Other DOD efforts include making increased purchases of commercial commodities under the Commercial Commodity Acquisition Program. More recently, the Defense Logistics Agency (DLA) has moved to purchase food from local markets and acquire commercial petroleum products, drugs, and medical instruments. Efforts are being made to purchase commercial equipment that is designed to meet similar defense and nondefense specifications, such as telecommunications gear, computers, light trucks, and sedans,

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[1] This discussion draws heavily on the report of the U.S. Department of Defense Advisory Panel on Streamlining and Codifying Acquisition Laws (also known as the 800 Panel, hereafter called the Acquisition Law Advisory Panel), *Streamlining Defense Acquisition Laws, Report of the Acquisition Law Advisory Panel (o the United States Congress,* chapter 8, Streamlining Defense Acquisition Laws, January 1993.

[2] 10 U.S.C. § 2310 (b)(6).

[3] Acquisition La, Advisory Panel, op. cit., footnote 1, pp. 8-3. The Defense Procurement Reform Act of 1984 is Public Law No. 98-525, § 1202, 98 Stat. 2588 (1984).

[4] Acquisition Law Advisory Panel, op. cit., footnote 1.

[5] Public Law 102-484, $4211, 106 Stat. 2315, 2662 (1992), *enacting* 10 U.S.C. § 2501(c).

[6] W.T. Kirby, *Expanding the Use of Commercial Products and '<Commercial-Style" Acquisition Techniques in Defense Procurement: A Proposed Legal Framework* in the *President's Blue Ribbon Commission on Defense Management, Final Report: A Quest for Excellence,* appendix H, 1986.

DOD currently advocates an increase in the purchase of NDIs. Directive 5000.1, for example, requires that the maximum practicable use shall be made of commercial and other nondevelopmental items.

More ambitious programs for commercial items have been proposed. Responding to a fiscal year 1991 congressional authority to conduct pilot programs to determine "the potential for increasing the efficiency and effectiveness of the acquisition process using standard commercial and industrial practices," the Clinton Administration formally nominated seven pilot program candidates.[7] For example. DOD hopes to purchase commercially 85 percent of the Global Positioning System guidance hardware for the Joint Direct Attack Munitions Program.[8]

Among other pilot programs DOD planned to use were: commercially derived Boeing 767 airframes as a platform for AWACS being built for Japan and NATO; commercial engines in the C-17 and other aircraft; commercial training aircraft as its Joint Primary Training Aircraft Trainer; and off-the-shelf computers in the Fire Support Combined Arms Tactical Trainer.[9]

Secretary of Defense William Perry's June 1994 memorandum directing DOD to implement changes in the use of military specifications and standards is the most significant action taken to date.[10] The memorandum included provisions that will positively affect the ability to purchase commercial items. These will be discussed later in this chapter.

US AIR FORCE

Commercial airframes have been used for AWACS, *transports, tankers and surveillance aircraft.*

To date, however, in the face of persistent obstacles to commercial purchasing, these executive and legislative branch efforts have had only modest success in increasing commercialization. FASA and Mr. Perry's directive can both provide significant support for civil-military integration (CMI).

While purchase of commercial products and services for the bulk of the country's defense needs appears to be the simplest, most straightforward way to integrate the commercial and defense base, concerns over accountability of public funds have inhibited the adoption of this approach. A further hindrance to integration is the fact that most major weapon systems—such as battle tanks, fighter jets, and submarines—and many of

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[7] 10 USC 2430, 809 Major Defense Acquisition Pilot Program. The legislative authority for the original six pilot programs terminated September 30, 1992.

[8] John Boatman, "Commercial Buys Key to Acquisition Reform," *Jane's Defence Weekly*, Nov. 6, 1993, p. 14. The Joint Direct-Attack Munition is a new program aimed at developing a guided glide bomb expected to arm most U.S. bombers, fighters, and other aircraft. The competitive first phase of engineering and manufacturing development has been awarded by the U.S. Air Force to Martin Marietta and McDonnell Douglas Aerospace,

[9] Department of Defense, *Acquisition Reform: A Mandate for Change*, Feb. 9, 1994, p. 15. The Federal Acquisition Streamlining Act of 1994 authorized the Secretary of Defense to designate five acquisition programs for participation in the pilot acquisition program: the Fire Support Combined Arms Tactical Trainer, the Joint Direct Attack Munition, the Joint Primary Aircraft Training System, the Commercial-Derivative Aircraft, and the Commercial-Derivative Engine.

[10] Secretary of Defense William J. Perry, *Memorandum for Secretaries of the Military Departments, Subject: Specifications & Standards: A New Way of Doing Business*, June 29. 1994.

the underlying components, subsystems, and services have no commercial market. Therefore, we can expect a separation of some portion of the base to persist. But even here, segregation can be ameliorated if defense purchasing expands into areas where qualified commercial alternatives exist.

CURRENT AND POTENTIAL USE OF COMMERCIAL GOODS AND SERVICES

OTA obtained some unofficial estimates of the amount of nondevelopmental item and commercial item procurement from the Army, Air Force, and DLA, but was unable, until very late in this assessment, to obtain an official estimate of the total amount of commercial items currently purchased by the government or by defense contractors for use in defense systems. Indeed, prior to April 1993, when the Services were directed by the Secretary of Defense to provide information on commercial purchases, they had no compelling reason for gathering such information and no mechanism for gathering it.

The Army, early in the assessment, provided OTA an unofficial estimate that about 45 percent of its procurement dollars are spent on NDIs, many of which are commercial or have high commercial content, e.g., bulldozers and tactical trucks. '2 Senior Air Force personnel estimated that some 10 to 15 percent of current Air Force procurement is commercial.

Better official estimates became available in March 1994. '3 DOD reported that 6.9 percent of the funds spent on "high dollar value items" (further limited to "major component level of first tier subsystems"), were spent on commercial items. The DLA also estimated that 18,3 percent of its spending went for commercial items.

Distinguishing commercial from noncommercial NDIs has been particularly difficult, as some commercial NDIs are produced to military specifications and standards, e.g., aviation parts.

While direct DOD commercial procurements appear heavily concentrated in the Operations and Maintenance (O&M) account, which provides for much of the day-to-day needs of a military—housing, food, clothing, fuel, general maintenance, and office supplies-commercial defense procurement is spread across the procurement spectrum, particularly in components, parts, and services purchased by defense contractors. This holds true even for militarily unique systems. (See box 4- 1.)

OTA Estimates

A better understanding of the existing level of integration is essential to policy development. But previous surveys, although useful, examined only portions of the DTIB. Case studies were even more limited. Data from DOD, even in its recent survey, were also selective.

In the absence of good data on the current use of commercial goods and services, OTA developed and tested a survey method for gathering data and making these estimates. The resulting trial survey provided estimates of the current and potential national defense use of commercial goods and services, the levels of process integration, and the size of the segregated base. Because of the limited nature of the trial, **these estimates should be treated with caution. They should be viewed as indicators of general trends, useful for guiding analysis. They should not be construed as definitive answers.** The estimates have been compared with the results of other, more targeted,

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[11] DOD reportedly spent $32 billion on NDIs in fiscal year] 993. However. [he definitions and measurement system used In thi S tally reportedly do "not take into account the use of commercial items and NDI in support of major systems, such as submarines and bombers. That is, DOD figures look only at direct purchases while ignoring the complexities of the lower tiers. DOD hopes next year to develop a procedure to take a closer look at commercial support items." (Anon.), "Going Commercial," *Defense Daily*, Dec. 13,1993, p. 369.

[12] Interview with the Senior Acquisition Executive, Army Materiel Command.

[13] R Noel Longuemare, Principal Deputy Under Secretary of Defense (Acquisition and Technology), *Memorandum for Deputy Secretry of Defense—Subject: Measuring DOD Progress in Acquisition of Commercial and Nondevelopmental Items,* Mar. 4, 1994.

BOX 4-1: The AMRAAM Part I: Commercial Purchases

The Advanced Medium-Range Air-to-Air Missile or AMRAAM (AIM-120A), was designed to replace the AI M-7 Sparrow as the Navy's and Air Force's medium-range air-to-air missile, Its advantages over the Sparrow include greater speed, Increased range, greater maneuverability, all-aspect look-down-shoot-down capability greater resistance to electronic countermeasures, a terminal seeker, and better maintainability and reliability The AMRAAM program Includes the missile, rail launchers, aircraft Interfaces, support equipment, and aircraft modifications for testing. [1] The Hughes Aircraft Co. was awarded the full-scale development contract in 1981 and began low-rate initial production in 1987 The Raytheon Co. was designated a second-source manufacturer

The AMRAAM Incorporates high technology that is military specific.[2] The missile does not Incorporate any major commercial components, and it has few identifiable subcomponents and specified materials that are nonmilitary But a 1990 Institute for Defense Analyses (IDA) study found that foreign sourcing in the AMRAAM Increased at the more difficult to track fourth and lower supplier tiers. While IDA lacked the resources to do a complete survey, it is reasonable to assume that the constraints on commercial items were similarly loosened at these levels

For the life of this missile, it is unlikely that many components will be procured commercially But there are "value engineering" projects ongoing to Incorporate some commercial components. It is too early to forecast the results Subcomponents, such as generic semiconductors, wires, connectors, fasteners and basic materials, might be bought off-the-shelf. For example, IDA identified numerous electronic subcomponents as commercial in origin, though they were tested to meet military standards.[3]

The potential savings for Increased commercial procurement at the lower hers (tier 3 and below), however, appear to be a very small fraction of program costs, as these tiers—in the overall base—receive less than 10 percent of total DTIB spending. (See chapter 3) However, while the monetary savings might not be great the potential exists for Increased access to technology that might enhance system performance and indeed preserve a viable defense base, But the incorporation of commercial components raises logistics concerns A recent Air Force study recommended adopting a modular approach to systems design that might make it easier to use commercial components as long as they contain standard interfaces [4]

[1] U S Government Accounting Off Ice "Missile Development Advanced Medium Range Air-to-Air Missile (AM RAAM) Certification Issues GAO-NSIAD-86-124BR July 1986 p 6

[2] This box is the first of a series of three that briefly discuss the AMRAAM technology and industrial base as it relates to the policy issues addressed in chapters **4, 5,** and 6

[3] See Erland H Heginbotham et al Dependence *of U S* Defense *Systems on Foreign Technologies,* IDA Paper P-2326 Institute for Defense Analysis December 1990, pp B-III-7 and B-III-1O

[4] U S A r Force Joint *Command Commercial Off- The-Shelf* (COTS) Supportability Working Group (CSWG) Final Report June 1991

SOURCE Off Ice of Technology Assessment, 1994

surveys and case studies, and more recently with the available DOD data. Box 4-2 outlines how the OTA survey was conducted.

Figure 4-1, on page 8, shows OTA's estimates of current and potential spending on commercial goods and services. About 15 percent of the value added in the private sector portion for national defense is estimated to be spent on commercial goods and services. Note that this estimate ineludes the commercial purchases by defense contractors and subcontractors of components, parts. and services, as well as direct government purchases. Figure 4-1 presents OTA's estimate of a potential tripling of the value added directed to-

BOX 4-2: OTA's Industrial Survey

OTA's estimates of current and potential commercial purchases, integration of processes, and levels of segregation in the base are presented in a series of pie charts depicting the portion of the private sector DTIB that might be affected by the policies discussed in the relevant chapter.[1] These estimates also serve as a guide in discussing the possible range of CM I cost savings associated with proposed policy changes,

OTA's estimates of DTIB integration were derived from an informal survey of industrial sectors randomly selected from 541 sectors that sell some national security goods and services. The 20 industrial sectors were selected according to their total value added to national security purchases of goods and services. Because of the method used to select the sectors (selection, with replacement) three of the sectors were selected twice. One was discarded because of a data error. The value added by these sectors accounted for over 40 percent of national security spending in 1992.

OTA interviewed representatives in each sector to learn about the amount of current integration in their respective sectors, the barriers to integration, and their views of the possible impact of selected legislative reform on possible Integration in this sector. The data from the interviews were then weighted and merged to form the estimates presented in each chapter The data were also checked against data from previous case studies, surveys, and Bureau of the Census information.

In analyzing DTIB data, OTA focused on "value added, " instead of more easily obtained '(gross sales" figures. Sales data incorrectly attribute the entire value of a product to the industry from which it was purchased, thus Ignoring the value of components, parts, services, etc. that came from other industrial sectors. Moreover, the use of gross sales figures would significantly double-count defense spending.

Whale OTA lacked the resources necessary to conduct a full-scale, formal CMI survey, this trial can serve as a guide as to how a more comprehensive assessment of CM I might be approached. Appendices C and D provide a more detailed discussion of methodology relevant to data gathering.

[1] OTA was limited in its input-output analysis to the private portion of the DTIB Although this portion IS by far the most significant, future estimates should include the public portion of the DTIB By definition, the public portion of the DTIB is segregated from the CTIB at the facility level

ward commercial goods and services if the United States were to substantially alter its acquisition policies.

It is this incremental portion of DTIB spending that is most affected by the policies discussed in this chapter, and from which most of the savings and other benefits that accrue from increasing commercial purchases will come.

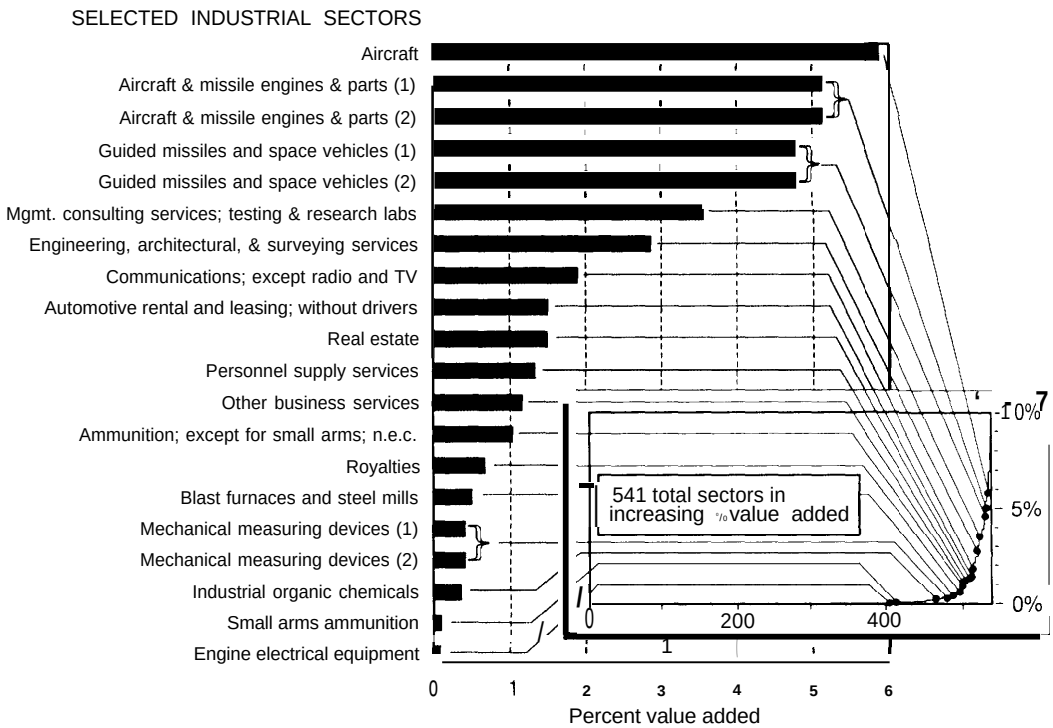
Some major end-items, such as aircraft engines, transport ships, and transport aircraft, might be purchased commercially—some of these were included in OTA's survey. But the largest near-term gains in commercial procurement would probably be derived from purchase of components, commodities, and services from the second and lower tiers. [14]

POLICY OPTIONS TO INCREASE COMMERCIAL PURCHASES

Previous studies have identified significant barriers to the purchase of commercial goods and services. These barriers were mentioned repeatedly to OTA during the course of this assessment. Bar-

[14] Since spending is the lower tiers and for direct services totaled about 56 percent of private sector total DTIB spending in 1992, the roughly 45 percent estimated increase is possible, but must include a significant portion of prime contracts, too.

BOX 4-2 continued: OTA's Industrial Survey



SOURCE Off Ice of Technology Assessment, 1994

riers that appear to have the greatest impact are listed in table 4-1.

If the percentage of goods and services commercially purchased is to be significantly increased, DOD must adopt a number of acquisition policy changes to lower these barriers.

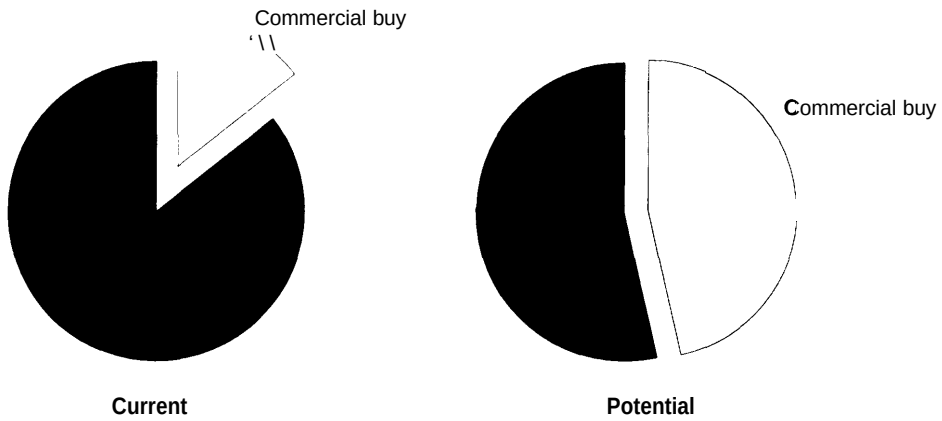
Definitions of Commercial Goods and Services

There has been no generally accepted definition of commercial goods and services. Instead, DOD has defined commercial goods and services in a variety of ways. Critics charge that the inconsistent and largely inadequate definitions of commercial items and services have been an important element of the debate over defense acquisition reform.

The Market's Definition

A commercial good or service, according to the market, is an item or service that is legally for sale (e.g., it is not a prohibited drug or stolen merchandise). The commercial market contains a wide variety of these products and services: some are expensive and one of a kind (Trump Towers), others are inexpensive and mass produced (Barbie dolls). Similar products can vary in quality and price. Consumers base their choices on whether they need the product (a new car) and whether it meets their requirements (high gas mileage or high acceleration). They also make trade-offs between price and quality. Sellers tout their products with messages that appeal to a combination of characteristics designed to make them desirable. In the give and take of the marketplace, sellers and

FIGURE 4-1: OTA Estimates of Current and Potential National Defense Spending at All Tiers on Commercial Goods and Services in the Private DTIB



SOURCE Industrial survey conducted by the Off Ice of Technology Assessment, 1994

buyers have various degrees of power to influence the transactions. Prices for the same or similar products can vary. Donald Trump can specify his requirements—including, say, marble in the restrooms—and negotiate with the builders to lower their price. Consumers can buy their Barbies at a discount store-or quit buying them and move on to another product,

Quality cannot be assumed; some products are shoddy. But some companies focus on developing and advertising quality goods. Voluntary boards set standards for specific products. Independent testing agencies, such as Underwriters Laboratories, test products. The government mandates minimum safety standards on many products. Consumers interested in quality can look for products that have been independently tested, or they can test the products themselves before making a purchase.

The give and take of the commercial market assures some degree of quality control (assuming consumers want the best product) and cost regulation (high prices associated with high profits can attract other, lower price sellers into the market). The government hopes to take advantage of these market forces by buying commercial goods and services to help set price and quality in many defense areas. But there are limitations to this tactic. While the private purchaser risks his/her own money, the government purchaser uses public funds and bears responsibility for those funds.

Importance of a Government Definition

Setting a definition of a commercial good or service for the government is thus not simply an academic exercise. Items meeting the "definition" of commercial will be much easier to obtain under most acquisition reform proposals. As defense R&D funding decreases, DOD access to the fruits of commercial R&D will become even more important. DOD is currently attempting to identify defense-related technologies where the commercial sector leads. Without changes in acquisition policy that encourage commercial purchases, however, DOD may be forced to spend its limited resources to duplicate private sector R&D, and continue to develop separately technologies that are already commercially available. For example, one defense contractor interviewed by OTA claimed the firm was precluded from buying electronic components from a U.S. manufacturer for the valid business reason that the firm refused to comply with DOD cost and pricing requirements.

As a result, the contractor was ultimately compelled to purchase less capable, but adequate, Japanese components.

The choice of definition will limit the impact of reform policies dealing with commercial items and services. **A definition that is too narrow** may result in policies that fail to fully capture the potential savings associated with increased commercial procurement. It may limit commercial purchases to everyday items, such as food and motor oil, while bypassing more sophisticated product areas, such as electronics. Access to rapidly developing commercial technologies may be the most important benefit of commercial purchases, outweighing the cost savings of buying consumables or commodities commercially.

Conversely, **a definition that is too broad** may promote policies that apply commercial buying practices to goods and services that have no viable market other than DOD, and, therefore, are not commercial. Without a viable commercial market, DOD may have difficulty assessing whether it is paying a fair price for an item.

Government Definitions of a Commercial Item or Good

Several alternative definitions for commercial items have been proposed. The 1989 edition of *The DOD Dictionary of Military and Associated Terms* defines commercial items as:

> . . . articles of supply readily available from established commercial distribution sources, which the Department of Defense inventory managers have designated to be obtained directly or indirectly from such sources.

This definition tightly limits the range of goods deemed commercial by opening the process only to those goods supplied by established and designated sources.

TABLE 4-1: Barriers to Commercial Goods and Services

- Government cost-accounting requirements
- Procurement process, culture, and skills
- Citation of military specifications and standards.
- Rights in technical data
- Unique contract requirements.

SOURCE Off Ice of Technology Assessment, 1994

The Acquisition Law Advisory Panel proposed a much more expansive definition (see box 4-3), one broad enough to permit the purchase of: 1) new technology, 2) items modified for DOD,3) commercial items not yet available to the public, and 4) items with a limited commercial market.

The definition of commercial items adopted by Congress in the Federal Acquisition Streamlining Act of 1994 (FASA) draws on the Advisory Panel's definition. The new definition appears broad enough to allow for the acquisition of new technology if it evolves from an item of the type generally used by the general public, but is available "through advances in technology or performance and that is not yet available in the commercial marketplace, but will be available. . . in time to satisfy the delivery requirements under a Federal Government solution."] [5]

The conference report notes the intent to ensure that commercial products incorporating technological advances are included, while at the same time ensuring that there are sufficient commercial marketplace opportunities to provide for measuring price and product quality.

The Advisory Panel definition was even more broad and might be more difficult to implement. Grey areas would exist for items supposedly developed for the commercial market, but without a market yet, or for items with relatively low com-

[15] Federal Acquisition Streamlining Act of 1994, Section 8001, (a) Definition, (B).

BOX 4-3: Acquisition Law Advisory Panel Definition of a Commercial Item

"(A) Property, other than real property, which (i) is sold or licensed to the general public for other than Government purposes, (II) has not been sold or licensed to the general public, but is developed or IS being developed primarily for use for other than Government purposes; or (iii) IS comprised of a combination of commercial items, or of services and commercial items, of the type customarily combined and sold in combination to the general public.

(B) The term 'commercial item' also includes services used to support items described in subparagraph (A), such as Installation, maintenance, repair and training services, whether such services are procured with the commercial item or under a separate contract; provided such services are or will be offered contemporaneously to the general public under similar terms and conditions and the Government and commercial services are or will be provided by the same work force, plant or equipment,

(C) With respect to a specific solicitation, an item meeting the criteria set forth in subparagraphs (A) or (B) if unmodified will be deemed to be a commercial item when modified for sale to the Government if the modifications required to meet Government requirements (i) are modifications of the type customarily provided in the commercial marketplace or (ii) would not significantly alter the inherent nongovernmental function or purpose of the item in order to meet the requirements or specifications of the procuring agency;

(D) An item meeting the criteria set forth in subparagraphs (A), (B), or (C) need not be deemed other than 'commercial' merely because sales of such item to the general public for other than governmental use are a small portion of total sales of that item, and

(E) An item may be considered to meet the criteria in subparagraph (A) even though it is produced in response to a Government drawing or specification; provided, that the item IS purchased from a company or business unit which ordinarily uses customer drawings or specifications to produce similar items for the general public using the same work force, plant, or equipment. "

SOURCE U S Department of Defense Advisory Panel on Streamlining and Codifying Acquisition Laws (also known as the 800 Panel, hereafter called the Acquisition Law Advisory Panel), *Streamlining Defense Acquisition* Laws, Report *of the Acquisition* Law Advisory *Panel to the United States Congress,* Chapter 8, Streamlining Defense Acquisition Laws, January 1993, pp 8-17 and 8-18

mercial demand,[16] where market-based pricing and competitive innovation might not exist. Yet the Panel did not intend that its definition bear the entire weight of determining when commercial contracting should be applied-other factors would be considered. The FASA definition appears broad enough to incorporate more new technology. But using a broad definition of commercial items will require greater flexibility in purchasing rules, involving the delegation of authority in making procurement decisions. Absent such changes, a broad definition may not be helpful.

Definitions of a Commercial Service

Services account for about one-third of total defense spending (see figure 3-2 in chapter 3), and represented over 30 percent of the direct and indirect purchases for national defense in OTA's survey of industrial sectors, including: engineering, architectural, and surveying services; personnel supply services; and other business services.

The Advisory Panel decided not to recommend amendments to current law addressing commercial services because it could not identify any legal

16 For example, subparagraph (D) of the Pane] definition would *allow* vehicles such as the High Mobility Multipurpose wheeled Vehicle and similar systems sold only in small quantities to the public to be considered "commercial items" for acquisition purposes, but it would not *require* them to be deemed commercial items.

impediment to commercial service contracting other than the Service Contract Act.[17] The Panel reported its conclusion that firms providing services to the government generally were not as constrained by existing acquisition laws as were firms providing manufactured products.[18]

The Advisory Panel, however, concluded that the services used to support commercial goods sold to the government should be considered commercial, provided that such services are, or will be, offered to the general public under comparable conditions and are, or will be, provided by the same workforce, plant, and equipment. FASA includes "installation services, maintenance services, repair services, training services, and other services if such services are procured for support" of a commercial item defined in the bill. [19] Like the Panel, the congressional provisions stipulated that such services had to be offered to the public and employ the same workforce.

But Congress went further and included services offered and sold competitively in substantial quantities, in the commercial marketplace based on established catalogue prices for specific tasks performed and under standard commercial terms and conditions.[20]

While the negative effect of current acquisition laws and regulations are less evident than are the arguments concerning manufacturing, there is some evidence that firms providing services to DOD face acquisition barriers that raise costs and discourage some firms from working with DOD.

OTA found, for example, that although service activities appear more amenable to integration than manufacturing activities, many of the service firms interviewed report that they currently face special government cost-accounting requirements, audits, and special contract clauses.

While firms providing services on a time-and-material, commercial-style contract would still need to provide an accounting for reimbursement, OTA concluded that integration might be facilitated by a broader definition of commercial services.

The existence of a commercial market from which the government can obtain pricing information—thus avoiding the need to collect cost data separately—is the common thread in the definitions of both commercial items and services offered here.[21]

Even with acceptable definitions of commercial goods and services, however, significant barriers to exploiting commercial products remain. The more salient policy changes that might address some of these barriers follow. These include measures designed to ensure that commercial goods and services reflect true market prices, meet military quality requirements, and will be available in crisis and over the long term.

Government Cost-Accounting Requirements

Government cost-accounting requirements have been cited repeatedly as a major barrier to expanded commercial procurement. The Acquisition Law Advisory Panel, for example, noted that:

> ... one of the most expensive and disruptive procurement requirements involves mandatory adherence to cost principles and accounting

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17 41 U.S.C. §§ 351-358. The Act raises the minimum wage in the service industry.

18 The Department of Defense Acquisition Law Advisory Panel, *Streamlining Defense Acquisition Laws, Executive Summary: Report of the DOD Acquisition Law Advisory Panel,* Defense Systems Management College, March 1993, p. 15.

19 Federal Acquisition Streamlining Act of 1994, Section 8001, (a) Definitions, (E).

20 I bid., (F).

21 DOD accounting of commercial goods and services is further confused by the use of the term NDI. Officially, NDIs include commercial goods as a subset, but they are often referred to as separate entities. Formally separating the two might facilitate future discussions of NDIs and commercial goods and services.

BOX 4-4: Software and Tuna

Special cost and pricing requirements limit the number of enterprises willing to do business with DOD. An example is the General Services Administration's (GSA) recurring problem with major computer software vendors, Last year, a collection of vendors, including some of largest and most popular—Microsoft, Lotus, and Borland—refused to give GSA all the information it requested as a condition of being listed on the GSA Multiple Award Schedule The schedule allows government officials to procure small quantities of commercial items at the lowest possible price, while avoiding the paperwork and delay of competitive bids, The vendors felt that GSA requests for Information were unreasonable, arguing that they did not collect such information or supply it to other customers. Moreover, if mistakes were made in the information presented to GSA, company officials could be held criminally liable--a risk they never faced in commercial transactions. Eventually, however, the boycott crumbled as competitive pressures in this annual $100 million market pushed companies to accept GSA conditions.[1] Whether this would have occurred in the face of a more robust commercial market is not clear.

Similarly, to avoid governmental Intrusions into its bookkeeping, one of the main domestic suppliers of canned tuna will not sell directly to DOD. Instead, it has established a distributor for military sales, whose books are open to the government [2] The result, however, is that DOD buys its tuna at the added cost involved in having a middleman,

1 See John Burgess, "Software Firms Turn on Each Other as Boycott of GSA Unravels, " *The Washington Post*, July 1019931 PP F1 -2

2 Interview With Defense Personnel Support Center staff

SOURCE Office of Technology Assessment, 1994

standards enumerated in statute, in the FAR (Federal Acquisition Regulations), and by the Cost Accounting Standards Board (CASB).[22]

The 1993 Defense Science Board Task Force on Defense Acquisition Reform called the current "cost-based contracting" system, with its unique cost accounting, the single most intrusive element of the process.[23] (See box 4-4.)

Cost accounting affects not only prime contractors. Cost and pricing data requirements flow down from defense prime contractors to their subcontractors, extending the cost accounting barrier to the lower tiers—thereby limiting potential suppliers.

The Truth-in-Negotiations Act (TINA), which requires contractors to provide cost and pricing data to demonstrate that their prices are fair and reasonable, is cited as a particular problem, Although TINA specifically exempts commercial items from its provisions, the past inadequacy of the definition of commercial item has meant that, in practical terms, companies wishing to sell to the government are often required to provide cost and pricing data.

Commercial firms producing hundreds of thousands of units per year—many of them tailored to meet individual orders--do not routinely collect cost data by individual contract covering an individual item in the manner required by the government. Instead, they examine costs by product line or manufacturing unit. Hence, the detailed cost information required by the DOD program

22 Acquisition Law Advisory Panel, op. cit., footnote 1, pp. 13-14.

23 Office of the Under Secretary of Defense for Acquisition, Report of the Defense Science Board Task Force on *Acquisition Reform*, July 1993, p. 4.

office may simply not be available from a commercial accounting system. Further, even if the information were available, companies may be unwilling to accept the inherent risk of either civil or criminal penalties possible as a result of simple errors in such data. The costs of installing a data management system that tracks such information can be prohibitive. OTA ran across several instances in which firms refused to sell to the government because of such requirements.

The government's "most favored customer" provision. requiring the company to offer the government the lowest price paid by any commercial customer, means that all invoices must be checked in order to document the lowest price. In many cases, because of promotional sales, the company may not know the lowest selling price.

The negative effects of such requirements are illustrated in the convoluted purchase of several thousand commercial Global Positioning System (GPS) receivers-cited in box 4-6 as a commercial technological success—in the Persian Gulf War. Faced with an immediate military need, the Army waived all military technical requirements and specifications related to the purchase of commercial GPS receivers. But no responsible procurement official could be found to waive the requirement that the company certify that the government was being offered the lowest available price. Nor would any company official so certify—and risk a felony charge—since the seller could not be sure that this widely sold item was not being offered somewhere at a lower price. In the end, the Japanese government purchased the receivers without a price certification and donated them to the U.S. Army, subsequently crediting the purchase against the Japanese financial contribution to Desert Storm.[24]

In the current government contracting environment, the disincentives associated with collecting unnecessary cost and pricing data (e.g.. higher costs to the government, reduction of potential suppliers) have not been apparent to government contracting personnel, while the costs of not collecting such information (e.g.. potential over-billing, second guessing by others) are all too apparent. Therefore, such data are often required. even in procurements judged to be competitive .25

While the Acquisition Law Advisory Panel acknowledged a need for a "uniform, specialized accounting system which protects the government from the imposition of unreasonable charges" in the case of "cost plus" or complex incentive contracts, it concluded that applying the same requirements in instances where market information is available incurs unnecessary additional costs and may lead firms to refuse to sell to the government. The results are separation of defense and commercial activities and avoidance of government work. A Center for Strategic and International Studies (CSIS) survey of 206 firms that sell to the government supported these observations. Half of the respondents had established a separate data collection system to provide cost and pricing data. Some 32 percent separated their administration in order to ease reporting requirements.[26] The cost of this separation is passed on to the government in higher prices and increased overhead charges.

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[24] U.S. Department of Defense, Acquisition Law Advisory Panel, *Executive Summary*, op. cit., footnote 18, p. 5.

[25] The Aerospace Industries Association reported that a survey of 40 top aerospace contractors estimated that the firms spent approximately $250 million year supplying such data in competitive procurements.

[26] Debra van Opstal, *Integrating Civilian and Military Technologies: An Industry Survey* (Washington, DC: The Center for Strategic and International Studies, April 1993). Twenty firms separated administration only, three separated R&D as well, nine separated production and administration, and 34 separated R&D, production, and administration. Although these firms were not random] y selected, and therefore the data cannot be generalized to the broader base, they were principally defense manufacturing firms and represent about 13 percent of the total DOD DTIB spending. OTA's own interviews found instances of both separated accounting and of refusal to sell to the go\ ernment.

Eliminate Certain Cost Accounting and Pricing Requirements

The elimination of special government cost accounting requirements for commercial goods and services is the change in policy most often suggested for lifting this barrier. This would allow market pressures to provide cost control.

The Acquisition Law Advisory Panel, among others, recommended that the threshold for cost and pricing data requirements be stabilized at $500,000. DOD not only concurred with the Panel recommendations, but has also recommended broadening the exemption to include "commercial products and leading edge commercial technology."[27] A $500,000 threshold affects more than 98 percent of DOD contract actions, reducing government oversight costs. The $500,000 threshold was incorporated in FASA.

Other recommended changes include extending the exemption for adequate price competition in TINA to goods purchased from a business that sells the same or similar items commercially, using the same or similar production processes. Exempting contract modifications to those contracts awarded under the expanded definition of adequate price competition or under catalog or market pricing has also been recommended. Such provisions reduce costs for many commodities, reduce government oversight requirements, and ultimately produce savings through elimination of oversight personnel. These provisions were included in FASA.

Many of the benefits of provisions for exemptions have been thwarted in the past by either the failure to use them, or the fact that the contracting officers have had the discretion to ask for cost and pricing data on any contract above $25,000. Further, critics noted that the attempt to limit the requirement for cost and pricing data on commercial items (in DFARs subpart 211) was rarely used in its first 18 months and is limited by the lack of a consistent definition of commercial items.

Again, definitions are important. The more constraints included in the definition, the more likely that a particular good or service falling under that definition will have a large enough market to ensure competitive market pricing. For example, if the criterion for a commercial good is that there must be a minimum number of commercial vendors and that the defense purchase would constitute a small percentage of total product sales, then DOD could be reasonably assured of obtaining a true market price. But these conditions will be more difficult with some products, particularly those that are new and have yet to establish a significant market.

Commercial buyers deal with this problem every day. For example, there are many goods and services available only from a limited number of vendors. Examples include commercial aircraft, power generation equipment, and heavy construction equipment. Competition is nonetheless fierce in these areas.

Similarly, commercial customers of one-of-a-kind goods and services avoid price gouging through bargaining, based on an understanding of relative market values. Part of bargaining is a readiness to forego certain purchases if the proposed price exceeds estimated value.

Estimates of the value of a commercial good or service that does not yet have competitive pricing are made using standard price analysis methods. This method is already used for some federal procurements under the FAR to provide DOD with the necessary information to be a smart buyer.[28]

A problem remains. Eliminating cost accounting requirements for some items may place defense contractors—whose products include a mix

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27 U.S. Department of Defense, Office of the Assistant Secretary of Defense (Public Affairs), News Release, *DOD's Acquisition Reform Recommendations to 800 Panel Report, No. 517-93,* Oct. *28, 1993.*

28 Cost analyses are also done, once DOD has access to cost accounting data. Commercial firms almost never release this cost data to Other businesses.

of commercial and defense and thus remain subject to DOD cost accounting rules—at a disadvantage. One way of dealing with this issue is to move to a firm, rather than a product, exemption.

Independent of whether DOD chooses to purchase commercial goods and services according to a narrow or a broad definition, in some cases it may pay more than it would under the current cost accounting regime.

Commercial transactions can be complex. In calculating whether to buy an item commercially, government buyers will need to examine the purchase within a larger context. For example, a supplier of aircraft parts to both defense and nondefense customers may sell individual parts to defense cheaper than it sells such parts to its commercial customers under current contract procedures. Yet this may not be the bargain it appears to be if, for instance, the firms deliver to their commercial customers more rapidly, provide them access to new technology, maintain their parts inventory, and offer maintenance and other services as a part of an overall contract. The commercial customer often buys not only the part, but also a long-term service commitment (often competed every 5 years or so) that eliminates inventory and inventory tracking requirements. Some estimates of total savings to the commercial firms over the total cost to the military customers are on the order of 50 to 80 percent. But achieving such **savings for the government requires a dramatic restructuring of the entire DOD support (e.g., eliminating government depot maintenance and inventory control for the items), as well as its acquisition system.**

Proponents of CM I argue that the current cost accounting system is very expensive and that the **net savings** from commercial procurement would dwarf any instances of higher prices or "waste" due to instances of government buyers not getting the best available price. For example. the two major manufacturers of large aircraft engines, Pratt& Whitney and General Electric, have estimated the burden of special government accounting rules ranges from $5 to$12 million per year, per firm. In that very competitive industrial sector, savings might be expected to be passed back to the government.

Should Congress decide to eliminate cost accounting requirements from the commercial portion of the DTIB, however, it must be prepared to defend the change against the inevitable revelation of price gouging and illegal behavior by one vendor or another. Still, the projected benefits of unleashing a large percentage of the DTIB to commercial procurement appear to be worth the potential risks. These are discussed in more detail later in this chapter.

Procurement Process, Culture, and Skills

The current acquisition culture, with its special cost accounting, use of military specifications and standards, etc., has been established for over four decades. The experience and skills of procurement officials, few of whom have worked in any other environment, could serve as an obstacle to the acceptance of commercial items and practices. The Grace Commission warned, "the long-standing nature of the problems makes them particularly difficult to remedy, since cultural as well as technical issues are involved."[29]

Under the current system, acquisition personnel need to know more about how to apply the regulations than about the actual products they buy. One business executive, explaining why his company had ceased to bid on government paint contracts, said that "after 20 years of selling paint to the government, my company dropped bidding on government contracts because the process was nonsensical, costly, and filled with mind boggling hassles." He was particularly troubled by '*contract administration officers who know almost

[29] The President's Private Sector Survey on Cost Control in the Federal Government, *Report of the Office of the Secretary of Defense Task Force*, July 13, 1983, reprinted in U.S. Congress, House. Committee on Armed Service\. *Defense Acquisition: Major U.S. Commission Reports (/w). 1988), v 01, 1*, 100th Congress, 2d Session, Committee Print No. 26 (Washington. DC: U.S. Government Printing Office, No\. 1, 1988).

nothing about the paint they are purchasing, since they lack any chemical or engineering background." [30]

The way in which the defense procurement system operates reinforces this culture. Uniformed officers, for example, are often rotated in and out of acquisition assignments, moving on just as they come to understand the projects they supervise and thus depriving projects of institutional memory. Further, the intensity of congressional and media oversight of the acquisition process can make it appear safer to err on the side of conformity than to take the initiative by using waivers that allow cost-saving even under the current system.

This process has resulted in an acquisition workforce without many of the skills or the inclination to buy commercial products or to operate in a commercial manner. Furthermore, the slowness of the process alone—it takes months or years to get the funds authorized and appropriated, bids let, and proposals evaluated—along with its adversarial nature and the seemingly endless paperwork, have discouraged many commercial firms businesses from even attempting government work.[31]

Adopt Commercial Buying Practices

One change in process and culture said to be essential to taking full advantage of the commercial market is the adoption of commercial buying practices. There is no single definition of buying practices that can be termed "commercial." The Defense Systems Management College (DSMC), however, has included under this rubric techniques, methods, customs, processes, rules, guides, and standards normally used by business.[32] Box 4-5 discusses how commercial businesses buy goods and services.

The Advisory Panel on Acquisition Law identified many statutes whose flow-down requirements disrupted normal business patterns. These include creating "a subcontracting obligation that is inconsistent with normal commercial practices, in which subcontracts are arranged well in advance of shipments."[33] FASA addressed some of these issues, but still has provisions for small and minority-owned business restrictions. Adopting commercial buying practices will affect not only commercial purchases, but will also promote integration of commercial and defense R&D, manufacturing, and maintenance (chapter 5). Management of the militarily unique segment of the base will also be affected (chapter 6).

DOD has launched a number of initiatives aimed at making its purchases more like those of a commercial customer. For example, the Navy has instituted a combined system of best value procurement and vendor preelection. In this process, vendors are interviewed and their past efforts reviewed to form a ranked order of preferred vendors. When a contract is drawn up, the first company on the preelection list is brought in for negotiations. If the negotiations fail, the next vendor is contacted. Each of the Services has also experimented with multiyear procurements, but Congress has been generally unwilling to release this authority to DOD.

Raising the simplified acquisition threshold from $25,000 to $100,000 reportedly would lift the burden of the more complex purchasing proce-

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30 H. peter Tepperma, "Procurement Pains: Why My Company Stopped Bidding on Government Paint Contracts," *Washington Post*, Sept. 19, 1993. Tepperma is CEO of Seagrams Coating Corp., and Chairman of the Government Paint Suppliers Committee of the National Paint and Coating Association.

31 *DOD's Acquisition Reform Recommendations to* 800 *Panel Report,* op. cit., footnote 27. DOD reported that the average lead-time for contract awards below $25,(XX3 is 26 days. Above $25,000, the average lead time is 90 days for simple sealed bids and 210 days for competitively negotiated contracts.

32 Defense Systems Management College, *Commercial Practi ces for Defense Acquisition Guidebook*, (Washington, DC: U.S. Government Printing Office, 1992), Summary, p. 1-2.

33 *Executive Summary: Report of the DOD Acquisition Law Advisory Panel*, op. cit., footnote 18, p. 100.

BOX 4-5: How Commercial Businesses Buy Goods and Services[1]

Commercial businesses use a number of approaches to buying goods and services, including pricing, price analyses, negotiations, and past relationships Businesses can buy just like the public Business purchasers can walk into a store or thumb through a catalog, make a selection of the items on display, and pay the marked price Commercial services can also be purchased the same way, paying for services according to posted hourly wage rates, or a set fee for completion of a task. A company buyer decides to pay the fixed price if it meets the company's expectations of an acceptable value. What constitutes an acceptable value varies from one company to the next, but includes assessments of need, price relative to other sources, quality relative to other sources, timeliness of delivery, quality of customer service, and location One advantage businesses often have over the individual consumer is the opportunity to pay less for an item by buying in bulk

Businesses engage in price negotiation over commercial products. The seller has the advantage of knowing how much money he or she needs to make from the deal, The buyer mayor may not have a good idea of the market price for the item, but should have assessed what the product is worth to the company The less competition, the more important it is for the buyer to conduct price analysis and an internal value assessment The buyer can seldom be certain of having obtained the best deal, only that the deal was good enough for the company's purposes. This uncertainty is what concerns many critics of government commercial purchases [2] Businesses must function in this uncertain environment daily, relying on the skills of their buyers to make the best possible transaction

In practical terms, businesses do not shop for the best deal on every purchase Even the federal government does not do that, giving local buyers discretion over small purchases and limiting competition to a few sources Businesses often develop long-term relationships or "strategic partnerships" with suppliers and subcontractors that meet their special needs (e g , quality and timeliness). Even though the price of the product may not always be the lowest available, the buyer believes it constitutes the best available value In this way, commercial business limits the certainties of the process and tries to get the best available service over the long term. Special relationships in defense procurements, however, have been viewed as undermining free and open competition, although there has been Increased willingness to seek the "best value" in contracting

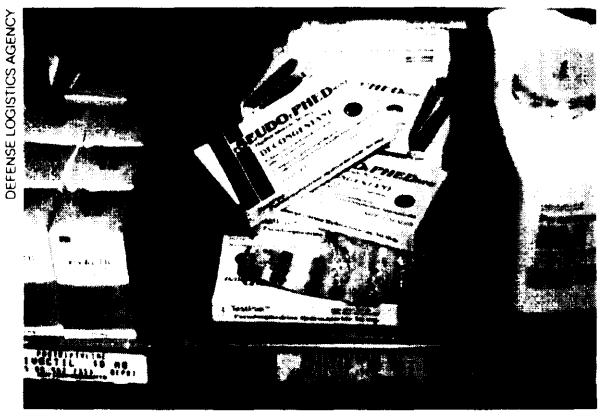
One trend in the commercial sector is the qualification of a company's supplier base. This selection process allows firms to obtain quality products from companies without having to rely on new bids or market analyses for each purchase, Although different firms use different processes, the basic elements are the same. The buying firm establishes a set of quality standards that suppliers must meet. Some firms inspect their suppliers' facilities and quality control processes, others rely on product testing, quality recognition awards, *or* periodic reports. In all of these relationships, however, trust is seen as critical. Violations of that trust can result in removal from the approved vendor list.

Finally, commercial buyers avoid many of the problems of owning their own goods by leasing or renting goods from others This option is seen as especially useful for items that are difficult to maintain overtime (e g , cars, computers, offices) or when the firm's need for such items fluctuates Buyers decide if a particular lease is a good value in the same way they decide for purchases, factoring in the depreciated value of the product over the length of the lease

[1] This discussion is based on OTAS interview of 12 commercial firms

[2] The term Commercial purchase" used rather broadly here to ease the discussion Business-to-business sales are often referred to as industrial purchases

SOURCE Off Ice of Technology Assessment, 1994


DEFENSE LOGISTICS AGENCY

Many military needs can be met directly with commercial products

dures from approximately 40,000 contract actions (with a value of about $2 billion) each year.[34] This change was made in FASA.

The DLA, which has responsibility for purchasing many common Service items, has initiated several programs whose ultimate result, if successful, will be to operate more like a commercial business. These programs include:

- *Best Value* Buying+ valuates performance and quality factors in addition to price.
- *Long-Term Business Instruments-considers* options for future purchases, indefinite quantity contracts, and multiyear terms.
- *Electronic Commerce--uses* electronic networks to solicit bids, and to evaluate purchase orders.
- *Direct Vendor* Delivery-streamlines the acquisition process, reduces inventory costs.
- *Long-Term Contracting—provides* an increased planning horizon and incentives for manufacturing process investment for future contracts.

Many of the DLA initiatives cut costs by reducing the number of times that items must be handled by the government. Thus, DOD customers can buy directly from civilian vendors, eliminating depot middlemen. The DLA anticipates that such moves should generate significant savings and quicker response to the needs of the military.

Medical supplies to Alaska, for example, are now being delivered by Federal Express instead of the Military Airlift Command, saving an estimated 50 percent in delivery costs while providing faster service. The use of a commercial delivery service, coupled with better inventory control, ultimately reduces waste. In the past, for example, about 25 percent of the military's stocks of medicine in Alaska expired on the shelf each year.[35] This is no longer the case.

There has been concern over the possibility that the government's drive for efficiency, including long-term contract arrangements and best value buying, might "bundle" several contracts together into a larger single contract and, in the process, eliminate opportunities for small business to participate. While some bid protests were registered early in the DLA restructuring process for precisely these reasons, DLA personnel report that the agency has paid special attention to assuring that small firms are not eliminated. DLA argues that bundling contracts is not an objective and that their procedures have been supported by the General Accounting Office. Nevertheless, these concerns illustrate one potential problem of buying commercial.

Change the bid and proposal process

One of the most important steps in adopting more commercial buying practices is changing the current bid and proposal (B&P) process. The traditional B&P process has been characterized by a lengthy series of paperwork hurdles, with the possibility that the contract award will be challenged by a bid protest, thereby lengthening the process further.

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[34] DOD's *Acquisition Reform Recommendations to 800 Panel Report*, op. cit., footnote 18.

[35] Briefing from Medical Directorate, Defense Personnel Support Center, DLA, May 25, 1993.

FEDERAL EXPRESS

Commercial services, such as Federal Express, now provide worldwide services once only available through the military.

The executive branch provides a mandated 15 days notice before releasing requests for bids and proposals and allows 30 days for companies to respond before a contract is awarded. Many factors can force extensions to this process. Though intended to promote competition and enhance small business opportunities, the process is now an impediment to both. For example, the mandated notice prevents the routine use of electronic bulletin boards to announce new business opportunities and electronic data exchange systems to rapidly receive quotes.

In the future, many of the contract actions might be accomplished electronically, without the currently dictated delays. While the process is more efficient, businesses, especially small businesses, must learn to operate in this new environment and will require some training.[36] FASA's Federal Acquisition Computer Network (FACNET) is designed to help facilitate electronic commerce.

Increase market analysis/investigation

As DOD gives up many of its traditional buying practices, it will need to develop a better understanding of the commercial market, have the ability to determine whether there are commercial products that can fill defense needs, and be able to set a fair price for those products. FASA directs the use of market research to determine if commercial items are available to meet an identified need.

DOD will have to increase the use of its *market surveillance* and *market investigation techniques.*[37] *Market surveillance* provides buyers the initial information on the general availability of items to fill possible needs. It is an activity conducted by acquisition personnel striving to remain technically current and aware of market trends in their areas of expertise.

A market investigation, on the other hand, takes place only after a specific need is identified. It determines whether a particular item can satisfy a particular defense use. (See box 4-6.)

Market surveillance and investigation takes time, and requires technical understanding of products and training. Market analysis also requires that DOD gain access to existing commercial databases and help develop and update others in product areas where none exist.

Retrain or Rep/ace Procurement Staff

Almost everyone OTA interviewed agreed with findings of previous studies that adopting commercial buying practices will demand a new set of skills in the defense contract community. A DSMC study of commercial practices for defense acquisition argued, for example, that inadequate acquisition training "is probably the single biggest inhibitor" to government adoption of a commercial approach.[38] The study further noted that:

> Acquisition personnel are not usually trained in how to conduct market research, surveys and analyses . . . [and] . . . acquisition managers at all levels are not sensitive to their benefits and do not require them as a matter of course nor as a part of normal acquisition routine.[39]

A lack of training can have many consequences. Contracting officers reportedly require certification of most favored customer price (e.g., lowest cost) because they are not properly trained to conduct proper market research.[40]

An Air Force group studying the use of commercial products also reported potential personnel barriers to reform, noting that "Air Force personnel attempt to fit commercial acquisitions into

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36 DLA's Defense personnel Support Center, for example, conducts training for small firms.

37 Office of the Assistant Secretary of Defense for Production and Logistics, *Buying ND/: SD-2,* October 1990, pp. 3- I to 3-5.

38 DSMC, *Commercial* Pr_ti_e-, *for Defense Acquisition Guidebook,* **op.** cit., footnote 32, p. 2-6.

39 Ibid.

40 Jeff Bingaman et al., *Integrating Commercial and Military Technologies for National Security: An Agenda for Change* (Washington, DC: The Center for Strategic and International Studies, 1991), p. 35.

BOX 4-6: Small Lightweight GPS Receiver: A Market Investigation

One of the more frequently cited recent examples of a commercial product successfully filling the needs of soldiers in the field is the small lightweight Global Positioning System (GPS) receiver--termed the SLGR. This success was partly the result of a market investigation.

During the Persian Gulf War, DOD bought several thousand commercial GPS receivers to augment the more expensive and bulky military GPS receivers on hand, These receivers relay geographic position (latitude, longitude, altitude, and velocity) and time Information based on data received from the GPS, a constellation of navigation satellites Given the almost featureless terrain of parts of the Iraqi desert, these devices proved Invaluable, enabling ground troops to maneuver in areas that had not been mapped,

The primary technical difference between the commercial and military versions of the GPS receivers is accuracy DOD sought to share some of the navigational benefits of the system with the rest of the world while keeping certain advantages to itself. Military GPS receivers thus have an accuracy of + 10 to 20 meters Commercial receivers accuracy is limited to about + 80 meters, Military receivers are also said to be more rugged than the commercial version used in the Gulf

The Army launched the SLGR program in 1986 to determine whether lightweight commercial GPS receivers could meet Army requirements.[1] In March 1987, the Army began a market Investigation with the goal of procuring a lightweight, preferably hand-held, low-cost, commercially available GPS receiver that could be used by a wide variety of personnel with minimal training. [2]Following a period of research, the market investigation team drafted a list of minimum requirements and additional desired capabilities, and published these in Commerce *Business Daily.* Nine companies responded with 11 products, Three of the 11 products had all the required features In 1989, Trimble Navigation was declared the contract winner and 1,012 SLGRs were purchased for field trials.

Several thousand commercial receivers were purchased from multiple sources to meet Gulf War needs [3]While the SLGR represents a technical success, it was not, as noted earlier, a procurement success, Because of the inability to waive the lowest cost certification, many of the devices had to be purchased by the Japanese for the Allies.

[1] Off ce of the Secretary of Defense DOD Caselette "Nondevelopmental Item Acquisition Abbreviated Case Study Small Lightweight GPS Receiver '

2 u s Army SLGR Market Survey July 31, 1987, P 2

3 u s Department of Defense, *Conduct of the Persian Gulf War Final Report to Congress,* appendices A-S, April 1992

SOURCE Off Ice of Technology Assessment, 1994

traditional development processes," rather than adapt to the use of commercial items.[4] The group recommended that a major training effort be initiated, including special courses at the DSMC and the Air Force Institute of Technology.

The amount and nature of training required is likely to differ according to the type of product procured. The Defense Logistics Agency's Defense Personnel Support Center—already practicing commercial purchasing and selected to

[4] *Joint Command Commercial Off- The-Shelf (COTS) Supportability Working Group (CSWG) Final Report,* June 1991.


DEFENSE LOGISTICS AGENCY

Electronic data interchange is already changing the way the military does business. Here, U.S. Marines at Parris Island engage in electronic commerce

participate in one of DOD's pilot commercial acquisition programs—suggests that acquisition workforce training might best focus on the use of new technological tools, such as Electronic Data Interchange, necessary to implement Electronic Commerce, and new contracting alternatives.[42] Other commands, with more complicated products, might use training to foster an understanding of available product technology. But DOD will have to consider allocating training dollars toward commercial buying practices in any case. Still, new training may not cost additional funds—there is considerable training underway. It will, however, require a different focus.

Replacing the current acquisition workforce with personnel from the commercial sector is another alternative. Such an approach could be used to rapidly create a force of *buyers* trained in commercial business techniques and in the product technology for which they will be responsible. But such an approach would likely be very disruptive. Government organizations interviewed for this assessment argued that the current workforce could be properly retrained. They argued that the problem has been a matter of process, not people. The existing system provides no incentive to buy commercially and no time on the job to become, or remain, expert in particular areas.

Regardless of the means used to develop the qualified future acquisition workforce, personnel will require better technical training and longer job tenure than in the past. They will need the opportunity to conduct continuous market surveillance, so that they are aware of available products and technology and can make early use of this knowledge in procurement decisions. To allow the rapid procurement of off-the-shelf items, they will need support for conducting market investigations. They will also need the mental agility and technical knowledge to recognize cases when militarily unique products are the best choice. The goal is to maximize the use of commercial goods and services, not to sacrifice military capabilities. (See figure 4-2.) Achieving this goal requires a considerable increase in the responsibility, authority, and initiative of procurement officials.

Develop Incentives for Using Commercial Goods and Services

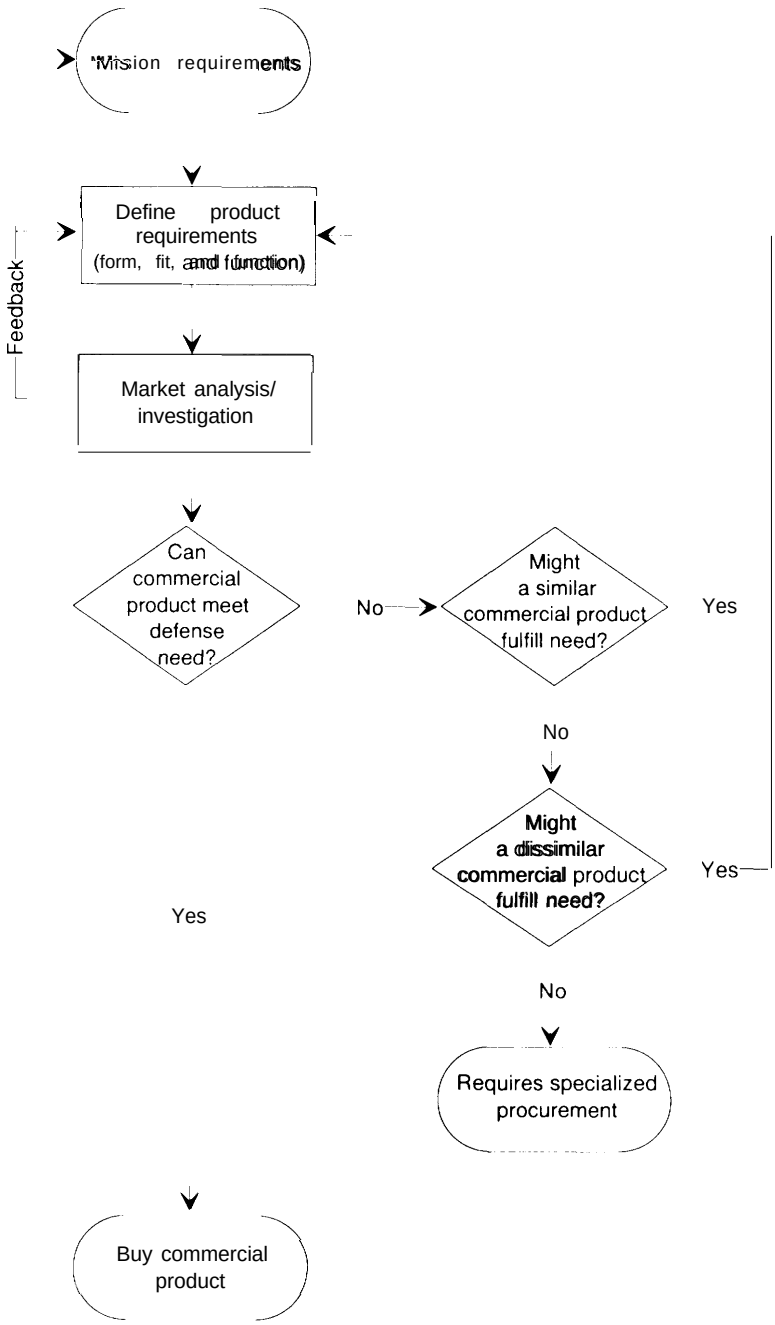
Changing the current procurement culture involves fundamentally altering the incentive structure to promote greater use of commercial goods. Efforts towards this end have already begun. Secretary of Defense Perry has stated "the desire to turn the system on its head."[43] Secretary Perry's June Memorandum on Military Specifications and Standards is the first step in that process. A program manager who chooses a militarily unique product must justify that choice. But procurement personnel must be made to feel that decisions to procure commercially will not, in and of themselves, bring the system to a halt, or jeopardize their jobs.

The OTA assessment team was informed in several interviews that the threat of a bid protest—and the subsequent suspension of work—was enough to make some contracting officers shift a

42 Discussions with DPSC personnel.

43 Lucy Reilly, "MILSPECs in Perry's Sights at Pentagon," *Washington Technology, 3,* May *6, 1993,* p. *8.*

FIGURE 4-2: Notional Smart Buyer Decision Process



SOURCE Off Ice of Technoiogy Assessment, 1994

procurement decision away from commercial specifications. The impact of the recent DOD military specifications and standards decision on this behavior remains to be seen. But many recommend that the current system be changed to promote more responsible protests.

Additional incentives for change must be created. Firms considering the use of commercial components deserve financial incentives to do so. Government acquisition personnel need a new structure in which lowering system cost is weighed against projected performance of militarily unique items.

The Grace Commission[44] argued that contractors were in the best position to appreciate the cost impacts of specifications. It recommended that DOD should authorize the use of financial incentives to encourage contractors to challenge unimportant or irrelevant standard requirements when responding to an RFP. These incentives might consist of cash payments.[45] The current approach to incorporation in systems involves the "value engineering" clause of FAR. Its use is reported to be limited and to vary by program.

Citation of Military Specifications and Standards

During the past four decades, many studies have identified the excessive and, at times, inappropriate citation of military specifications and standards as a particularly formidable barrier to the use of commercial products. Critics have argued that military standards and specifications often differ from commercial standards and specifications so dramatically that they effectively prevent the use of equivalent or even higher quality commercial goods and services. Shipbuilders, for example, have argued that this is the case for the future Navy sealift ships. Often the cited specifications and standards were seen as simply unnecessary—sometimes merely copies of old documents. Certainly there is little reason to have detailed military specifications for off-the-shelf consumables. Mr. Perry's initiative on military specifications and standards, if properly implemented, should change this.

Specifications and standards have also differed from Service to Service. A contractor producing similar items for more than one Service may need to comply with different standards for each. In addition, some military specifications and standards have been updated too infrequently, falling behind best commercial practices, forcing companies to use obsolete processes.

A recent Office of the Secretary of Defense publication noted that:

> The problem for a commercial company. as with government-unique accounting principles, is that compliance with government standards often requires a departure from commercial practices, not to mention the company's own processes which have led to commercially successful products.[46]

Such departures from established processes can raise costs, reduce quality, and convince a commercial firm not to undertake DOD business.

Military specifications and standards, however, often serve a valid purpose, (See box 4-7.) Indeed, the 1983 Grace Commission argued that "MILSPECs have long been a target of misdirected criticism." The proper target, the authors maintained, should be procurement officials who are not sufficiently selective in citing military specifications requirements in contracts. Misapplication of military specifications and standards has been the primary problem.

44 The Office of the Secretary of Defense Task Force of the President Private Sector Survey on Cost Control in the Federal Government.

45 *Report of the Office Of the Security of Defense Task Force,* op. cit., footnote 29, pp. 778-779.

46 Department of Defense, Office of the Assistant Secretary of Defense (Public Affairs), *News* Release, "DOD'S Acquisition Reform Recommendations to 800 Panel Report," Oct. 28, 1993.

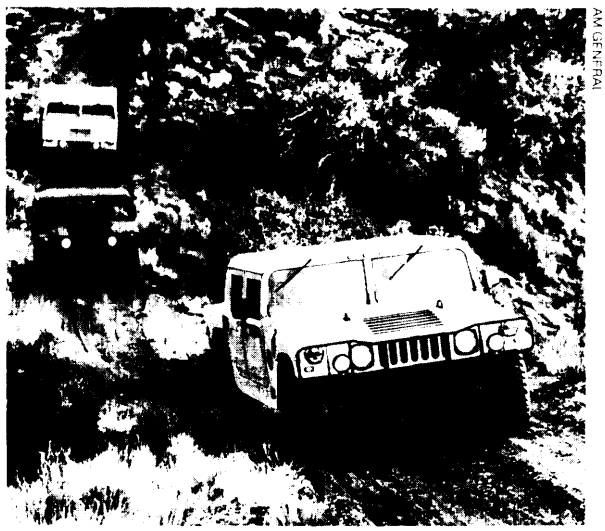
The DOD-chartered Process Action Team (PAT) for Specifications and Standards, whose November 1993 report formed the basis for Secretary Perry's June Memorandum on specifications and standards, developed a strategy to decrease reliance on military specifications and standards. The Secretary "wholeheartedly" accepted the report and approved the recommendations "to use performance and commercial specifications and standards in lieu of military specifications and standards, unless no practical alternative exists to meet the user's needs."[47]

The PAT report specifically recommended that: performance specifications be the preferred method of buying new systems, modifications, and NDI, including commercial products; manufacturing and management standards be canceled or converted to performance or nongovernment standards; new proposals and contracts be flexible, providing incentives for a contractor to submit alternative solutions to military specifications and standards; the use of military specifications and standards be restricted; and oversight using process control and nongovernment standards be promeoted.[48]

The program of change outlined by PAT and endorsed by the Secretary of Defense calls for heavy involvement by senior DOD leadership, extensive training, and long-term commitment to change if the overuse of military specifications and standards is to be eliminated.

Make Performance Specifications the Preferred Method of Buying

Moving to performance specifications would have a great impact on integrating processes as well as easing the purchase of commercial items. The initial impact will be observed in the purchase of commodities—food, personal items, etc., that are continually purchased. Over time, as new systems are procured, greater benefits will accrue.



Commercial Hummers (front and rear) were developed from the militarily specified Hummer (center)

Studies indicate that such a move would reduce the need for government oversight and ease the problem of technical obsolescence since new items might be retrofitted into military platforms. PAT estimated that adopting performance specifications might save $550 million over the next two years. Though this estimate appears optimistic. significant savings appear possible.

There is reason to believe that performance specifications will promote the transfer of technology into the defense arena. But the use of performance specifications increases prospects that those defense firms continuing to develop militarily unique products and retaining engineering and design capabilities will prove noncompetitive for newly defined commercial products. To the extent that such firms restructure or are replaced by commercial firms with those capabilities, this problem might be managed. But care must be taken to ensure that the design and engineering talent essential to develop and build new systems—held to be the core of the U.S. defense base—is retained.

[47] Secretary William Perry, memorandum, Op. cit., footnote 10.

[48] Process Action Team for Specifications and Standards, *Final Report: Briefing*, Nov. 19, 1993.

BOX 4-7: Light Tactical Vehicles

The U.S. Army—and the other Services to a lesser extent—employ large numbers of light tactical vehicles in a wide variety of roles, Two vehicles—the High Mobility Multipurpose Wheeled Vehicle (HMMWV) and the Command Utility Cargo Vehicle (CUCV)--accounted for 85 percent of the military's light tactical vehicles in fiscal year (FY) 1992. This share was projected to rise to 97 percent in FY 1993.1 The two vehicles are a successful example of using commercial items where appropriate, and military specifications where needed.

The M-988-series HMMWV, more commonly called the Hummer, is a lightweight, diesel-powered, four-wheel-drive vehicle built by the AM General Corp. in Mishawaka, Indiana. It was designed specifically for the military. It is used by the three Services in a number of configurations (cargo/troop carrier, ambulance armament carrier, TOW missile carrier, and shelter carrier), all constructed on a common 1¼-ton chassis,

The Hummer is an example of a military product whose manufacturer is looking to expand into the commercial market.[2] The vehicle's main selling point is extreme ruggedness. As of June 1994, more than 1,000 Hummers have been sold commercially. To compete head-to-head with other commercial 4 x 4s, each commercial Hummer comes with a 36-month/36,000 miles bumper-to-bumper warranty. In July 1993, AM General also Introduced a lower cost commercial model to meet the market demand for a basic work truck An Important market for the commercial vehicle may be organizations such as the Forest Service, or mining and petroleum firms requiring reliable transportation across difficult terrain.

Somewhat surprisingly, the early commercial variant of the Hummer costs $10,000 to $15,000 more than its military counterpart. This price differential arises from the need to meet Department of Transportation safety laws, Environmental Protection Agency emission laws, and market expectations for comfort. To meet highway safety standards, for example, the commercial Hummer required a new door design Addition-

[1] U S Army, Tank-Automotive Command, Fleet Planning Office, U S *Army Tactical Vehicle Fleetbook*, January 1993, p 117

[2] AM General may get competition from an unusual source, the Ulianovsk Automobile Plant As Part of a new joint venture, this Russian plant has announced plans to sell its version of a military all-terrain vehicle on the American and Canadian commercial markets Like its American counterparts, the jeep-like UAZ will need to be modified to meet U S safety and environmental regulations Early models are expected to compete primarily on their exceedingly low price tag of about $10,000 See James H Rubin, "Russians Roll in U S Jeep Market Boxy *UAZ* Vehicle is Called Pride of the Russian Military.'" *The Washington Post*, July 9, 1993, p Cl 1

Cancel Military and Adopt Commercial

This is at the heart of the Secretary's June 1994 Memorandum. It can largely be accomplished within the current acquisition structure. Indeed, DOD already had a number of initiatives to permit greater exploitation of commercial electronics components prior to Perry's memorandum.

The Assistant Secretary of Defense for Acquisition Reform reported in October 1993, for example, that DOD had "increased the number of adopted non-government standards from 3,279 to **5,617** (a51 -percent increase)" and that "the number of commercial items descriptions had increased from 1,973 to 4,857 (a 146 percent increase over the past seven years)."[49] But while forward movement has been evident, it has been slow. The Secretary's communication should speed the process. Further, while the cancellation of these military specifications and standards appears to be a straightforward task, the entrenched nature of the bureaucracy could make it Herculean, Successful reform is far from assured, as the

[49] News Release, op. cit., footnote 46.

BOX 4-7 continued: Light Tactical Vehicles

ally, high volume buys can lower the per unit vehicle price to the military Military prices are affected by the sophistication of the variant purchased For example, a basic cargo/troop carrier is less expensive than an ambulance

AM General has realized some savings in the commercial Hummer, but the savings/penalty equation is complex For example, components for the 12-volt commercial electrical system are cheaper and easier to obtain than the less standard 24-volt system required by the military, but the entire electrical system must be different from the military type And while the commercial Hummer is constructed on the same manufacturing line using many of the same components, interior outfitting and exterior painting occur in a separate building

AM General purchases about 65 to 70 percent of the cost of a military HMMWV from lower tier vendors. Three of the major subsystems are modified commercial off-the-shelf products the engine, the transmlssion, and the T-case Many of the individual components and fasteners are also procured commercially The rest of the vehicle, however, is manufactured to military specifications and standards, including most of the chassis, the radiator, the axles, and the tires—although the tires have since been added to the Goodyear catalog—and by some criteria may now be considered commercial

The 1¼-ton CUCV, on the other hand, IS a commercially designed, 4x4 light tactical utility and cargo vehicle built by General Motors in Flint, Michigan from 1983 to 1986, The CUCV is closely related to the Chevrolet C/K series full-sized pickup and Blazer Like the Hummer, it has an automatic transmisslon and a diesel engine It was built in five configurations cargo, utility, ambulance, shelter carrier, and chassis only Some of the shelter carriers have been modified with dual rear wheels.

Both the Hummer and the CUCV were procured on fixed-price contracts, as nondevelopmental items built to performance specifications. The CUCV was not intended as a front-line vehicle Military modifications Include camouflage paint, lifting eyes, blackout marker lights, and slave cable receptacles. A subcontractor fabricated and installed specialized ambulance items.

During the Persian Gulf War, the CUCV was used more widely in the field than anticipated. It proved insufficiently rugged for off-the-road field operations It has since been slated for Corps-level and higher operations that require little off-road driving At division level and below, Hummers are replacing the CUCV.

SOURCE Off Ice of Technology Assessment 1994

meager results of no less than seven major initiatives intended to decrease reliance on militarily unique specifications and standards have shown. [50]

It is difficult to identify a risk to canceling inappropriate and outdated specifications and standards. Though there will be costs associated with reviewing the standards, such review will have to be undertaken in any event. Indeed, the current problem arises in part from an earlier unwillingness to pay the costs (in time and money) to systematically review and update specifications and standards.

Adopt New Methods of Quality Control

Market forces help to ensure quality within the commercial base. Given a reasonable degree of competition, firms with poor quality control will find it difficult to stay in business. Conversely, companies known for consistent high quality will often attract new customers. Thus. it is in a ven-

[50] Ibid.

Onsite inspections are one method of ensuring quality but (here are alternatives

dor's self-interest to maintain quality. This is accomplished through product tests, employee quality programs (e.g., total quality management), and statistical process control. Firms may underscore their commitment to quality through product warranties.

In the past, the requirement for quality testing often arose in areas in which defense technology was on the leading edge and manufacturing techniques were uncertain. Now the commercial sector leads in many key areas, particularly electronics. In these areas, accepting commercial quality standards can increase commercial purchases while preserving high quality.

The Under Secretary of Defense for Acquisition and Technology has authorized the use of American National Standards Institute/American Society for Quality Control and the International Organization of Standardization quality standards in place of MIL-Q-9858A and MIL-I-45208A in defense acquisition programs. This new policy will be incorporated in the next update of DOD Instruction 5000.2.[51]

For many goods and services, market surveillance might provide sufficient information on which to base a purchase decision. In some markets, DOD could follow the lead of commercial customers and conduct plant visits to inspect quality control mechanisms. Other goods and services, especially those with less competition or with more product uncertainty, might warrant internal DOD testing.

Participate in Commercial Standards Bodies and Consortia

If DOD is to place greater reliance on commercial products and standards, it will need to become even more involved with the standards bodies and industry consortia that set industrial specifications and standards. Industry will adopt rules that provide tangible benefits rather than meet DOD desires.[52] But DOD involvement may help steer industry in desired directions. For example, DOD might help create commercial standards for a "ruggedized" product, thus increasing the chance that DOD could rely on ruggedized commercial products and thereby allow greater exploitation of the commercial sector.

DOD participation in standards development is not cost free, and there is an inherent risk that excessive DOD involvement in developing commercial standards might negatively affect U.S. industrial competitiveness. But given the diminished role of DOD in overall purchases, the potential of this occurring appears small, and the risk is certainly manageable.

Technical Data Rights

Government demand for rights in technical data has been a contentious issue. There are two facets to this problem. The first concerns the kind of data the government will receive and in what format. The second is with what rights the data will be delivered.

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[51] Under Secretary of Defense John M. Deutch, *Memorandum for Secretaries of the Military Departments and Directors of Defense Agencies on the Use of Commercial Quality System Standards in the Department of Defense (DOD),* Feb. 14, 1994.

[52] The ADA computer language is an example of a military standard that industry has been unwilling to accept.

Data requirements are defined by data item descriptions (DID)—a kind of military specification—in the technical package of the contract. In many cases. the government will specify the data needed to operate, maintain, or repair the item; train its personnel; or reproduce the item. The last tends to be particularly contentious, since for many companies manufacturing process data is treated as sensitive proprietary information.

To complicate matters further, DOD often requires that data be presented in a militarily unique format that can increase costs. For example, in one purchase of a commercial vehicle, the government waived cost and pricing requirements, but then insisted upon a data item description for the manual. This required the company to rewrite its commercial vehicle manual, without financial compensation—since the vehicle's price was set in the commercial marketplace.

The use to which the government puts the data it receives (e.g., its rights) is another problem area. Government use of data falls under one of three categories of data rights: limited rights that obligate the government to protect all data received under a contract; government-purpose rights, which permit the government to share the information with any number of other contractors under assurances that it be used only for specified government applications; and unlimited rights, which grant the government license to disseminate the data in any way it chooses,

The last is particularly contentious. Sometimes, the government requests unlimited rights simply to ensure that the product will be available if the original supplier goes out of business. At other times, the purpose is to generate competition through a second source—without having to pay twice for the same development—to reduce, or at least hold down, costs. From the government's point of view, being tied to a single supplier for the decades that the system may be in service can pose a significant and undesirable financial burden.

While it is difficult to quantify the costs of such a policy, it is clear there are negative effects. Many firms have refused to compete for government contract money for R&D, to sell products to DOD that incorporate commercially developed components, or both.

The implications can be serious. The most innovative firms are protective of their R&D and manufacturing processes. By demanding unnecessary rights in technical data, DOD may deprive itself of access to the most advanced and innovative technologies and processes. As a result, DOD may be decreasing the number of firms willing to do business with the military, further eroding competition.

To address these problems, DOD needs to alter its approach to technical data rights. In place of demands for expansive access to technical data with unlimited rights to that data, it should exempt most purchases from technical data rights clauses and focus its energies on the limited set of technologies and processes for which such data are vital. These objectives might be met through license or escrow agreements.[53]

Exempt

To maximize commercial purchases, DOD might pursue technical data rights only in cases where there is a genuine need. Products that are deemed both critical and not easily replaceable would likely fall into this special category, A procurement officer could be required to demonstrate that the need for technical data rights is compelling before demanding the data.

This exemption should also extend to contract evaluation. For example, some companies have reportedly had to "release technical data rights to

[53] Under FASA commercial items "shall be presumed to be developed at private expense unless shown otherwise. "

win a contract even when providing it is not legally required."[54]

License

Presumably, increased commercialization should reduce the numbers of unique items and processes and obviate the need for data rights in many cases. But the DOD mission and some of the unique performance characteristics and logistical requirements will continue to necessitate rights in technical data in some instances.

In these cases, the increased use of licensing arrangements would be appropriate. Licenses might resolve issues of proprietary R&D and access to innovation, thus allaying the concerns of vendors that granting government access risks a loss of technology and a lack of sufficient compensation.

Escrow

An alternative solution would be to limit access to technical data rights to dire events, such as mobilization and war, or when the firm has gone out of business. Placing relevant technical data rights in escrow is one way to accomplish this. The firm could thus protect commercially valuable technologies except in extraordinary circumstances.

Unique Contract Requirements

The myriad of contract requirements is another set of barriers to buying commercially. These include source preferences policies such as the Buy America Act and the requirement to use American shipping. In addition to these two, source preferences and mandates in seven other critical areas were noted by firms in the CSIS study:

- domestic specialty metals,
- jewel bearings,
- certain domestic commodities,
- miniature and instrument ball bearings,
- precision components for mechanical time devices,
- high-carbon ferrochrome, and
- high purity silicon.[55]

Affirmative action and socioeconomic directives, such as set-asides for minority-owned business and other special groups, constitute another set of unique contract requirements. Socioeconomic contract provisions cited in the CSIS report include those requiring use of:

- small business concerns,
- women-owned small businesses,
- labor surplus area concerns,
- affirmative action for special disabled and Vietnam-era veterans, and
- affirmative action for handicapped workers.[56]

Imposition of source preferences and socioeconomic contract conditions disrupts normal commercial business practices in picking vendors, and requires certification and training to ensure compliance. Inefficiency is the byproduct.

Such regulations also hinder DOD efforts to exploit the international market. Ironically, this international market includes many U.S. firms with global operations. For example, one of the largest producers of canned fruits and vegetables, Dole, has been unable to sell its canned pineapple to DOD because it procures overseas the bulk of its pineapple for canning. Instead, DOD pays a premium to buy canned pineapple from the few domestic canners still in business.

Limiting purchases to domestic sources often raises the overall cost of DOD goods and services. Buy America legislation, for example, while protecting American firms vital to U.S. defense production, has at times required the purchase of domestic products that could be bought more cheaply abroad. Thus, for years DOD purchased coal in the United States and shipped it at a pre-

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54 U.S. *Congress, Office* of Technology Assessment, *Building Future Security: Strategies for Restructuring the Defense Technology and Industrial Base,* OTA-ISC-520 (Washington, DC: U.S. Government Printing Office, June 1992), p. 94.

55 Jeff Bingaman et al., *Integrating Commercial and Military Technologies for National Strength,* op. cit., footnote 40, p. 66.

56 Ibid., p. 67.

mium to U.S. troops in Germany. The indiscriminate nature of this legislation may render it less effective in protecting vital U.S. sources of supply than other approaches, such as that available under Title III of the Defense Production Act.

The Acquisition Law Advisory Panel reported that the problem with these requirements is not in any one specific contract requirement but in the overall system. Firms are reluctant to deal with a DOD that applies "a combination of frequently changing requirements—some inconsistent with others, most requiring audit and the generation of reports, and all inconsistent with commercial practice."[57]

The Acquisition Law Advisory Panel reviewed 114 socioeconomic statutes, either separate sections of the U.S. Code or specific sections of various public laws. The Panel found that the defense contracting officers themselves are hard pressed to keep up with changing federal procurement policy and procedures, including these socioeconomic statutes. While many defense firms have become adept at negotiating the tangle of laws and regulations, commercial firms with only a small potential defense market are less likely to bother.

FASA raised the Simplified Acquisition Threshold to $100,000. This will permit "99 percent of DOD's contract actions . . . to be accomplished using simplified procurement procedures,"[58] and exempts such purchases from many unique contract requirements.

FASA directs that the Federal Acquisition Regulation include a list of provisions of the law that are inapplicable to contracts or subcontracts under the threshold. These changes should greatly facilitate the contract process for the vast majority of contract actions.

Still, unique clauses remain an issue for the contract actions that account for the bulk of the DOD budget (e.g.. those above $100,000). Here additional actions might be considered.


INGALLS SHIPBUILDING

Legislation requires U S Navy warships to be constructed in U S shipyards

Eliminate Clauses and Rely on Civil Law

Some of the special contract clauses and requirements involve social goals, such as nondiscrimination in employment practices, that largely parallel coverage in general federal law. Where federal law exists, many observers argue that it—rather than a special contract clause—should be used.

In other cases, such as small business, there is no parallel coverage. In those cases some observers argue that the social goals might be met in a different way than through contract clauses—perhaps becoming a factor in some selections or considered as a part of a "best value" selection. Advocates of such an approach argue that the problem is the contract-by-contract application of

57 Acquisition Law Advisory Panel, *Executive Summary*, op. cit., footnote 18, p. 28.

58 *News Release*, op. cit., footnote 46.

such requirements. There should be other ways, such as best value selection, to guide firms to adopt pro-social-goal strategies.

In either case, the idea of change is not to ignore the social goals of each of these programs, but to achieve the goals in a less disruptive manner.

Identify and Support Critical Technologies and Sectors

A primary justification given for the continuation of Buy America provisions is the need to retain a core of technologies and capabilities within the American DTIB. While such considerations would presumably be reduced by greater integration, support is likely to continue to be required in some technologies and sectors.

Critics of "Buy America" provisions argue that the government could be more selective in choosing technologies and industries that are vital to American defense. DOD currently has an effort aimed at identifying the vital technologies and industrial sectors it might support in the future.

Subsidize Parties Directly

Finally, a variety of mechanisms (e.g., tax exemptions, grants, or programs through the Commerce Department) could promote the current beneficiaries of unique contract requirements, such as small business, disabled veterans, and the U.S. specialty metals industry, without involving the DOD acquisition process directly. This would eliminate much of the paperwork that undermines expanding DOD's commercial supplier base. It would not preclude these firms from effectively competing for defense contracts.

BENEFITS AND RISKS OF POLICIES

Past studies, along with the surveys and interviews conducted for this report, confirm that a number of obstacles within DOD's acquisition structure discourage the use of commercial products, services, and practices. The policies outlined in this chapter can reduce these barriers. This section briefly summarizes some of the potential benefits and risks of increased use of commercial products and services.

Benefits of Policies

Projections of savings from increased commercial purchases vary. The Grace Commission estimated that: 1) eliminating the requirement for contractors to comply with military specifications would save 1 percent on weapon acquisition; and 2) increased use of commercial hardware and equipment and industry standards (in lieu of military ones) would save 0.5 percent.[59]

The case studies in support of the Acquisition Law Advisory Panel cite savings ranging from 30 to 50 percent on particular items if commercial items are used in lieu of militarily specified items. The DLA estimated the savings on medicine in Alaska (cited above) as up to 25 percent a year. DOD has estimated average savings of about 10 percent for commercial purchases based on its experience with the ADCP Program in the late 1970s. Some savings have been even more spectacular.

The case studies in the final report of the Defense Science Board's 1986 study on the use of commercial components in military equipment were the most carefully controlled and well-documented comparisons of military and commercial product costs that the OTA assessment team reviewed. The DSB identified several commercial and militarily specified systems with essentially the same functional requirements. It found:

> . . . the cost of military equipment can be from 2 to 10 times more expensive. Acquisition time can be much longer, and reliability may be no better—indeed in two cases it was much worse. In several cases, the size of the militarized equipment is significantly smaller, reflecting weight and volume constraints in weapon sys-

[59] The President's Private Sector *Survey, Report of the Office of the Secretary of Defense Task Force, op. cit.,* footnote 29, p. 790. OTA was unable to find the studies on which these estimates were said to be based.

tems. The continuing trend of miniaturization in commercial electronics should lessen the need to repackage to meet military needs.

We believe this data indicates the range of cost and schedule savings possible, without sacrifice of reliability when DOD can fulfill system and subsystem needs with commercial products.[60]

OTA did not attempt to calculate a precise amount of savings that might accrue from policy changes that increased commercial purchases. We did, however, attempt to outline a range of possible savings based on the OTA industrial sector survey and the savings suggested from the case studies in order to give policy makers a better understanding of the potential returns from implementing policies of the type discussed in this chapter.

The estimated range of savings shown in table 4-2 are based solely on the private sector DTIB and on the assumption that benefits are principal y derived from activities that change categories—e.g., move from either process integration or segregation to commercial purchases.

The table indicates that, while expanded commercial purchases in specific cases might yield substantial savings. resultant net DTIB savings might remain relatively small. For example, even if DOD saved 30 percent on every new commercial purchase. DOD would still only achieve a 10 percent overall savings from funds going to the private sector.

A total savings of 10 or even 15 percent applied to the sizable private sector DTIB budget would be significant, but nowhere near the often implied savings of 30 to 50 percent. Further, such savings will not be immediately available.

Savings associated with the purchase of consumables (e. g., food and clothing) might begin immediately. but savings related to more expensive spare parts and new systems might not occur for several years. Given that the development of new defense systems that take advantage of commercial parts is likely to be slow in a potentially fiscally constrained environment, savings will be even slower in appearing. The 1993 Report of the DSB Task Force on Acquisition Reform recognized this delay and projected its savings would occur over a 5-year period. Even that time frame appears optimistic. however, not only because it will take time to incorporate or retrofit commercial items in defense systems, but also because defense spending is likely to be lower than the DSB considered.[61]

Achieving additional significant savings will probably demand more change than simply modifying rules so that items can be purchased from a catalogue. For example, in the civilian sector, firms operating similar equipment. such as airlines, achieve savings not only by negotiating lower prices on individual spare parts, but through contracted arrangements that may include rela-

TABLE 4-2: Budgetary Impact of Increased Commercial Purchases[a]

Estimated average savings	Impact on total private DTIB budget
0%	0%
5 %	2 %
10“/0	3%
15“/0	5%
20 ”/0	60/0
250/o	80/0
30 ”/0	10“/0

[a]Based on OTAS industrial sector survey estimate that about 32 percent of private DTIB spending is changed as a result of chapter 4 policy options Only includes the impact on the private sector at the fac lity level
SOURCE Off Ice of Technology Assessment, 1994

[60] Office of the Under Secretary of Defense for Acquisition, Report of the Defense Science Board, *Use of Commercial Components in Military Equipment*, June 1987, p. 32.

[61] Report of the Defense Science Board Task Force on *Defense Acquisition Reform*, op. cit., footnote 23, p. C-3.

tively long term (3 to 5 years) maintenance and inventory control services as a part of the overall purchases. These firms save money not only on a particular part, but also eliminate the need for the airline to maintain and track an inventory. The service agreement may also include upgrades to the system. The firm providing the parts and services may assume configuration control over its parts. Such an approach would require major restructuring in the DTIB.

Significant savings, however, might accrue from the elimination of activities (e.g., parts stockage and inventory tracking) in the public sector DTIB and from reductions in government contracting and oversight personnel associated with current acquisition practices. A 10 percent reduction in the public sector DTIB might translate into a $2.2 billion/year savings. This too, would take several years to be fully realized.

Savings, of course, constitute only one of the benefits of greater commercial purchases. Greater access to new technologies, reduced acquisition times, and a larger mobilization base are also important. These benefits are most likely to accrue if a broad definition of commercial goods and services is adopted.

Commercial purchases should provide DOD greater access to state-of-the-art commercial goods and services, particularly in rapidly developing technical areas, such as electronics, telecommunications, and computers. Though these changes will have some effect among prime contractors, it is at lower tiers that commercial purchases are most likely to occur. Here the increased "dual-use" purchase of components might also enhance commercial competitiveness and preserve the DTIB.

Improved access to technology would not be limited to so-called "high-tech" items. Past efforts at commercialization indicate that the availability and quality of products improved in almost all cases where commercial substitution occurred. Evidence from interviews and DLA programs indicates that purchasing commercial goods and services reduces the time needed to acquire both advanced technology items and more basic goods and services.

We cannot point to concrete evidence that increased commercial purchases promote American global economy competitiveness. To the extent that DOD embraces commercial purchasing, however, fewer government dollars will be wasted on redundant capabilities and paperwork, and a greater share of DTIB dollars might go towards strengthening the CTIB.

Costs and Risks of Policies

There are costs and risks associated with the increased use of commercial goods and services. These fall into two major categories: 1) short-to-medium-term costs and risks associated with the immediate transition, and 2) longer term costs and risks associated with the future viability of the DTIB and the ability to meet future defense needs.

Shifting to more commercial goods and services entails some upfront costs in retraining of government personnel, changing and eliminating inappropriate military specifications and standards, and increasing the use of market surveys and analyses,

Reductions in oversight personnel might initially entail additional personnel costs (e.g., retirement packages). Some of the policies allowing the greater use of commercial goods and services (e.g., raising the commercial acquisition threshold) may result in greater opportunities for waste, fraud, and abuse. Indeed, it has been suggested that "raising the commercial acquisition threshold is likely to last only 'until somebody embezzles money with one of those simplified procurement processes, and then you will see the regulations come back.'"[62]

It is unclear how large this risk might be. While GAO has reported that DCAA identified almost $3 billion in "defective pricing" charges to the

62 David A. Fulghum, "Congress Lowers Goals for Acquisition Reform," *Aviation Week & Space Technology,* May 9, 1994, p. 78.

government between 1987 and 1992, the actual amount of funds finally identified as fraudulently claimed are far smaller. For example, testimony at congressional hearings indicated that only about $1 million of a total of almost $2 billion originally identified as fraudulently claimed was finally levied against firms.[63]

Even if there is no increase in misuse of government funds, in the event of more widespread use of commercial products and services, some firms may make higher profits on defense contracts. This may be viewed as a form of unfair profiteering.

Critics argue that pursuit of a policy of best-value buying may exclude smaller or newer firms in favor of larger, more established ones. The Small Business Administration is reported to have expressed concern that the increase in the small-purchase threshold from $25,000 to $100,000 would "undercut small vendors' ability to compete on contracts."[64]

Expanded commercialization may therefore put smaller defense-dependent businesses at risk in favor of larger firms-including foreign firms-that are better able to demonstrate qualifications to perform on time. This may be exacerbated by some of the tools of market analysis and surveillance. As the more limited number of acquisition personnel do their market surveys their findings may be skewed towards larger firms-effectively limiting suppliers to larger, better-known brands and firms,

Currently integrated defense firms making both commercial and defense items may also be threatened by the increased use of commercial products and services. Managers interviewed pointed out that elimination of government accounting requirements for individual contracts will work against companies with other defense business involving militarily unique equipment, still requiring government cost accounting.

There are also some longer term risks associated with increased commercial purchases. One concern is over increased foreign dependence for critical items. The commercial base appears to be much more internationally intertwined than is the current DTIB. Further, the current foreign content in U.S. defense systems appears to be greater at the lower tiers—the tiers most amenable to commercial purchasing. A 1992 Department of Commerce study of three Navy systems (the Harm missile, Verdin communications, and the MK-48 torpedo), for example, found the greatest foreign sourcing occurring at lower tiers; about 5 percent of the purchases at tiers 2 and 3 were supplied by foreign sources.[65]

Greater dependence on foreign suppliers is a situation that is bound to concern policy makers. Reports, for example, that spare parts from overseas suppliers were delayed during the Gulf War aroused significant discussion in the United States after the war. Concern about the reliability of supply from abroad will persist, absent legislation in key supplier nations allowing preemption of commercial customers.

Compatibility of components and services provided under expanded commercialization is a further concern. The use of commercial parts and services raises the specter of interoperability problems. Some suggest that, even with "form, fit, and function" requirements, there may be situations in

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63 *Inside the Pentagon,* "Defense Contractors Still Abusing Overhead Cost Guidelines," Oct. 12, 1993. According to House staff, however. this situation may be due to the unwarranted dismissal of fraudulent claims. Specifically, some congressional staffers *'speculate that in practice the DCAA presents questionable claims to the contracting officer who, confused about allowable claims, may just split the expenses down the middle and assess no penalties against the contractor. "

64 Joyce Endoso, "SBA Battle\ Pentagon's Attempt to Raise Small Purchase Threshold," *Government Computer News*, Aug. 2, 1993, p. 8. The resulting legislation increased the threshold, but reserved contracts under $ 100,000 for small business unless no small business can be found to do the work.

65 US Department of Commerce, Bureau of Export Administration, *National Security Assessment of the Domestic and Foreign SUb~Qntractors: A Study of Three Navy Weapons Systems*, March 1992, pp. ii-111.

which subcomponents are not interchangeable, particularly in field maintenance.

Finally, some observers fear that the increased use of commercial products and practices will lead to reduced system performance. There is, however, no inherent reason why this has to be the case. Personnel interviewed by OTA all argued that commercial specifications and standards were only appropriate if they met the military performance requirements.

BENEFITS OUTWEIGH THE COSTS

Despite the difficulty of quantifying the results, the benefits of increased use of commercial products, services, and practices appear to outweigh any costs or risks associated with their increase. Many of the actual cost savings will occur over time as new products and services are purchased. Possibly even more important than cost savings, however, may be access to the new technology embedded in commercial products and services. Without such access the United States may be unable to maintain a leading-edge DTIB.

SUMMARY

Many of the actions discussed in this chapter can be taken by the executive branch alone. But congressional support for such changes will still be essential. Changes in specifications and standards, for example, are likely to prompt concerns among small defense-dependent firms, some of which may require major internal changes to compete with more efficient commercial firms. Congress will have to consider whether the potential gains from the preservation of the DTIB outweigh the potential negative effects on these individual firms.

DOD can also begin retraining its acquisition workforce to make maximum use of commercial goods and services. But congressional funding support is key to such training. Congressional backing is also important in implementing the system of market surveillance and analysis that is necessary if the United States is to take full advantage of the commercial marketplace.

Other changes, however, depend on congressional actions. One of the most important issues involves defining what constitutes commercial goods and services for defense procurement. FASA addresses this issue. As noted earlier, broadening the definition of commercial goods and services to allow the purchase of items not yet in the commercial sector, or that maybe purchased by only a few commercial customers, could promote the use of new technologies by the defense sector, but at the risk of insufficient commercial market to assure competitive pricing. A narrow definition might ensure that purchases are backed by adequate pricing data, but leave military purchasers vulnerable to losing out on new technology.

Eliminating the requirement for special government accounting for small contracts will reduce the expense of maintaining special cost accounting systems and lower the price of some products purchased by DOD, but it could increase instances of profit-taking at the government's expense. Yet it appears that the potential overall savings far exceed any additional costs.

Commercial purchases, however, might result in a greater percentage of foreign purchases. On the other hand, global competition may lower prices and improve U.S. quality. DOD will need to monitor the trends and the potential for technology vulnerability.

Eliminating the unique contract requirements that support socioeconomic goals may negatively affect some national socioeconomic goals. Some argue that the contract clauses are redundant, since many of these provisions are also embedded in U.S. law. Others hold that maintaining special DOD provisions remains important because it is easier (0 assure compliance using government-controlled defense spending. At the same time, many firms have come to view these special provisions as their avenue to economic growth. Congress will want to consider these alternatives.

Ultimately, the increased purchase of commercial goods and services can help achieve the integration goals of saving money and increasing

access to technology. Its most important contribu-(ion, however, may be to help preserve a future defense technology and industrial capability. The ability to achieve these objectives will depend on (he degree to which changes such as those outlined in this chapter are implemented.

Integrating Processes for Goods and Services 5

Chapter 4 examined opportunities for increased use of commercial goods and services to meet defense needs. Some defense requirements, however, are so highly specialized that they cannot be met by the commercial marketplace. It may nevertheless be possible for the Department of Defense (DOD) to obtain many benefits of the commercial market through a procurement environment that encourages integration of commercial and defense R&D, manufacturing, and maintenance at all levels: industrial sector, firm, and facility.

An **integrated process** is one in which common assets—technology, people, facilities, and administrative organization—are used to produce both defense and commercial goods and services. At the industrial sector level, examples of integrated processes might include joint industrial and government standards bodies, shared national test facilities, and the use of common technologies. At the firm level, integrated processes might include common corporate functions (e.g., planning, personnel, training, and possibly R&D) but separate defense production facilities. At the facility level, integrated processes might entail commercial and defense products being developed, manufactured, or maintained side-by-side by the same personnel.

Many of the processes used to design, develop, produce, and maintain military and commercial equipment are technically identical or very similar. But current acquisition policy often makes military processes substantially more costly and time consuming. Eliminating process integration barriers might lower acquisition and life-cycle costs, provide both sectors with greater access to innovative technologies, reduce acquisition time, ex-

pand the potential defense technology and industrial base (DTIB), and even enhance U.S. commercial competitiveness.[1]

This chapter opens with a survey of the current level of process integration and estimates of the potential for further growth. The chapter then builds on the analyses in chapters 3 and 4 in assessing the barriers to process integration. It concludes with a discussion of policy options for increasing integration across all levels and analyzes potential implications of such policies.

THE CURRENT AND POTENTIAL USE OF INTEGRATED PROCESSES

Estimates of the current and potential use of integrated processes are even harder to obtain than estimates of commercial purchases. In large part, this is because DOD has not collected relevant data.

The lack of estimates is also due to the inherent ambiguities in defining process integration. These ambiguities stem from the wide variety of processes that may or may not be integrated. At the facility level, a manufacturing plant may include a number of general processes (e.g., receiving, stocking, internal transport, manufacturing, packaging, shipping, cost accounting, maintenance, and R&D) and specific processes (e.g., use of a particular stamping press, touch labor by a particular employee, and quality inspection), any of which may be divided along commercial and defense lines.

Commercial businesses with no connections to DOD do not, in fact, necessarily integrate all similar processes. While they commonly separate many of their processes along product lines, businesses base their decisions to integrate on a variety of factors (e.g., proximity to sources of supply or transportation nodes, differing equipment requirements, differing production volumes, and special labor skills). (See box 5-1.)

Determining which processes have been segregated for economic reasons, as opposed to those segregated primarily because of the DOD procurement environment, is extremely difficult, and often the results are subjective.

While data on integration are scarce, a 1992 Center for Strategic and International Studies (CSIS) survey of 206 government prime contractors asked specifically about current levels of integration.[2] The survey found that 15 percent of those surveyed did no commercial business, while 13 percent sold only off-the-shelf commercial items to the government. Thirty-nine percent of the respondents segregated their commercial and federal business operations. Twenty-one percent set up unified management systems within a single operation to comply with government requirements. Only 12 percent conducted both government and commercial business in the same

[1] Certainly, many of the technologies and industrial sectors of interest to DOD-including aircraft, aircraft engines, electronics, communications, and avionics—have significant commercial, as well as defense, value. U.S. aerospace firms, for example, exported over $43 billion worth of aerospace products in 1991, over 80 percent of which was civil aerospace products. Firms have long argued that better integration of their R&D, manufacturing, and maintenance processes not only could lower the cost of aerospace goods purchased and maintained by the U.S. military but also would help make U.S. producers even more competitive abroad. U.S. Department of Commerce, "Aerospace," *U.S. Industrial Outlook 1993* (Washington, DC: U.S. Government Printing Office, January 1993), pp. 20-25. In that same year, the aerospace industry accounted for more than *25* percent of the Nation's R&D expenditures, while DOD ordered $22.7 billion in aircraft engines and parts, and funded more than $6 billion in aeronautics R&D. This market has declined, with 1993 exports of $39.6 billion, and 1994 exports estimated at less than $34 billion.

[2] Debra van Opstal, *Integrating Civilian and Military Technologies: An Industry Survey* (Washington, DC: The Center for Strategic and International Studies, April 1993), p. 5.

BOX 5-1: The AMRAAM, Part II: Integrated Processes

At the systems-integration level of production, the Advanced Medium-Range Air-to-Air Missile (AMRAAM) is a militarily unique item. The missile is built by Integrated firms (Raytheon and Hughes), but prospects that the missile could be assembled on an Integrated production line in an Integrated facility alongside commercial items appear practically nil. At the subcomponent level, in the lower production tiers, some manufacturing processes are Integrated. There appears to be room for further Integration in the future For example, a current ARPA-funded project involving Hughes and a smaller firm seeks to use commercial gyros in the AMRAAM. Research is ongoing to upgrade the AMRAAM's computers, computer software, sensors microelectronics circuits, and advanced composite materials These technologies overlap the defense and nondefense sectors Therefore, R&D might be accomplished by Integrated firms, possibly in Integrated facilities, and the resulting products might be dual-use

Estimates on the amount of Integration possible for R&D, manufacturing and maintenance, or from system Integrator to the lowest hers, are difficult to make Industry representatives interviewed for this report were optimistic that much more Integration could occur, but they noted that Incentives for Integration were lacking.

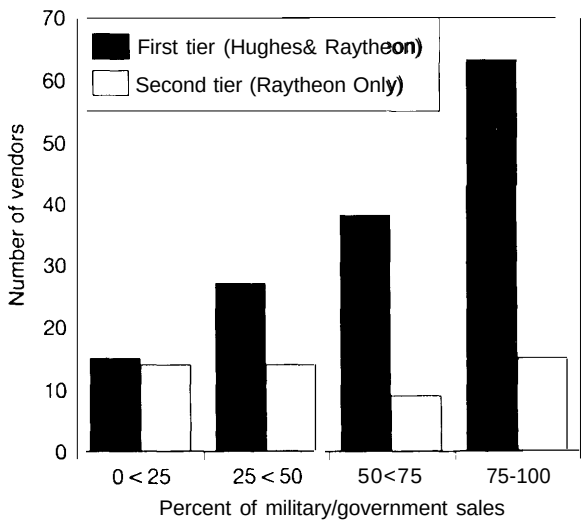
One way to judge Integration potential is to compare the technologies embedded in the missile with the technologies in commercial products. The AMRAAM and other guided missiles draw from a number of advanced technologies, including

microelectronic circuits	fiber optics	sensors and components	radar
photonics	explosives	advanced composites	
computers	software	rocket motors and propulsion	

Of the 10, only two (rocket motors and propulsion, and explosives) primarily serve defense The remaining technologies have significant commercial applications

The figure shows that while the first tier of suppliers to the two AMRAAM prime contractors depends heavily on military and government business, vendors in the next tier are far less dependent on government sales About 44 percent of the vendors in the first tier depend on the military/government for more than 75 percent of their business volume, and 45 of the 135 first-tier vendors produce more than 90 percent of their output for defense. Second-her vendors have a much more commercial orientation.[1] It is not difficult to understand why software, optical sensors, and microelectronics are among the driving forces of modern electronic products for industry, business and the home

Concentration of AMRAAM Vendors in Military/Government Business

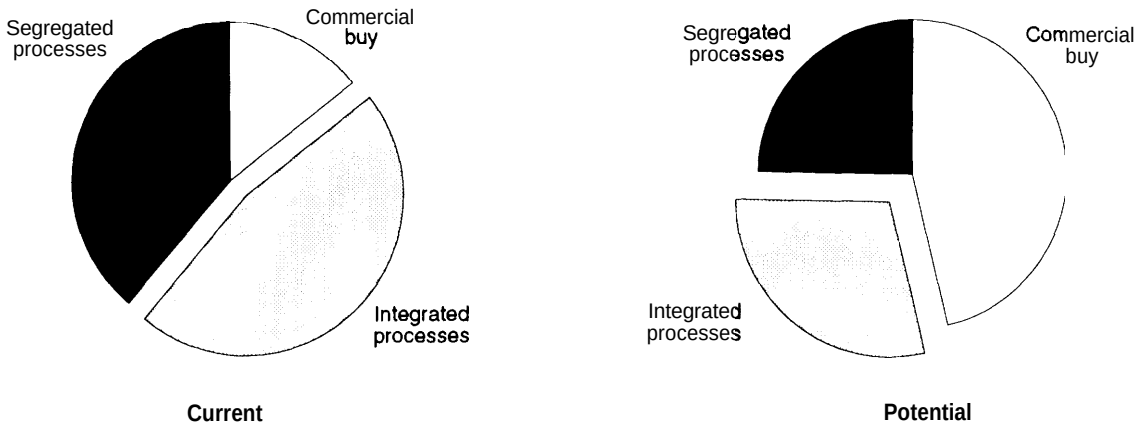


SOURCE Ivars Gutmanis Analysis of the Civil-Military Integration Feasibility for Selected U S Industry Sectors Washington, DC

1It is important t. remember however, that while a firm may perform both commercial and defense work the work they do for each is not necessarily related

SOURCE Ivars Gutmanis "Analysis of the Civil-Military Integration Feasibility for Selected U S Industry Sectors Report for the OTA Assessment on Civil-Military Integration Washington DC, 1993

FIGURE 5-1: OTA Estimates of Current and Potential National Defense Spending on Goods and Services Produced: A Focus on Integrated Processes



SOURCE Industrial survey conducted by the Off Ice of Technology Assessment, 1994

facilities. The amount of segregation observed in the CSIS sample is noteworthy because the firms surveyed were concentrated in three industrial sectors that appear to be amenable to integration of processes:[3] aircraft, aircraft and missile engines, and radio and TV communications equipment.

OTA Estimates

The responses to OTA's industrial survey (outlined in chapter 4, box 4-2) suggested that approximately 46 percent of the value added to goods and services in the private DTIB is from integrated processes. (See figure 5-1.) These estimates include both direct and indirect purchases.[4]

While the pie charts depicting current and potential degrees of integrated processes seem to suggest a reduction in the "integrated processes" wedge, this change reflects what actually are major shifts from "integrated processes" to "commercial buy" (discussed in the previous chapter) and from "segregated processes" to "integrated processes."

Previous studies and OTA's own analysis of additional selected industrial sectors[5] indicate that lower tiers of industry are more integrated

[3] The OTA definition of integration is mor, expansive than that used by the CSIS study team. As noted in chapter 3, OTA considers integration at various levels from sector, to firm, to facility and workbench or assembly line. OTA was given access to the CSIS data and could therefore apply its definition to CSIS data. OTA's assessment of the CSIS data would show a somewhat higher level of overall integration than would the CSIS's interpretation of the same data, but still shows considerable segregation.

[4] The expansive OTA definition of integration attempts to identify and estimate integration at discrete points in the development, production, and maintenance process, and OTA's estimates of current integration therefore may be higher than other estimates.

[5] I, addition t. the OTA survey of randomly selected sectors and its case studies, OTA earlier examined 11 industrial sectors and conducted extensive interviews with personnel in firms that produced products ranging from large weapons systems to basic raw materials. The sectors were: shipbuilding, aircraft, communications equipment, portable laptop computers, flat-panel display technologies, apparel industry, munitions, circuit breakers, fluid power products, gear manufacturing sector, and composite materials. Also see Office of the Under Secretary of Defense for Acquisition, Defense Science Board Task Force Report, *Engineering in the Manufacturing Process,* Aug. 21, 1992.

than are the prime-contractor system integrators. Opportunities for increasing integrated manufacturing are greater at the lower industrial tiers, but the lowest tiers are already extensively integrated.

The policy options considered in this chapter are designed to foster the shift from segregated processes to integrated processes. The OTA industrial sector survey estimated that this shift will affect about 15 percent of private DTIB value added. After accounting for those goods and services estimated to shift to the commercial category, the OTA industrial survey produced an estimate that about 30 percent of the future value added will come from integrated processes. The policies principally affect the 15 percent of goods and services moving from the segregated base, but may also produce savings and enhance technology transfer even in those operations that do not shift categories.

Many DOD efforts to increase the use of integrated processes have occurred at the industrial sector and facility level. The policy options discussion later in this chapter considers measures of effectiveness of current DOD programs.

BARRIERS TO INTEGRATING PROCESSES

There are many well-documented barriers to process integration. Some are inherent in the technology—a technology may have no immediate commercial value. Technology barriers limit the amount of process integration that can take place, how rapidly such integration can occur, and, ultimately, the amount of money that might be saved. Other barriers, such as unique acquisition policies, are imposed by DOD and could be quickly lowered to promote DTIB process integration with the commercial technology and industrial base (CTIB).

Inherent Barriers

Many defense technologies are not amenable to process integration for a number of reasons, including the absence of a commercial market, uneconomic production rates, or classification.

Weapons and other military systems meant to perform and support combat missions, for example, are often complex and expensive, incorporating unique technologies with few, if any, commercial counterparts. The electronics for fighter aircraft and precision-guided munitions often require greater miniaturization and the ability to withstand more extreme stresses than the electronics aboard commercial aircraft. And although the polymer composite material in stealth aircraft may be the same basic material used in a commercial airliner. the precision construction of a radar-evading aircraft is far more demanding than is the construction of a commercial aircraft.

Such differences extend to manufacturing itself. Many of the skills and technologies involved in the construction of a nuclear submarine, for example, are unique to the military. Similarly, the ammunition sector is estimated to be more than 90-percent segregated. Much of this separation is likely to continue in the future. Unique product requirements, coupled with the absence of a commercial counterpart, make it difficult to envision profitable civilian and defense R&D or manufacturing of ammunition.

These inherent barriers are exacerbated by the low rates of production characteristic of military items. Over the past decade, for example, modern fighter aircraft have been produced at a rate of about two to five per month. Aircraft carriers are produced at the rate of about one every five years. Attack submarines have been produced at the rate of three per year. Other products, such as small-arms ammunition, clothing, and rations, may involve highly varied production rates that change with little notice. Such fluctuation in production. combined with the military character of the products, promotes the growth of specialization in which contractors are dependent on defense business.

Finally, some technologies are deliberately kept off the commercial market. The nuclear weapons industry is a case in point. Much of the industry involved in the fabrication of weapons and in the processing and reprocessing of nuclear materials remains highly restricted.

Imposed Barriers

There are, however, many defense goods and services that might be appropriate for commercial processes, even if the final product is not itself commercially viable. Further, some rapidly evolving commercial technologies may offer DOD more advanced capabilities than are available from purely defense sponsored R&D efforts. Computers, for example, share much of their hardware and production techniques with their commercial counterparts. Commercial computers may not need to be as rugged as military ones, but some civilian uses are nearly as demanding, such as oil exploration and field research of various sorts. Many of these computers could be developed in a common R&D program, produced on a single line, and maintained by a common labor force using common procedures.

But just as many goods and services that might be purchased commercially currently are not, many of the goods and services that are amenable to integration continue to be produced in segregated facilities or production lines. While the total amount that is needlessly segregated due to laws, regulations, and current procurement culture is unclear, OTA's survey estimated that at least an additional 15 percent of goods and services might be moved from the segregated into the integrated process category.

Most of the barriers to the use of commercial products discussed in chapter 4 also impede process integration, albeit within a different context.

The primary barriers are:

- government cost-accounting requirements;
- procurement process, culture, and skills;
- military specifications and standards;
- rights in technical data; and
- unique contract requirements.

These barriers are listed roughly in the order of their overall effect as reported in the CSIS industry survey and in OTA's interviews.[6]

Government Cost Accounting Requirements

Special cost accounting and oversight requirements may be an even greater barrier to integrating processes than they are to purchasing commercial items. Indeed, the Defense Science Board Task Force on Defense Acquisition Reform called the current cost-based contracting system, with its unique cost accounting, "the most important single intrusive element of the current process."[7]

A principal part of the problem, as noted in chapter 4, is that government accounting standards do not conform to modem commercial accounting practices. Government contracts require far more detail in allocating costs than do commercial management information systems. Firms doing defense work must carefully track all hardware and components, not only to ensure the reliability of the parts but also to verify their cost. They must also track personnel billing against specific contracts and monitor the use of government furnished equipment. In addition, prime contractors are required to collect cost and pricing data from suppliers, although the suppliers are not required by law to supply such data to the prime contractors.

The risk of criminal penalties for errors compounds the burden, discouraging some business executives from seeking defense work. Industry representatives report that government accounting requirements increase the amount of oversight, which, in turn, raises the cost of the goods and services supplied to the government.

Industry observers think that the Federal Acquisition Streamlining Act (FASA) of 1994 may

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6 As noted elsewhere, ranking either [he most important barrier, or the most important response is difficult. There are differences among industrial sectors and among tiers. Lower tier firms, for example, are often more concerned about rights in technical data than are weapon systems assemblers. Firms responding to the CSIS industry survey placed provision of cost and pricing data and accounting requirements as number one, followed by unique government contract requirements, protection of proprietary data, penalties for certification errors, and technical requirements and quality control standards (military specifications and standards).

7 Office of the Under Secretary of Defense for Acquisition, *Report of the Defense Science Board Tusk Force on Defense Acquisition Reform*, July 1993, p. 6.

have little effect on these issues for firms making militarily unique items.

The problems imposed by government cost accounting extend to R&D as well as manufacturing. The 1993 CSIS industry survey, for example, reported that firms ranked cost and pricing data requirements as a primary reason for segregating their R&D activities. An earlier CSIS CMI study reported that some firms' reluctance to engage in defense R&D could be traced to past experience with government cost-accounting rules.[8]

The precise costs associated with the government cost-accounting system are difficult to measure and may differ across industrial sectors. Both General Electric and Pratt & Whitney, the two principal U.S. producers of jet aircraft engines, have reported several million dollars a year in additional costs associated with meeting defense orders. Much of this is attributed to cost accounting requirements. Intel Corp. reportedly spent $2 million in a failed attempt to put an acceptable government cost accounting system in place.[9]

Government cost accounting was introduced to maintain oversight on tax dollars. Supporters of these procedures argue that they remain necessary to control waste, fraud, and abuse. As proof, they cite continuing reports of inappropriate charges by defense contractors. [10]

A lack of data on the relative costs and benefits of the current government oversight regime forestalls analysis of the utility of government cost accounting. Reports by the Defense Contracts Audit Agency (DCAA) and the General Accounting Office stress the problems found and largely ignore the costs of oversight itself.

Some studies suggest, however, that the present system for preventing waste, fraud, and abuse is ineffective at holding down government costs. A recent study by the Defense Science Board Task Force on Defense Acquisition Reform, for example, argued that "the public protection offered by the current system is not a very high standard.'" It characterized the current system as one that "encourages increases in the price of goods and services, discourages investments in efficient production, and creates a regime of contention between the government and its suppliers."] [2]

Procurement Process, Culture, and Skills

The acquisition workforce poses somewhat different challenges for process integration than for commercial purchases. Commercial purchases raised questions about: the workforce's knowledge of available goods and services, the definition of what constitutes a commercial product, and requirements for cost and pricing data on commercial goods and services. While process integration also raises some of these issues, they must now be considered within the context of program management, plant oversight, and quality control. What is at issue here is the ability of the acquisition workforce to adopt commercial manufacturing standards and quality controls in place of existing defense operating methods.

The estimated acquisition workforce, as defined by the Packard Commission and according to dataasofDecember31, 1993, is approximately 178,000, 94 percent of whom are civilians. This includes 23,000 contracting personnel and 4,500 contract auditors in DCAA. (See table 5-1.) Many observers argue that the 23,000 contracting personnel are hard-pressed to keep up with current contracting requirements and that this situation will continue even with legislative changes.

[8] Jeff Bingaman et al., *Integrating Commercial and Military Technologies for National Security: An Agenda for Change* (Washington, DC: The Center for Strategic and International Studies, 1991), p. 18.

[9] Defense Science Board Task Force on *Defense Acquisition Reform,* op. cit., footnote 7.

[10] See for example, *Inside the pentagon.* "Defense Contractors Still Abusing Overhead Cost Guidelines," Oct. 12,1993.

[11] Defense Science Board Task Force on *Defense* Acquisition *Reform,* op. cit., footnote 7, p. 13.

[12] Ibid.

	Army	Navy	Air Force	DLA	DOD totals
Civilian	40,479	73,610	30,638	22,366	167,093
Military	1,356	2,836	7,012	—	11,204
Total	41,835	76,446	37,650	22,366	178,297

SOURCE Defense Manpower Data Center, 1993

Changes might include far less onsite government presence and fewer industry reports. The government workforce could adopt techniques such as statistical process control. They might, for example, conduct periodic inspections rather than be onsite. Some changes are already occurring. The government is examining and accepting new process control techniques—including accepting the use of commercial manufacturing standards in place of military standards.

The Army has also instituted a program to eliminate many program management tools that had been designed, in turn, to prevent a repeat of earlier acquisition failures and are frequently included as contract deliverables. These include: development of integrated logistics plans; risk management plans; and the numerous meetings between government and contractor personnel to discuss these plans.

Such costly government requirements have not been a focus of private sector concern, since contractors were paid for them. In some cases they have added millions of dollars to a contract. The Army has concluded that since these activities are inherent in good program management the Army does not need to check the plan-just the results.

Differences in the manufacturing standards adopted by each Service have led firms to make similar items for different Services in separate facilities. Integrated firms producing militarily unique and commercial items still face several different government oversight requirements. Developing a common DOD standard would improve prospects for integration with commercial operations too.

Facility exemptions have also been advanced for streamlining direct government oversight. Past efforts have included: the Exemplary Facility Program; the Army's Continuous Process Improvement Program; and the Defense Contracts Auditing Agency's Corporate Risk Assessment Guide (CRAG). These have often been viewed as unsuccessful by industry. They involve upfront costs paid by participating firms, with few guarantees of recouping those costs. The Office of the Secretary of Defense (OSD) discontinued the Exemplary Facility Program, for example, after little discussion with the companies involved. Firms also argue that relief from oversight in one area merely invites oversight in another area.

Overall savings from changes in the culture and skills of the acquisition workforce maybe partially quantified by considering the potential reductions in oversight workforce. The Defense Science Board Task Force on Defense Acquisition Reform estimated that a 30-percent reduction in the acquisition workforce might be possible, which could translate into a $4 billion annual saving. OTA's own estimate of potential savings is about $2.1 billion. This estimate is based on a 178,000 person acquisition workforce earning an average of $40,000 per person.] [3]

13 Average provided by the office of the DOD Comptroller.

BOX 5-2: Reliability of Electronic Equipment

The complexity and difficulty of changing and applying specifications and standards are evident in the argument over alternates for predicting reliability in electronic equipment, MIL-HDBK-217, the "Reliability Prediction of Electronic Equipment Handbook" currently used to estimate the reliability of military electronics, has been criticized as being out-of-date and inaccurate, Critics argue that it does not reflect emerging technologies, leads to costly overdesign, and prevents higher reliability from being achieved. For example, they point out that the Handbook has a

> bias toward MIL-SPEC screened ceramic parts that essentially precludes consideration of modern plastic-encapsulated parts that can be more reliable than more costly ceramic-packaged chips in many military and aerospace applications.[1]

Supporters of the Handbook counter that it provides "a necessary standardized medium for assessing reliability and comparing designs, " based on careful analysis. They maintain that any problems result from misuse or misinterpretation of the Handbook. Moreover, they argue that the Handbook is a flexible analytic tool, designed to provide a database for comparing design options, Identifying over-stressed parts, and providing input for analysis. They further hold that very little money is spent to keep the Handbook current

In June 1992, the Army authorized $1 million to pursue an initiative aimed at providing alternatives to the Handbook The Air Force and Navy are both reportedly Interested in the Army project.

[1] George Watson "MIL Reliability A New Approach, " *IEEE Spectrum* August 1992, pp 46-49

Military Specifications and Standards

As discussed in chapter 4, military specifications and standards have been used to define not only the physical characteristics and expected performance of the product, but also-most importantly from the perspective of issues addressed in this chapter—many of the manufacturing processes to be followed. Standards that describe, among other things, how the system is to be built and tested and how the work is to be managed are cited as major cost drivers and impediments to process integration. The Defense Science Board Task Force on Defense Acquisition Reform, for example, estimated a "20 percent to more than 50 percent" additional cost to a product when compared with best commercial practices. [14]

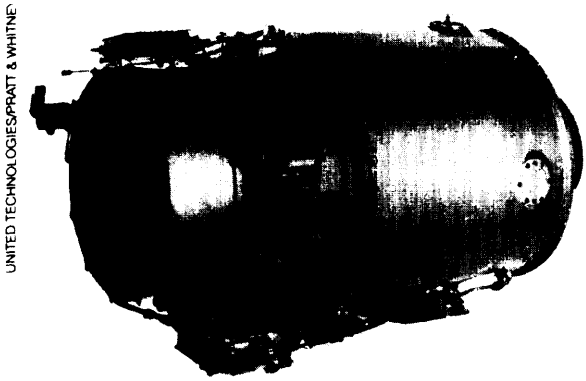
According to the Advisory Panel on Acquisit ion Law Reform, military standards often require commercial companies to depart not only from commercial practices but also from a company's individual processes that often lie behind the firm's commercial success. [15]

Debates over the appropriateness of particular military specifications and standards can be contentious. Box 5-2 looks at one example from electronics. Critics argue that this is an area in which acceptance of commercial standards and integration of processes might be particular y appropriate for DOD.

The flowdown of specifications and standards to lower tier contractors makes it more difficult to acquire dual-use materials, components, and subsystems for major systems. There have been few incentives for prime contractors or suppliers to seek alternatives to militarily specified components, or to propose changes in process standards

[14] Defense *Science* Board Task Force on *Defense Acquisition Reform,* op. cit., footnote 7, p. 6.

[15] The Defense Systems Management College, "Streamlining Defense Acquisition Law, " *Executive Summary: Report of the Acquisition Law Advisory Panel to the United States Congress, 1993,* p. 14.



The Pratt & Whitney Canada JT15D *turbofan engine is designed for small executive, commuter and military training jets.*

used. That situation is changing with Secretary of Defense William J. Perry's June Memorandum on Military Specifications and Standards, which endorsed the recommendations of DOD's Process Action Team for Specifications and Standards and directed the Service Secretaries and other Service personnel to implement changes. [16] The Team recommended that:

- Manufacturing and management standards be canceled or converted to performance or nongovernment standards.
- Future contracts provide incentives to contractors to propose alternative solutions to military specifications and standards.
- The use of military specifications and standards be prohibited except where required for truly militarily unique needs.
- Process control of nongovernment standards be used in place of quality control testing and inspection, and militarily unique quality assurance systems. [17]

DOD had already begun to act on some of the recommendations even before Secretary Perry's memorandum. For example, in February 1994, Under Secretary of Defense John M. Deutch authorized program offices to use ANSI/ASQC Q90 and the ISO 9000 service standards in contracts for new programs. The offices could also use these standards for follow-on efforts to existing programs instead of MIL-Q-9858A (Quality Program Requirements) and MIL-I-45208A (Inspection System Requirements). Under Secretary of Defense Deutch stated that the purpose was to improve process capability, control, and quality "by endorsing a single quality system in any contractor facility." [18]

Case studies have attempted to document the costs associated with the inappropriate use of' military specification and standards when commercial standards would do, but the cases available, while providing insights on the costs, do not provide a basis for generalization. The Defense Science Board Task Force on Acquisition Reform estimated savings from 10 to 25 percent or more from integrating the production of transport aircraft, jet engines, electronics and software, and similar items. [19] Such savings are difficult to document across the budget. But in individual cases it is clear that adoption of commercial standards sometimes offers dramatic savings. DOD can make many, if not all, of these necessary changes under its current authority.

Rights In Technical Data

Almost half of the respondents to the CSIS Industry Survey listed protection of proprietary data as a reason for segregating operations. While there is

16 Secretary of Defense William J. Perry, *Memorandum for the Secretaries of the Military Departments, Subject: Specifications and Standards—A New Way of Doing Business,* June 29, 1994.

17 Briefing: *Process Action Team for Specifications and Standards Final Report, Nov.* 19, 1993.

18 Under Secretary of Defense, John M. Deutch, *Memorandum for Secretaries of the Military Departments, Subject: Use of Commercial Quality System Standards in the Department of Defense (DOD),* Feb. 14, 1994.

19 Defense Science Board Task Force on *Defense Acquisition Reform,* op. cit., footnote 7, p. 8. Estimates of savings on some individual items were far greater-examples of gloves and radar provided an estimated 60-percent savings and some communications equipment was estimated to cost only one-tenth that of similar militarily specified items.

general agreement between government and industry that the government should have access to the data it needs to install, operate, and maintain its systems, tension arises concerning other uses of data that could compromise commercial proprietary information.

Chapter 4 noted that the government's ability to distribute a contractor's technical data can have the advantage of creating new producers in the supplier base (theoretically driving down costs) and/or ensuring continued capability. Since the government maintains many of its systems in service for decades, the cost and risk of dependence on a single supplier can be significant. From the contractor's viewpoint, however, this approach can put at risk the very technologies and processes that convey competitive advantage in the commercial marketplace.

There are three categories of rights the government can acquire:

- *limited* rights—which allow the government to use all delivered data for government purposes: *government purpose license rights—which* allow the government to distribute the data to others under a limited use restriction (e.g., the third party promises not to use the knowledge acquired in other activities); and
- *unlimited rights-which* grant the government the right to distribute the data without restriction.

Under any of these arrangements the government may receive and use internally any data delivered under the contract. But there is disagreement over the government's requirements for unlimited rights to the manufacturing and process data needed to reproduce an item (e.g., to distribute the technical package to other contractors; to order, redesign, or manufacture an identical product or system).

Under current regulations, the government may require unlimited rights in data when the technology was specified by, developed during, or required for the performance of a government contract or subcontract. This gives the government wide latitude to demand unlimited rights in data or software for products or technologies used in or modified for DOD systems and presents problems for a competitive firm.

An example illustrates the problem: The government fully funds the development of a part or system and the item is then built in a privately financed manufacturing facility. The government clearly has a right to data pertaining to the operation, installation, maintenance, and repair of that part or system, but in requiring the data that would permit it to second source the item, the government also obtains de facto rights to the privately funded process technology. Industry argues that the government merely exercises the contractor's manufacturing capability and expertise; it does not own the process, only the product to which that process was applied.

While the provision in FASA that provides the presumption that technical data under contracts for commercial items are developed exclusively at private expense may have a positive effect on commercial purchases, it does not appear to address many of the problems facing those attempting to integrate processes (e.g., potential requests for a commercially developed manufacturing process used to make a militarily unique item).

These technical data rights rules are grave disincentives for commercial firms to employ state-of-the-art products or processes in DOD systems. Under the current system, any producer willing to integrate facilities risks compromise of proprietary process information. The Defense Science Board noted: "the unique DOD demand for data rights beyond normal commercial practice . . . results in separate processes being developed for DOD and commercial work."[20] During interviews, the OTA assessment team found a number of cases that supported this conclusion. Disputes over rights to data are likely to escalate with any increase in the use of commercial products and increased integration of processes.

[20] Defense Science Board Task Force on *Defense Acquisition Reform, Op. Cit.,* footnote 7. p. 5.

Whatever the costs of duplicating production facilities, the real cost of this barrier is probably its negative impact on DOD's ability to access cutting-edge process technology.

Unique Contract Requirements

A host of unique requirements appear in government contracts. Five categories are said to create serious barriers: affirmative action laws, procurement integrity statutes, small business subcontracting plans, domestic sourcing requirements, and contractor responsibility laws. All are intended to achieve important national goals beyond government procurement.[21] Some specific examples were outlined and discussed in more detail in chapter 4.

The effect of these unique contract requirements on processes is to disrupt long-term supplier relationships by requiring alternative suppliers; and disrupt normal business processes by requiring tracking and reporting of compliance. Critics argue that attachment of these conditions as specific contractual obligations adds incremental cost to the procurement process for possibly small social benefit (in the case of the existence of other relevant law).

The negative effects of these contract requirements on integration of processes are concentrated at the firm and facility level. Tracking and reporting on compliance adds to the operating costs. Full compliance may undermine the development of long-term business relationships with suppliers. This may be a particular problem as the base is down-sized. FASA is viewed as providing no relief in this area for the bulk of DOD funds (e.g., in the case of contract actions greater than $100,000 for militarily unique items).

POLICIES FOR INCREASED PROCESS INTEGRATION

A number of approaches to reducing or eliminating the imposed barriers that impede process integration have been suggested. To succeed, they must be tailored to the three broad activities (R&D, manufacturing, and maintenance) that govern the life-cycle of military goods and services. Furthermore, although integration is usually discussed with regard to the facility level (manufacturing line or R&D lab bench), it might also occur at the industrial sector and firm levels. To be effective, policies must be tailored for the level or levels at which they might have positive effects. Table 5-2 provides some examples.

A truly integrated approach would address all commercial and defense technology and industrial processes from R&D, to manufacturing and services, to maintenance.

The Impact of Technology

Modem technology may be facilitating a shift toward integrated processes. (See box 5-3.) A recent example of process integration from the outset is a new modular avionics radar designed by Westinghouse to detect wind shear. The basic designs of both the defense and commercial versions share many common characteristics and can be modified to fit on a variety of aircraft.[22] An often cited example of earlier integration is the Air Force's KC-135 tanker and the commercial Boeing 707. Both aircraft were spawned from a common jet transport prototype developed by Boeing.[23]

In the past, integration has often involved "spin-off," i.e., the transfer of technology from the military to the commercial sector. Radar, computers,

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21 Debra van Opstal, "White Paper on Barriers to Commercial-Military Manufacturing Process Integration" (Washington, DC: Center for Strategic and International Studies, Dec. 10, 1992).

22 James J. Hughes, *Making Dual-Use Technologies Work* (Baltimore, MD: Westinghouse Electronic Systems), 1993.

23 John A. Alic et al., *Beyond Spinoff: Military and Commercial Technologies in a Changing World* (Boston, MA: Harvard Business School Press, 1992), p. 69.

TABLE 5-2: Process Integration at Three Levels

Level of integration	M/hat might be integrated	Examples of integration at this level	Examples of barriers to further process integration	Rationale for benefits of further process integration	Policies for increasing process integration
Industrial sector	All activities in a particular industrial sector, including companies, industry groups, standards bodies, government labs, defense acquisition officials, and academia.	Use of common technologies, processes, and specialized assets (e. g., unique test stands, wind tunnels, and in-industrial research centers) within an Industrial sector.	Differing commercial and military product and process requirements, separate specification and standard systems, go-it-alone attitude in businesses or DOD; classification of technologies, absence of measure of long-term effectiveness, opposition by Services and parts of the government.	Increase process technology transfer; reduce costs by avoiding duplication, increase international competitiveness; leverage limited R&D funds.	Foster DOD participation in commercial consortia and standards-setting bodies, open unique government facilities to commercial use; rationalize the DTIB and increase reliance on the commercial sector; promote joint development of manufacturing technologies, accept common technologies.
Firm	Senior management, divisions, branches, and assets of an individual company or corporation.	Sharing of corporate vision and resources, including management, workers, research centers, accounting and data systems, equipment, stocks, and facilities.	Need to shield commercial work from DOD oversight and added overhead costs, different accounting/data systems; different management and marketing environments, classification.	Internal technology transfer; maintenance of capabilities in commercial or defense downturns; economies of scale; in-increased long-term stability due to diversification, capital availability	Change requirements for rights in technical data, modify the use of military specifications and standards; design for dual-use, create more predictability in defense budgets through multi-year contracts.
Facility	R&D, production, maintenance, and/or administrative processes within a single facility,	Sharing of personnel, equipment, stocks, and administrative processes within a single facility; joint defense and commercial activity on a production line, in a work group cell, or at an R&D lab bench.	Need to shield commercial work from DOD oversight and added overhead costs; different accounting/data/supply systems, military uniqueness; use of military specifications and standards; limits on uses of government equipment, classification.	Cost savings; economies of scale, reduction of redundancies, reduction in capital investments; less worker retraining; lower overhead costs, direct process technology transfer; job retention,	Streamline acquisition rules and reduce direct oversight; promote commercial standards; develop function-based standard data packages, design for dual-use; fund technology areas rather than individual technologies.

SOURCE Office of Technology Assessment, 1994

BOX 5-3: Technology Trends Facilitating Process Integration

The Defense Science Board and others have noted that many important technologies are converging in products with both military and civilian applications.[1] These developments may enhance the ability to integrate CTIB and DTIB processes, Convergence is especially prevalent in the electronic industrial sectors, where commercial technologies often lead their defense counterparts and where commercial firms emphasize consistent quality and durability.

In addition, advances in computers, manufacturing, and communications technology hold the promise of more flexible or agile manufacturing. Many believe these advances will cause a fundamental change in mass production to "mass customization. " Several benefits could follow from this shift:[2]

- the flexibility to produce at low rates, with cost and quality similar to that in high-volume production,
- the capability to mix production—converting rapidly from one product to another with minimal retooling costs or delays—in cases where products are procured in small quantities; and
- the ability to adapt and rapidly Incorporate new product and manufacturing technologies in existing or new products,

Simulation and modeling techniques are increasingly useful in testing designs. Reportedly, "the adoption of rapid prototyping technologies has reduced by 50 to 80 percent the time Involved in getting prototype parts."[3] These techniques can help validate manufacturing, maintenance, and management processes, While some of these tools are becoming available even at the smallest firms, the more complex tools still require expensive computing equipment. Firms or facilities might benefit from the capacity to easily share the costs of such equipment across defense and commercial product lines. DOD would benefit from this cost sharing, as well as from the direct benefits of modeling, such as rapid prototyping.

Meanwhile, various testing and quality control methods or philosophies, such as statistical process control or '(zero defects, " have improved the reliability of commercial products, often to the point that they are more reliable than defense items produced on assembly lines run according to military standards. Studies have argued that many of the military manufacturing standards developed in the past may be both unnecessary and detrimental to production (e. g., visual testing of electronic parts).

These developments may provide new opportunities to manufacture specialized military products on the same assembly line as similar, or related, commercial products, employing the same tools, stocks, and labor, Even if process Integration is more applicable in components and subcomponents than in final assembly, it could still have a major impact on overall weapon systems costs and the size of the potential base. DOD might especially benefit from manufacturing flexibility, since peacetime production rates are often relatively low—essentially batch production—while wartime production rates might be much higher.[4] The Defense Logistics Agency (DLA) has been experimenting with harnessing technical developments to hedge against wartime needs using contractual agreements that take advantage of such flexibility. The DLA, for example, has negotiated and exercised standby agreements with commercial firms and supported the Introduction of new technology to ramp up production of military clothing in the event of a national crisis

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[1] Defense Science Board 1986 and 1989 Studies on *The* Use *of Commercial Components In Military Equipment* Also see John A Alic et al *Beyond Spinoff Military and Commercial Technologies in a Changing World* (Boston, MA Harvard Business School Press 1992), p 47

[2] Manufacturing Systems Committee, DOD MANTECH Advisory Committee, *Manufacturing Systems Strategic Plan*, March 1993 p 59

[3] Office of the Under Secretary of Defense for Acquisition, Defense Science Board Task Force Report, *Engineering in the Manufacturing Process,* Aug 21 1992, p F9

[4] Analysts note, however, that the total capacity of a flexible line might be relatively inflexible, because such a line would be planned for use at near full capacity during peacetime The ability to Increase defense products, therefore, will depend on displacing nondefense products on demand

and composites are examples of spin-off technologies. But technological changes and the shrinking defense base suggest that in the future there may be more "spin-on" of commercial product and process technologies. applied to defense needs. Raytheon's MILVAX computers, manufactured under license by the Digital Equipment Corp., are military versions of Digital VAX computers and can use commercial software .24

Some technology, however, will undoubtedly still be transferred from the military to the commercial sector. A recent example involves Raytheon Corp. 's design of its first gallium arsenide monolithic microwave integrated circuit (MMIC) chip for commercial use. The commercial chip was produced in the same facility that produces chips for Raytheon's Missile Systems Division. Raytheon reports that the chip is of high quality and meets the commercial market demand for high-performance devices, without the use of DOD testing and documentation.[25]

Policy changes should seek to take advantage of technology trends, to facilitate technology transfer both into and out of the DTIB, and to reduce duplication of effort.

Process Integration at the Industrial Sector Level

Government policies affecting process integration may be easiest to institute and least controversial at the industrial sector level. Recent broad policy initiatives, such as the Technology Reinvestment Project (TRP), will affect integration at all three levels, but the important technology development effort will have immediate, and possibly greatest, effect at the industrial sector level.

As noted in table 5-2, at the industrial sector level, process integration may involve cooperation in the development and distribution of process and product technology. It may also involve rationalization of specialized technical or industrial assets to meet defense and nondefense needs. Sector-level integration allows the DTIB and CTIB to work from the same base of knowledge and make better use of resources. While all technologies in a sector might not be relevant to both defense and commerce, many technologies might be---especially if efforts are made to exploit dual-use opportunities.[26]

Commercial participants in the integration of a particular industrial sector might include business, labor, professional organizations, and standards and testing bodies. Defense participants might include defense firms and representatives from the public sector (DOE and DOD laboratories, depots and other maintenance facilities, manufacturing arsenals, and test centers). The degree of overlap in private sector representatives from the DTIB and CTIB might provide an indication of current integration.

Industrial sector integration might involve developing common manufacturing or maintenance techniques; participating in standards and testing bodies; establishing joint centers for R&D; conducting common trade conferences and exhibitions; and sharing assets, such as wind tunnels, launch pads, and test stands. Sharing resources can help ensure that an industry is not permanently divided into a DTIB and a CTIB. The aircraft engine industry, for one, has had a long-term, Air Force-sponsored engine development program in which the results are shared by military and commercial participants.

DOD and DTIB involvement may influence decisions (e.g., on research emphasis, test protocols, and maintenance techniques) in directions that benefit DOD needs, but decisions also must be commercially sound. For this reason, propo-

[24] Ibid., p. 73. Chapter 4 discusses the option of buying many commercial items directly. thus taking full advantage of the commercial R&D embedded in those items.

[25] "Raytheon Designs MMIC Chip for Commercial Use," *Aviation Week and Space Technology*, July 20, 1992, p. 50.

[26] Such integration does not imply centralized industrial planning, but rather a concerted effort to take advantage of available resources and developments.

nents of integration argue that a fundamental principle for successful integration is the design of defense equipment to make optimum use of dual-use items.

The SEMATECH consortium, for example, uses government funding to develop manufacturing technology for future generations of microchips—a development that may be more critical to international industrial competitiveness than to defense. The recent DOD initiative on flat-panel displays is designed to support the development of a commercial industry that might also meet the needs of a more limited defense market. Underlying assumptions in both efforts include that civilian developments in these fast-moving sectors drive technology and that future defense needs can be ensured at lower cost through a strong commercial industry.

But critics of such efforts argue that government initiatives are unlikely to be as efficient as the market in supplying defense needs. Such efforts, they allege, will "waste money, fall prey to political pressure and distort competition."[27] Still, most critics do not deny that there is a role for government in technologies of importance to defense—what they question is the size and character of that role. (See box 5-4, pp. 119-120.)

Three key objectives of a industrial sector-level process integration effort are: 1) leveraging funds, 2) increasing the level of knowledge in the sector, and 3) diffusing new technology.

Leveraging funds is especially important given the downward trend in defense spending. Increasing industrial sector-level process integration might allow DOD to eliminate redundancies that exist between the public and private sectors of the base and focus future DOD efforts on militarily unique technologies that have no commercial market, rather than duplicating commercial efforts.

Limited government funds might be directed at these militarily unique areas, with some continued spending in commercial sectors such as microelectronics, where government seed money may be important.

The ability to leverage funds depends on DOD's readiness to exploit technologies with both defense and commercial application. This is not always possible, since the military may have specific performance requirements (stealth aircraft) that do not exist in the commercial sector.

But even where differences in the final application exist, it may be possible to identify processes applicable to both defense and commercial products. Software and design technologies, for example, are important to both the commercial and defense composites industry. Both markets are demanding increasingly sophisticated product designs. An Army Research Office effort to develop design software that will reduce the time from product concept to delivery has both defense and private-sector applications.[28]

Rationalization of public and private R&D, production, and maintenance activities will also leverage funds. One of the principal R&D integration challenges, for example, is to identify proper public and private roles and to effectively rationalize the activities. In the past, 30 to 40 percent of defense R&D was conducted in military service laboratories or in Department of Energy (DOE) weapons laboratories. These public-sector facilities generally focus on technologies with high military potential, and pursue research with a potential for long-term payoff. Future research will have to take maximum advantage of commercial developments, while maintaining some militarily unique research.

Cooperative Research and Development Agreements (CRADAs) can also help leverage funds by transferring technology from federal lab-

27 Robert J. Samuelson, "Flat Screens and Subsidies," *The Washington Post*, May 19, 1994, p. A23.

28 OTA Composite Materials Case Study, forthcoming background paper supporting this assessment.

TABLE 5-3: Funding for Defense Related Economic Adjustment (dollars in millions)

	FY 1993 Awards	FY 1994 Appropriations	FY 1995 Authorization conference bill
Technology reinvestment project			
ARPA Dual-Use Partnerships	82	150	245
Commercial-Military Integration Partnerships	42	100	96
Advanced Manufacturing Technology	23	30	30
Regional Technology Alliances	91	100	80
Manufacturing Engineering Education Program	28	24	24
Manufacturing Extension Program	87	0	25
Dual-Use Technology Assistance Extension	91	0	0
TRP-related Small Business Innovative Research	7	NA	NA
Subtotal	451	404	500
Reprogrammed funding	—	120	
MARITECH	—	30	50
Other dual-use technology programs			
Agile Manufacturing and Enterprise Integration	29	35	35
Advanced Materials Synthesis and Processing	29	30	30
U S -Japan Management Training	9	5	10
Subtotal	**67**	70	75
Small Business Innovative Research (SBIR)	85a	145a	161[a]
Nonpartnership dual-use technology programs			
High Definition Systems	92	85	68
Optoelectronics	23	32	26
Multi Chip Modules	22	29	25
Advanced Lithography	71	58	60
Advanced Simulation	—	59	21
Other Materials and Electronics Programs	32	64	32
New Navy Initiative	—	—	50
Subtotal	240	327	282
Grand total	758+85	951 +145	907+161

[a]SBIR funding is an **estimate** no specific amount mandated by law

SOURCE Off Ice of Technology Assessment, using Defense Budget Project, CBO, and DOD data, 1994

oratories to the private sector. The use of CRADAs has expanded as a result of changes in the law. There also appears to be more real interest at government laboratories in the face of budget cuts and mission changes, and greater interest by business.

The Technology Reinvestment Project (TRP) can also leverage government and private-sector funding. (See table 5-3.) The TRP is divided into several broad areas: Technology Deployment, Technology Development, and Manufacturing Education and Training. Its goals include diversification from defense to commercial products, integration of defense and commercial production facilities, deployment of technology to and from commercial industries, and development of dual-

The Oak Ridge Manufacturing, Prototyping, and Demonstratlons Center offers commercial companies expertise and demonstration equipment m a variety of manufacturing technologles, including multiaxis and nontraditional machining.

use technologies.[29] It can potentially leverage investment through the commercial-military technology partnerships, defense dual-use control technology partnerships, and defense advanced manufacturing partnerships.

TRP received $404 million in fiscal year 1994, of a total of about $1.7 billion for defense conversion and dual-use technology programs government-wide. This effort centered more on technology development and less on deployment, with priority given to developing dual-market items for the defense and commercial markets.[30]

The project may have its most immediate impact at the sector level. In the long run, however, it can affect integration at the firm and facility levels too, by creating dual-use technologies.

Although TRP has received significant support from Congress, the program has raised concerns about how technical research areas are selected, whether DOD and ARPA should be managing the project, and how the success of the project is ultimately to be determined.

Finally, the government is attempting to leverage past investments by making available the unique capabilities of government R&D facilities. The naval ship design facility at the David Taylor Model Basin has been touted for new commercial ship designs. Other facilities under discussion include the Arnold Engineering Center aerospace test facilities and supercomputer facilities at Los Alamos and Lawrence Livermore. The Oak Ridge Y-12 Production Facility has organized 15 Centers for Manufacturing Technology and is applying expertise developed during the Cold War to commercial manufacturing problems.

Increasing the level of knowledge in an industrial sector is a second key industrial sector-level goal. Achieving this goal will require an understanding of defense and civilian technology needs.

While the military Services have long had science and technology plans aimed at pursuing useful technologies, a comprehensive DOD-wide plan has only recently begun to emerge. In response to congressional requests to develop a process for evaluating the allocation of resources in the late 1980s, DOD developed a "critical technology plan."[31] The yearly submissions of this plan, however, were criticized as being a listing of interesting technologies rather than a guide to resource allocation. The *DOD Key Technologies Plan,* released in July 1992 and tied to the Department Science and Technology Strategy, was thought by some to be nearer the mark.[32] The S&T strategy contained seven research thrusts directed at military forces and operational requirements.

29 Advanced Research Project Agency Briefing, Apr. 6, 1993.

30 Ibid.

31 P.L. 101.1891 03Stat.1512 Paragraph 2508(a) directed the Secretary of Defense, working with the Secretary of Energy, to submit annually to the Armed Services Committees of the House and Senate a plan for developing the technologies considered most critical to ensuring the long-term qualitative superiority of U.S. weapons systems.

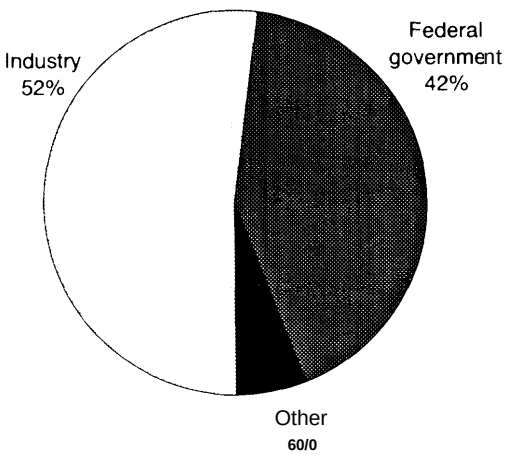
32 U.S. Department of Defense, Director of Defense Research and Engineering, DOD Key *Technologies Plan,* July 1992.

BOX 5-4: The Role for the Government in Integrated R&D

The government will undoubtedly continue to play an Important role in both commercial and defense R&D. The figure below-left shows total estimated R&D spending by source for 1993 The federal government provided $69.7 billion, about 42 percent of the total, Twenty-five federal agencies were engaged in funding R&D But 93 percent of the funding comes from the six shown in the figure below-right DODs share has dropped from a peak of 64 percent in 1986, to an estimated 52 percent in 1993, This is expected to drop to about 51 percent in 1994.1 Increased Integration of commercial and defense efforts might streamline the national R&D effort by eliminating personnel and avoiding unnecessary duplication

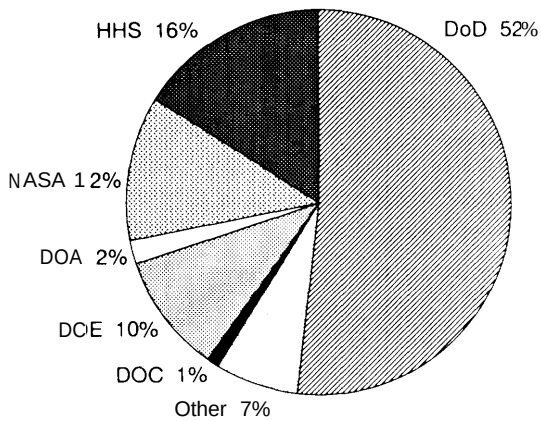
There are a number of initiatives, aimed at better coordination of the government R&D effort, that can potentially have a positive effect on the Integrated base. The development of a National Science and Technology Council (NSTC) raises coordination of government science and technology to a Cabinet-level group with the authority to establish budgets and resolve conflicts.[2]

R&D Funding by Source, 1993



Total $160.7 billion

Estimated Federal Obligation, 1993



Total $69.7 billion

SOURCE National Science Board, *Science and Engineering Indicators*, National Science Foundation (Washington DC U S Government Printing Off Ice 1993) (NSB93-1) pp 92 and 111

[1]National Science Board *Science and Engineering Indicators*, National Science Foundation (Washington, DC U S Government Printing **Off Ice 1993)** pp 104-111

[2]"Where N. Policy Has Gone Before , " *Washington Technology,* Mar 10, 1994

(continued)

BOX 5-4 continued: The Role for the Government in Integrated R&D

DOD initiatives to promote R&D integration include Project Reliance, a program designed to streamline Service activities, improve coordination, and avoid unnecessary duplication. Reliance could result in substantial savings. Second, the Off Ice of the Secretary of Defense and the Services are all examining opportunities for using civilian R&D in place of DOD-funded efforts. But efforts to identify specific civilian scientific activities of interest to defense are only just beginning. Third, the Services plan to direct more research effort to projects with potential commercial application. The Air Force, for example, plans to spend from 10 to 20 percent of its research funds on such projects. Both the Navy and Army plan to improve coordination of research involving Service laboratories, industry, and universities in order to leverage their limited research funds. Fourth, all the defense laboratories have increased their participation in technology transfer, The National Science Foundation notes that technology transfer activities can run the "gamut from the informal exchange of ideas between visiting researchers to contractually structured research collaborations involving the joint use of facilities and equipment."[3] They include Cooperative R&D Agreements (CRADAs), Patent License Agreements (PLAs), and technical outreach programs. The government, for example, expects to have more than 3,200 CRADAs in effect in 1995, many with defense-oriented laboratories—especially the DOE weapons laboratories, CRADAs are designed to allow transfer of technology to the private sector. Under these agreements, federal laboratories and the private-sector collaborators share resources in collaborative R&D. The laboratories also assist industry, both on a reimbursable basis and in an informal manner by responding to requests for information Oak Ridge National Laboratory, for example, provides support on technology development in materials forming and processing, and researchers at Los Alamos National Laboratory provide technical advice to small business, The government can thus assist industry Informally, provide more formal consulting help on a reimbursable basis, and grant licenses of technology developed within the government,

Government organizations also support and participate in a number of R&D consortia with defense and commercial applications, including the Great Lakes Composites Consortium, SEMATECH, and the Advanced Battery Consortium. DOD also provides support for activities led by other government agencies, such as the Automated Manufacturing Research Facility at the National Institute of Standards and Technology

The Advanced Research Project Agency is supporting several integration activities under its Technology Reinvestment Project (TRP). TRP is a mix of eight individual programs whose goal is to bolster the economic competitiveness of defense-dependent resources and increase the availability of dual-use technologies for national security purposes, TRP involves competitive awards, participation of a wide range of Industry, universities, nonprofit organizations, and state and local governments; and cost-sharing,

But government Involvement in many of these activities is not universally supported. While many in business welcome government activities, others in the business and academic communities complain that federal laboratories are competing directly with the private sector—and doing so unfairly because of U.S. government backing, These concerns have resulted in moves in Congress to bar federal laboratories from conducting research and services that "conflict with existing capabilities in the private sector."[4] The divid - ing line between government activities viewed as helpful and those viewed as threatening differs by firm, Drawing that line will be difficult.

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[3] 1 bid p 119

[4] "Competition from Department of Energy Laboratories Gets Capitol Hill Attention," Technology *Transfer News*, p 8

One—Technology for Affordability—was specifically intended to promote technologies that would result in more affordable defense systems .33

But DOD has never made a strong link with commercially relevant technologies. A 1991 report by the National Critical Technologies Panel compared DOD critical technologies, the Department of Commerce "'Emerging Technologies," and the Panel's "National Critical Technologies." There were to be sure many areas of overlap, but little evidence that DOD has sought to systematically exploit civilian technology investments. This may be changing. The Director of Defense Research and Engineering (DDR&E) is reportedly reviewing Department R&D efforts to identify research needs and determine those that can be met in the civil sector.

DOD and defense industry involvement in standards-making bodies can supply insight into developments of interest in the commercial sector. But a conscientious effort to incorporate commercial technology into defense systems is ultimately the most important step for the Department. Such a commitment, if enforced, will force military equipment designers and the Services to maintain an up-to-date understanding of commercial developments in their sectors.

Diffusing new technology is the third key aspect of integration at the industrial sector level. Many observers argue that the U.S. government can play a major role in diffusing technology. They argue that America's international economic competitors owe part of their success to a government role in developing critical manufacturing technology and in diffusing that technology throughout industry.

According to a 1988 Defense Science Board report, for example, the Japanese Ministry of Industrial Trade and Industry (MITI) "engages in effective, long-range planning for development of both the defense and civil sectors. This broad industrial planning effectively transfers technologies and products originally developed for civilian goods to the defense sector and vice versa."[34] Although there is a growing recognition that MITI has been neither all-powerful nor infallible in selecting and supporting technology, it has facilitated the development of government-commercial partnerships and has championed the growth of key industries.

CRADAs are one means of diffusing technology. DOD has developed a number of other mechanisms to help diffuse technologies. One involves government-commercial consortia to perform research in areas of mutual interest such as the Great Lakes Composites Consortium and the Great Lakes Industrial Technology Center, both of which conduct research on matters of interest to DOD and act as conduits for technology between the defense and commercial sectors.

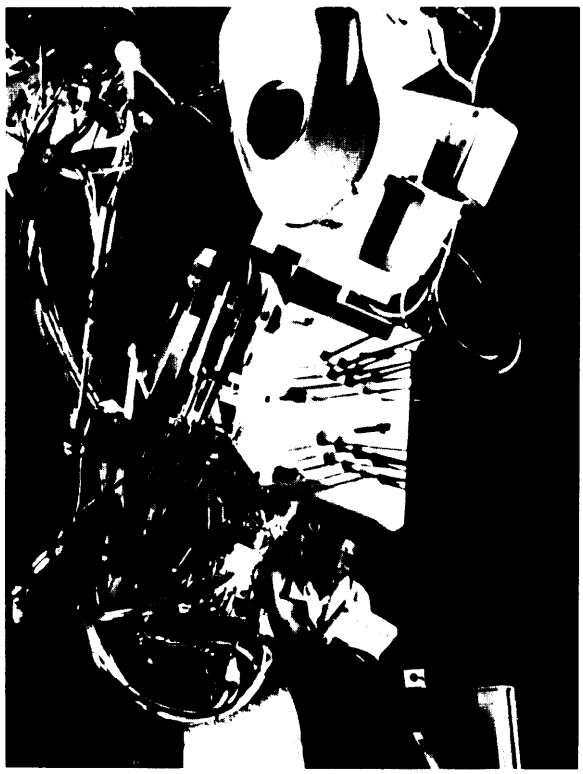
The Army's National Automotive Center (NAC) at the Army's Tank-Automotive Command also appears to address sector-level capabilities. NAC promotes collaborative R&D in dual-use technology in the automotive sector. It has CRADAs with Chrysler, Ford, and General Motors. NAC is also working with the Advanced Research Projects Agency, DOE, and the U.S. Council for Automotive Research on the clean car initiative that seeks to produce high-performance, fuel-efficient vehicles. The Army hopes to save millions in development costs through such cooperation and believes that the research has commercial benefits.[35]

Program-specific actions can help diffuse technology at the sector-level, but less wide] y than

[33] The thrusts were Global Surveillance and communications, Precision Strike, Air Superiority and Defense, Sea Control and Undersea Superiority, Advanced land Combat, Synthetic Environments, and Technology for Affordability.

[34] Office of the *Under* Secretary of Defense for Acquisition, *Final Report of the Defense Science Board 1988 Summer Study on the Defense Industrial and Technology>' Base*, October 1988, p. 18.

[35] Stacey Ever\, "Lockheed Charts Course Through Defense Cuts," *Aviation Week & Space Technology},* Jan. 3, 1994, p. 60.


GREAT LAKES COMPOSITES CONSORTIUM

The government and industry are forming consortia to develop new dual-use technologies. Here, the Great Lakes Composites Consortium applies advanced robotics to composite fiber placement.

broader efforts. The DOD Manufacturing Technology program (MANTECH) often funded manufacturing technology efforts directed at a specific program problem and made solutions available to industry. Another interesting example is the Manufacturing Operations Development and Integration Laboratories (MODILs) Program developed by the Strategic Defense Initiative Office (SDIO). The program promoted process integration at the industrial sector level, as well as at the firm and facility levels. (See box 5-5.)

Developments in integrating manufacturing technology can potentially benefit both the defense and commercial sector. The DOD Manufacturing Technology Advisory Group on Materials Processing, for example, argued that:

> The most immediate and obvious spin-off benefit of [its processing and fabrication] plan will go to the U.S. commercial aircraft industry. These same manufacturing technologies developed for military systems are directly scaleable and transferable to commercial airplane systems .36

A DOD advisory group on manufacturing strategy argued that:

> The most important government roles in advancing the technologies of manufacturing systems are to provide seed money for promising technical opportunities that would not otherwise be pursued and to bring individual companies together for mutual leveraging in areas of common need.[37]

The group concluded that a broad-based strategy—rather than programs aimed at a particular weapon system or company—was essential. The payback period on technology is far too long, the risks are too high, and the development costs are too great for individual companies or even entire industrial sectors to handle alone. Rather, the group argued, DOD and its contractors must join with the commercial sector in stimulating the development of manufacturing systems technologies and commercial products based on those technologies in advancing appropriate standards, and in sharing implementation experiences.[38]

The NIST manufacturing extension centers, partially funded through TRP, provide help to smaller manufacturers in adopting new manufacturing technology. There are other avenues, though, that DOD might explore in diffusing knowledge across sectors, including supporting standards-setting bodies. With reductions in military standards and specifications, and greater reliance on commercial specifications and stan-

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[36] DOD Manufacturing Technology Advisory Group, Materials processing & Fabrication Committee, *Materials Processing & Fabrication Technical Committee Strategic Plan,* Apr. 21.1993, p. 11.

[37] Manufacturing Systems Committee, DOD MANTECH Advisory Committee, *Manufacturing Systems Strategic Plan,* March 1993, p. 3.

[38] Ibid.

BOX 5-5: MODILs

Manufacturing Operations Development and Integration Laboratories (MODILs) were designed by the Strategic Defense Initiative Off Ice (SDIO) to bring unique government capabilities together with industry and university participants to develop and demonstrate new production and automation processes for specific technologies SDIO's objective was to ensure that an industry would exist to produce items that might be developed through its R&D program. With a relatively small budget of $5 million to $7 million per year, SDIO used a combination of focused workshops, joint projects, and equipment testing in its MODILs.

The Optics MODIL at Oak Ridge National Laboratory, for example, uses state-of-the-art precision-machining equipment to support collaborate experiments, Other MODILs Included the Advanced Infrared Sensors MODIL and the Signal Processing MODIL, both at Sandia National Laboratories, the Software MODIL at the National Institute for Standards and Technology; and the Space Fabrication and Test MODIL at Lawrence Livermore Laboratory Cuts in funding for strategic defense resulted in a loss of funding for the MODILs Only the Optics MODIL at the Oak Ridge Center for Manufacturing Technology will continue The other MODILs are being terminated.

Although the original purpose of the MODILs was to ensure that a future capability would be available to support weapons production, and not dual-use technology per se, the efforts developed technology in precision finishing and coatings and diffused that technology to firms for both defense and commercial applications.

dards, DOD might reasonably contribute to setting standards in sectors that serve both commercial and defense needs.

A recent example is a report by the Air Force Commercial Acquisition Streamlining Team urging electronic firms to adopt certain military specifications and standards as commercial specifications and standards. The report also urged DOD to use Qualified Manufacturing Lists to allow increased integration.[39]

The Maintenance Base

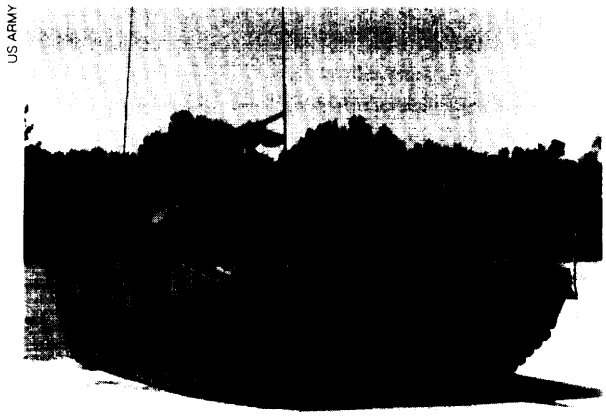
At the industrial-sector level the maintenance base will benefit from acceptance of common defense and commercial technologies. But the most important civil-military integration maintenance policy issue is rationalizing the public and private bases and eliminating redundancies. If defense and commercial activities use common technologies and equipment, then the preservation of a unique government maintenance base may no longer be necessary, and in an era of much reduced spending, it is surely less affordable.

The Benefits anti Costs of Sector-Level Process Integration Policies

The potential benefits of industrial sector-level integration, outlined earlier, include: 1) leveraging limited R&D investment funds, thus lowering costs to both defense and commerce; 2) increasing the potential defense suppliers by diffusing technology; and 3) providing access to new technology through increased involvement in consortium.

The potential savings in the rationalization of the public and private maintenance and overhaul base are substantial. But getting savings from rationalizing this portion of the base will require closing facilities and elimination of many government jobs. Current legislation strictly limiting the amount of maintenance that can be performed by the commercial sector would have to be revised or

[39] Pat Cooper, "DOD Study Touts Military Standards for Microelectronics," *Defense News*, June 6, 1994.



Many armored vehicles, originally manufactured by private companies, are maintained and upgraded at army depots

repealed. There is also resistance to closing government R&D facilities.

Deciding how much time, money, and energy to invest in policies aimed at sector-level integration is a challenge. Past studies have illustrated the difficulty of linking specific research funding with ultimate results.[40] Current initiatives may be even more difficult to evaluate. But, both TRP and CRADA raise questions on how to evaluate program effectiveness. If such activities are not to be viewed simply as jobs programs, then some metrics will need to be developed to judge their success.

A number of possible benefits in addition to new technology developments have been suggested for TRP. Deputy Secretary of Defense John Deutch has argued that the teaming of defense and nondefense firms is itself a measure of success. So too, he said, is the increased cooperation within the government. He has advised waiting until 1996 before making a broad judgment on the success of the project.[41]

But any benefits have to be weighed against the fact that TRP costs the U.S. government several hundred million dollars per year in direct funding and some tens of millions more in reimbursable independent research and development (IR&D) funds for proposal writing. Additional sums, perhaps tens of millions in nonreimbursable R&D funds, are spent by business on associated research and matching funds.

CRADAs can also transfer technology from laboratories to business, and introduce technology to the laboratories. But again, long-term program effects may be difficult to measure. Supporters envision the results of billions of dollars in federal research being transferred to U.S. business to promote international competitiveness and solve other nondefense problems. But skeptics argue that much past research has had little commercial potential. Further, some argue that CRADAs constitute a "mining of U.S. R&D investment." Without continued long-term investment in fundamental research, there will be eventually little new knowledge to transfer.

The most commonly suggested metrics for measuring TRP, CRADA, and other industrial sector-level activities, unfortunately, are all short-term, input metrics: dollars spent, TRP projects proposed, number of CRADAs, consortium established, and other input-oriented activities. While such measures may be of some initial use, they are insufficient in the longer term.

An effort to measure both short-term effects and long-term economic benefits of projects has been undertaken as part of the Advanced Technology Program at NIST. (See box 5-6.)

Several metrics that focus on measuring long-term effects of the TRP and other DOD programs have been suggested. These include: the number of patents granted or products developed over a given period of time; the amount of technology transferred from the public sector to the commercial and vice versa; and the relative success of industry in comparison with America's international competitors. (See box 5-7.)

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40 In the 1960s and 1970s, two studies, Operation Hindsight and Project Traces, attempted to link DOD research investment to product development. Neither was very successful in doing so.

41 "Deutch: TRP Unites Industry Bases," *Defense* Conversion, May 23, 1994.

BOX 5-6: Evaluating NIST's Advanced Technology Program (ATP) Projects

The ATP, begun in 1990, invests in projects that support technologies with strong potential for economic benefit The ATP evaluation plan stresses measurable goals whenever possible.1 The program has tracked and reported input data on nearly 1,000 applications and awards to nearly 90 projects, The ATP also sponsors third-party studies to track project results.

Tracking the short-term *and intermediate project results* provides an indication of ATP's Immediate effect on participating companies. ATP tracks how well businesses follow through on the business and commercialization strategies outlined in their ATP proposals Project managers collect the information during quarterly. year-end, and end-of-project reviews ATP IS field testing a new, customizable questionnaire designed to gather more detailed data than are now available A key goal is to gather data in a form that allows for easy updating and minimizes the reporting burden Several measurable short-term effects are thought to also provide Indicators of long-term economic success So, in addition to straightforward tracking of technical milestones, other Indicators are examined, including:

- Increased R&D Investment and R&D in new areas leveraged by ATP funds,
- increased Industrial collaborations and strategic alliances,
- strengthened technological Infrastructure,
- shortened R&D cycles,
- Investment in production capacity, and
- productivity Improvements.

Long-term economic impact is the bottom line for ATP. Program goals include Increased U S economic growth, Increased Industrial competitiveness, and creation of high-value jobs, Measures of the long-run success of ATP include:

- creation of new industries or industrial capabilities,
- Improvements in manufacturing costs, product quality, and time-to-market;
- increased worldwide market share;
- job creation, and
- private and social rates of return on investment.

At present, NIST says it is too early to measure long-term effects. Several products Incorporating the results of ATP-supported research have been Introduced or are near commercialization In addition, one company has Introduced ATP technology into a manufacturing process on a pilot scale, In general, however, almost all ATP projects are still in R&D. In most cases, it will take several years before a long-term effects study can be undertaken.

The planned approach to these long-term studies IS to use macroeconomics case studies to estimate specific benefits and costs of new technologies developed under ATP. Statistical sampling techniques will be used in selecting specific projects and programs for detailed study.

NIST reports that the measurement of long-term economic impacts of ATP requires three major efforts

- development of quantitative measures of the influence or effect that ATP has on the introduction and diffusion of each new technology it supports,
- development of quantitative and qualitative measures of the Influence or effect of each ATP-funded technology on the economy, and
- estimates of private and social aggregate economic benefits and costs from each new technology developed under ATP funds.

[1]NIST u s Department of Commerce *Setting Priorities and Measuring Results at the National Institute of Standards and Technology* U S Department of Commerce, Jan 31, 1994, p 13

BOX 5-7: Evaluating the Technology Reinvestment Project

Any evaluation of TRP would be more extensive and difficult than that of ATP, since its eight programs Involve several different goals education and training, technology development, and technology deployment

Possible measures for manufacturing education and training include:

- Number of students trained and placed per year.
- Client satisfaction with trained personnel.

The outcomes of technology development and deployment activities are more directly traceable to the mission of TRP. Several measures might be employed to evaluate technology development activities:

- Number of technical successes.
- Number of technologies adopted by military programs,
- Number of patents and citation of patents.[1]
- Number of organizations that form joint research ventures as a result of their experience in TRP.[2]
- Number of reapplications to the TRP.[3]

To some extent, these same metrics may also apply to TRP's technology deployment activities. Since the deployment activities include both the creation of technologies and the provision of extension services, the following supplementary metrics might be considered

- Changes in defense dependence-defense sales/total sales—attributable to deployment services or technologies.
- Increases in produchvity—increase in output per worker attributable to deployment services or technologies.
- Increases in market share attributable to deployment services or technologies,
- Customer satisfaction.

Assessing synergies across program activities would be a valuable way of measuring TRP's overall impact This will take time.

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[1] **Numerous** studies have shown that citation-weighted patents are highly correlated with other measures of technological ancl economic Importance See, for example, F Narin et al , "Patents As Indicators of Corporate Technological Strength, "*Research Policy (16) 1987,* pp 143-155, M Albert et al , "Direct Validation of Citation Counts as Indicators of Industrially Important Patents, *Research Policy* (20) 1991, pp 251-259, A FJ Van Raan (ed), *Handbook of Quantitative Studies o/Science and Technology,* (North-Holland 1988), M Trajtenberg, "A Penney for Your Quotes, " *Rand Journal of Economics, No* 1, 1990, pp 172-187

[2] A Link and L Bauer, *Cooperative Research in* U S. *Manufacturing* (Boston, MA D C Heath, 1989), suggests that firms cooperatively engaged in research not only revest more in R&D than they would have done in the absence of the relationship, but also that their other R&D is more productive owing to the transferability of basic technical knowledge and related research skills

[3] Firms applying to the Baldridge Award process report that they learn something useful about their Organization every time they apply In fact, many companies go through the process several times without any hopes of winning The same phenomenon might apply to TRP Also, if the activities undertaken by awardees would not have been undertaken in the absence of TRP money and if awardees reapply, this may indicate that know-how markets are being created by the award process

Technology development efforts are by nature risky. The industry sector-level efforts are relatively long-term. Some will succeed and some will inevitably fail. Their primary impacts are intended to come to fruition at some time in the future. For these reasons, any evaluation process should be ongoing and designed to assess the progress of each major effort rather than a few high-profile projects.

Costs and Risks

The policies directed at integrating processes at the sector level have a number of potential costs and risks. CRADAs, for example. have been criticized as potentially detrimental to the laboratories' defense mission, diverting critical personnel to short-term problem-solving rather than longer term scientific discovery. If the government has only limited R&D dollars, some argue that they should go exclusively toward technologies that the commercial sector cannot provide.

Some of the government personnel interviewed for this assessment expressed the concern that if process integration is too extensive, the government may lose all of its inhouse capabilities. It might lack sufficient technical expertise to be either a "smart buyer" or an "intelligent manager" of the technology it needs to support the nation's security.

Such concerns may be overdrawn. Other countries (e.g., Japan) do not have comparable public sector defense capabilities.[42] Still it would appear prudent to ensure that sufficient inhouse defense capability continues to exist to buy and maintain new technologies.

A concern raised in Congress, DOD, and industry is the amount of money earmarked by Congress for integration. Representative George Brown has noted that $103.8 million of the $474 million appropriated for dual-use technology for fiscal year 1994 (22 percent) was earmarked.[43] Representative Brown stated that $145.6 million of the $377-million conversion fund appropriated in the Operations and Maintenance accounts was earmarked as well. Those concerned about earmarking claim that the loss of financial flexibility will make development of a coherent integration program much more difficult, Certainly, such mandates have sometimes limited DOD flexibility to make economically sound choices. Representative Brown pointed out that earmarks make it difficult to follow the law mandating competition in spending of government funds for TRP.

Final] y, the government does not al ways appear to be of one mind about various measures aimed at increasing industrial sector-level process integration. Rationalization and consolidation between the private and public elements of DTIB are important. Yet the Services disagree about the extent to which commercial firms can meet maintenance needs. While the Navy is reportedly willing to make maximum use of industry's production capabilities and capacity for aviation depot-level maintenance, the Air Force has been far less enthusiastic about reducing the size of its depot system.

Given the large numbers of high-paying jobs at government facilities, Congress has been reluctant to rationalize R&D and maintenance bases, Retaining some inhouse capability is extremely important to guide technology developments in ways that are most helpful to operational commanders. These issues are discussed in more detail in chapter 6.

Process Integration at the Firm Level

Firm-level integration—the sharing of corporate resources (management, finances, possibly R&D) across divisional lines—is primarily a private-sector issue. There are public-sector organizations that engage in both defense and commercial activities (e.g., the DOE weapons laboratories): these were discussed under industrial sector-level integration. In the context of this discussion, an integrated firm is one that continues to do both defense unique and commercial business—but chooses to use separate divisions and facilities.

It maybe to the government interest for firms to integrate internally (e.g., go to facility-level integration). in order to reap the maximum benefit from shared resources. But the government cannot mandate such integration, nor. except in crisis and

[42] Supporter\ of inhouse capabilities note, however, that the Japanese have not yet had to battle test their equipment.

[43] "Pet Projects Endure at Defense Despite Opposition by Brown, " *Federal Technology Repot-t,* Nov. 25.1993, TRP supporters have argued that despite attempted earmarking, competition has governed project selection.

war, can it compel the use of private capabilities to perform defense work. It can, however, influence integration by removing some of the acquisition barriers outlined in this chapter. Still, as long as businesses fear that their commercial activities may be forced to carry burdens from defense work, they will choose to separate their activities. Retention of special government cost accounting, for example, even with the elimination of the use of many military specifications and standards and the elimination of rights in technical data requirements, is likely to result in retention of separated facilities.

Integration at the firm level, however, offers benefits to the government. Most importantly, it may allow the government to retain world class commercial firms in defense business--even if these firms separate those defense divisions from their commercial operations. Firms doing both defense and commercial business have access to, and might continue to develop, dual-use technology. The past view that integration at the firm level is a problem, and unacceptable, appears less valid now than during the Cold War. In the future, it will be a challenge to keep internationally competitive commercial firms involved in defense work. Certainly, the trends are toward consolidation and specialization—potentially increasing technological and industrial segregation just when access to commercial technology is most critical.

An integrated firm has advantages over a segregated defense producer. A recent study on dual-use technology indicated that firms doing both defense and commercial work may facilitate technology transfer through a policy of transferring personnel between their defense and nondefense operations, or at least not prohibiting such movement. The study found indications that between 1982 and 1986, about 24 percent of the scientists and engineers working on defense moved from defense to nondefense work, and about 27 percent moved in the opposite direction.[44] Personnel movement can increase the flow of information and technology, even if facilities themselves are segregated.

The main benefits of process integration at the firm level are: 1) preservation of a viable base, 2) stronger and more competitive firms involved in defense work, and 3) greater technology transfer—both spin-off and spin-on.

The elimination or reduction of current procurement barriers might persuade firms to adopt, or continue to pursue, a firm-level integrated strategy. Changing the rules on rights in technical data would eliminate the disincentives to incorporate commercial, company-developed technology (product or process) into defense products. Eliminating the use of many military specification and standards will move more components into the commercial category. Dropping the requirement for costs and pricing information on commercial products will promote the use of components from a firm's commercial division.

While firm-level integration may produce fewer directly measurable benefits than might facility-level integration (e.g., savings on individual products), it appears preferable to relying on totally segregated firms to conduct defense manufacturing, since the latter may have less access to commercial technology. Profitability and access to technology are incentives for integration. Government policies to promote firm-level integration will have to address these incentives. Even in the absence of radical acquisition reform that would promote facility-level integration, firms might still undertake defense work if such work allows them to leverage their technology, personnel, and assets; acquire new technology; and diversify into other areas.

Defense work will have to be profitable, or, if access to novel technology is available, at least not lose money. A strong advanced technology development program may entice some firms, particularly in sectors amenable to integration, such as

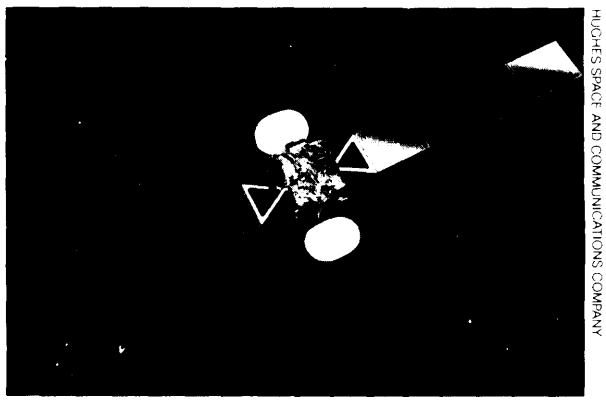
[44] Alicetal., *Beyond Spinoff*, op.cit., footnote 23, pp. 112-113. According to the report, indirect evidence indicated that most of this movement occurred within firms with both defense and nondefense divisions.

aviation and electronics. In more mundane production sectors, contracts will have to be of sufficient size to attract the interest of a firm that also engages in commercial operations. Multiyear contracting and government use of more commercial buying practices may also provide incentives for engaging in defense activity at the firm level. DOD use of commercial specifications and standards, or military performance specifications, may provide some incentives to pursue defense work even if acquisition rules continue to result in segregated activities.

Leveraging technology is especially attractive to firms in technologically intensive industrial sectors. Indeed, a Harvard study indicated that some firms have actively sought both defense and commercial business in order to fully exploit their competitive advantages. Thus, in the aerospace industry, many firms "(notably Boeing in aircraft, GE and Pratt & Whitney in engines, Hughes in satellites) have been able to specialize their design, marketing, and management for each market [commercial and defense] while leveraging a substantially common technology base."[45]

Similarly, communications satellite producers have leveraged technology. Westinghouse Corp. has reported leveraging the technology and expertise gained from decades of defense work to develop products such as a Modular Avionics Radar (MODAR), a dual-use product designed for look-ahead detection and avoidance of wind shear.[46]

Studies indicate that the incentives for sharing technology, labor, and equipment within a firm vary. Firms with large commercial sales relative to their defense sales may have little interest in increasing defense sales, especially if defense sales volume is uncertain, profit is low, and there are few if any potential technology benefits. In the absence of changes in the government's approach to rights in technical data, integrated firms will be cautious about sharing technologies between divisions. The OTA assessment team found a number of instances in which a firm's commercial division refused to supply technology to its defense division because of government demands for rights in technical data and for cost and pricing data.



Firm-level integration allows *Hughes to leverage corporate resources, benefiting both its defense* and commercial *satellites.*

One firm, for example, reported a case in which its corporate parent decided it could not risk disclosing the results of millions of dollars of commercial, company-financed research for a relatively small government development contract whose terms included a demand for the technology used in the item. Therefore, instead of using the advanced technology available in the parent corporation, the division searched out a small firm with similar, but less advanced, technology to support its research effort. The corporate parent of that defense division is now considering getting out of defense work altogether.

Acquiring new technologies and processes to allow a firm to better meet current or future needs has been another reason for corporations to integrate. The General Motors Corp. 's purchase of Hughes Aerospace might fall under this category. Firms might still stay in defense work if they deem the work to have sufficient overlap with other corporate objectives. A strong DOD research emphasis on dual-use products might attract such firms.

[45] Alic et al., *Beyond Spinoff*, op. cit., footnote 23, p.188.

[46] Hughes, op. cit., *Making Dual-Use Technologies Work*, footnote 22

Finally, firms may integrate to **diversify the portfolio of their capabilities and subsidiaries.** Corporate diversification was a major business strategy during the sixties, seventies, and early eighties, but was called into question during the mid- to late- 1980s as U.S. firms lost global market share-partly because of loss of quality in many firms' critical core areas. Studies indicate that successful corporate diversification involves an effort to retain and use a common core of interests and capabilities rather than develop entirely new ones.[47] If DOD is going to retain high-quality firms as defense suppliers, it will need to seek synergistic ways to exploit and enhance the core capabilities of these firms.

The Benefits and Costs of Firm-Level Process Integration Policies

As discussed earlier, during the Cold War when U.S. defense budgets were high, concern over civil-military integration largely focused on integrating facilities. Integrated firms-those with both civilian and defense divisions—were common. Proponents of integration sought to reduce the acquisition barriers that they identified as contributing to segregation within a firm and subsequent increased costs resulting from redundancies in facilities, workforce, etc. Yet there were benefits derived from integration at the firm level, internal transfer of technology probably being one of the most important.

The future defense situation is likely to be even more fiscally challenging than CMI proponents have previously anticipated. Under these circumstances, the government may well lose the services of many firms. The principal benefit to be derived from retaining integrated firms (e.g., retaining as much of the segregated portion of the future DTIB as possible within commercial firms) may not be cost savings, but the potential for shared technology between divisions within firms. Firms may transfer personnel (or allow the transfer of personnel) between defense and nondefense work and thus promote both spin-on and spin-off technology transfer. This is critical if DOD is to rely more on commercial technology in the future. Such firms may also integrate some critical activities—possibly having a combined R&D facility—while separating the remainder.

While the chief benefit is the potential retention of quality firms doing defense business, there are also risks. One risk is that specialized defense capabilities might atrophy if too much emphasis is placed on shared (i.e., commercial) technologies. Electronic warfare systems, for example, may use many technologies similar to other commercial electronic systems, but still require a set of specialized skills (an up-to-date understanding of the electronic threat) that demands full-time attention and does not overlap with the commercial base.

An integrated firm also faces risks to critical commercially developed technology if reforms dealing with rights in technical data have not been achieved. Indeed, retention of any acquisition rules that make the defense divisions of firms operate differently than the commercial division is likely to increase costs and reduce the benefits of firm-level integration.

Process Integration at the Facility Level

Almost all previous studies on CMI have focused on integration at the facility level .48 Facility-level process integration is a special case of firm-level integration, in which the integration occurs within a single facility (e.g., on the same factory floor, on a single assembly line). Such integration involves the sharing of personnel, equipment, facilities, and material to research, design, produce, and maintain defense and commercial goods, or to provide defense and commercial services. While

[47] David Leech *Patterns of Diversification: An Annex to the Report of the Defense Conversion Commission*, February 1993. See also Alic et al., *Beyond Spinoff*, op. cit., footnote 23, pp. 174-186.

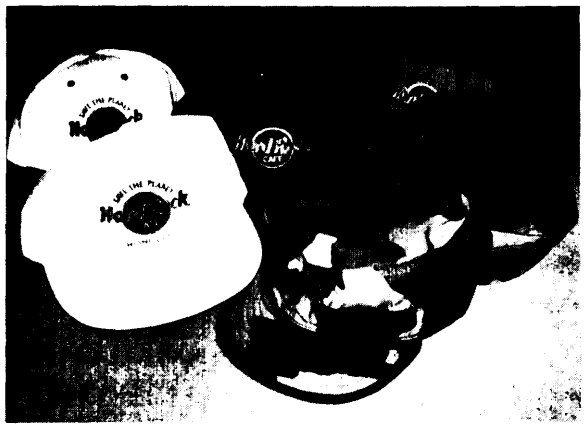
[48] The Report of the DSB Task Force on *Acquisition Reform* is an exception in including the potential impact Of rationalization of the private and public sectors.

the greatest benefits of process integration, in terms of savings and potential for technology transfer, may be found at the facility level, the acquisition changes required to achieve such integration may be among the most difficult to achieve. There are technical barriers to facility level integration (unique products and processes, classified technologies), but the principal barriers appear to be the acquisition laws and regulations that have been constructed to protect public funds. It is at the facility level that military operations and standards, government cost-accounting rules, rights in technical data, and other roles have had their full effect.[49]

Process integration at the facility level is expected to eliminate redundancies in equipment and personnel. Machinery, tools, personnel, management resources, buildings, etc., can all be used more efficiently if they can be employed for both commercial and defense ends.

The fungibility of a firm's assets and the similarity of its defense and commercial products and/or services affect the company ability to conduct defense and commercial work side-by-side. The case studies examined for this assessment, as well as OTA's industry interviews, confirm that the flexibility to work in both the commercial and the defense sectors is currently more prevalent among firms at lower tiers, among firms producing components and materials, and where the process and product technologies are largely common and government regulations are often felt only indirectly.[50]

OTA found that many facilities manufacturing military parts, subcomponents, and materials, for example, operate within more or less integrated manufacturing facilities. Such facilities include those that supply metal sealing material, silicone, dopants and wiring for defense electronics, glass for optical systems, chemicals for explosives, and certain resins for plastics.



ATLAS HEADWARE/DLA

Atlas Headware has completely integrated its production of military and commercial caps

"Higher order" defense-related components and systems, such as hydraulic systems, various valve assemblies, hoist systems, certain aircraft engines, computers, fiber optics components, and gyros and other navigation devices, may be manufactured in integrated facilities. That they are not, however, appears to be due at least in part to the imposition of the special accounting requirements, unique contract requirements, demands for technical data rights, etc., that have been so often identified as barriers to integration. As a result, the firms interviewed reported that there are often substantial inefficiencies. due to the need to maintain additional workers and resources in order to comply with these requirements.

Current Facility-Level Integration Efforts

Many of the ongoing efforts to increase facility-level process integration have been discussed ear-

49 The conclusion that acquisition barriers rather than technical barriers are the problem has been a consistent conclusion of studies such as the 199 I CSIS Study on Civil-Military Integration, the subsequent CSIS survey of 206 firms, and a study by the Electronic Industries Association, "Dual-Use in Government Electronics: Outlook for Commercial/Military Integration," which surveyed *33* firms in 1993.

5(1 The data base for this conclusion includes the assessment case studies, interviews with firms in 10 different industrial sectors, discussions at the manufacturing workshop, and analysis of the findings of previous CMI studies.

lier in this chapter. Changes in the law that allow companies to use IR&D funds to conduct R&D with commercial (as well as defense) potential, for example, have enhanced the ability of defense firms to perform dual-use R&D. Several of the firms visited by OTA were actively pursuing commercial possibilities using technologies originally developed for military application. Some of the firms visited by OTA combined their R&D operations, even though they maintained separate manufacturing processes. The Honeywell Corp., for example, maintains an integrated R&D Center of Excellence for its avionics work, but separates the defense and commercial manufacturing activities of these items. The changes in the use of military specifications and standards announced by Secretary of Defense Perry will surely affect facility-level process integration as well as increase the purchase of commercial items.[51]

Several firms interviewed were also involved in TRP projects. Some of the work is being done in integrated facilities, but in some cases the firms were planning to separate future commercial and defense operations.

Despite the changes being implemented, concerns over government oversight, the possible loss of proprietary data, and cost-accounting requirements continue to pose real barriers to integrating defense and commercial activities in a single facility. According to industry, the most important changes are eliminating the unique government cost-accounting requirements that result in separate cost accounting systems and layers of oversight, and the supporting certification process.

Concern over the rights in technical data remains very important not only in R&D but in manufacturing, where there is particular concern about the potential for loss of process technology should the government ask for that technology.

The changes in military specifications and standards recently proposed by DOD are critical, because they will promote the ability to design for dual use. It has repeatedly been argued that taking better advantage of commercial specifications and standards could save money and result in better products. The 60 percent savings that Westinghouse Corp. reported for its dual-use Modular Avionics Radar, compared to the militarily unique version is said to have come partly from waivers on military specifications and partly from initially designing for dual-use.

Future Efforts

Acquisition reform that addresses government accounting rules for integrated facilities may be difficult to implement. Executives attending the OTA manufacturing workshop stated that accounting procedures explain 90 percent of the reason for separation within their firms. The respondents to the CSIS industry survey also placed government cost accounting high on the list of reasons for segregating their defense operations. Many firms in the CSIS survey, principally aerospace and electronics manufacturing firms, had integrated portions of their operations but maintained two administrative systems for accounting purposes. The costs of such partial integration cannot be inconsequential.

One possible alternative would be facility exemptions from special government cost accounting requirements. Otherwise, firms producing both militarily unique and commercial products will have to retain an accounting system for its militarily unique items and spread the cost of that system over its commercial products, and thus become noncompetitive. Some firms believe that activity-based accounting holds the promise of providing a solution to this seeming impasse.

Secretary of Defense Perry has begun the changes on military specifications and standards, but these changes must be implemented by a sometimes reluctant acquisition workforce. To

51 Secretary of Defense William Perry, *Memorandum for the Secretaries of the Military Departments, op. cit.,* footnote 16.

promote integrated facilities, DOD must ensure that the three Services reconcile their own individual standards so that industry does not continue to be faced with special, and often conflicting, Service requirements for similar items.

Revision of the acquisition laws and regulations is necessary but insufficient to implementing acquisition reform that will allow integrated facilities. There must also be changes in the procurement culture—for example, eliminating outmoded government quality control procedures in favor of those used in the commercial world; eliminating the adversarial relationship that has characterized some contract and plant oversight; and retraining the government workforce so that they are able to effectively operate in this new environment. Integrated circuits or advanced materials, for example, may be differentiated by additional quality control checks, rather than different materials. The Hughes satellite system, with its modular design, embodies another possible approach to the problem, allowing different satellites, with different capabilities, to be built on a single "chassis." (See box **5-8.)**

The requirement that a facility be able to produce at a specified surge and mobilization level, combined with the extreme variation of defense contracts, has resulted in an overcapacity maintained by firms. This added overhead inhibits facility integration. Companies making private investments in commercial facilities that have payback periods of several years are unlikely to put defense and commercial work in the same facility and risk transferring underfunded government overhead costs to commercial production.

Multiyear defense contracting can help reduce the uncertainty of government funding, but the greatest potential benefits might come from a recognition on the part of government that DOD must pay to maintain surge capability for defense manufacturing. This now occurs with government-owned and contractor-operated (GOCO) ammunition facilities and is more of a problem at the prime contract level than at the lower tiers.

Some small firms trying to integrate commercial and defense work have raised the issue of insufficient financial support for commercial work. Many firms traditionally dependent on defense progress payments have not developed sufficient commercial lines-of-credit to finance investment in commercial programs. Banks are reluctant to loan money to small defense firms. One suggestion is that government funds be made available in the form of loan guarantees to support the commercial operations of small firms. However, while there is evidence that lack of funds is a problem with some firms and possibly some locations (e.g., Long Island, southern California), a recent survey by the Logistics Management Institute found that lack of capital is not a universal problem.[52] More data need to be collected to inform policy development here.

The opportunities for process integration in the **maintenance** base parallel those found in manufacturing, since items built on the same line should lend themselves to common maintenance procedures. But government procurement rules—especially cost accounting requirements—are a critical barrier. Facility exemptions would be helpful. But even more important might be the rationalization of the public and private maintenance bases. This is discussed in chapter 6.

Finally, **services** other than R&D (e.g., engineering, telecommunications, construction, and private security) may be the easiest segment to integrate if the defense and commercial work are related sufficiently and the problems of dealing with DOD regulations (including security) do not prevent the workforce from working on both defense and commercial projects. But chapter 4 noted that services appear relatively easy to commercialize,

[52] The LMI survey went to 1,217 randomly selected small contractors (chosen from among businesses having a prime DOD contract between fiscal years 1980 and 1992). LMI qualifies their results by noting that the total number of firms doing only subcontracting could be large compared to those with a prime contract. Still, 72 percent reported that lack of capital had not hindered conversion.

BOX 5-8: Designing for Dual-Use

Advocates of greater CMI argue that the real "key to commercial-military integration is designing for dual-use."[1] Weapons and other DOD equipment would be designed from the outset to incorporate commercial rather than militarily unique technologies.[2] Cost and manufacturability would be included in the design process as critical considerations. Advocates have argued that a dual-use strategy would require that "the DOD product will fit the parameters established by the supplier for flexible manufacturing, The products must have similar processes, use standard parts, employ identical Information systems, and require consistent manufacturing administrative practices."[3] Thus, the concept of designing for process integration from the start is essential.

When establishing requirements, DOD should take into account commercial developments in the relevant technological sectors. This would exploit not only the latest technologies, but also technologies that appear to be in the mainstream--rather than developing entirely new technologies.

Implementing such a strategy will require that DOD have trained personnel who keep abreast of technological developments, Moreover, DOD will need to consider the manufacturability of components in the process of setting requirements. It will also require more dialogue with industry in developing industry specifications and standards, as well as its own performance specifications.

Designing for dual-use may ease the integration of maintenance facilities significantly, since they will essentially be supporting the same goods.

Hughes Aircraft has reportedly followed a successful dual-use, or multi-use, design strategy in its satellite communications business using many common components on both its defense and commercial satellites.[4] The Hughes strategy was facilitated by the fact that defense and commercial communications satellites have many similar requirements. A critical aspect to the success of Hughes' communications satellites revolved not only the ability to design for dual use, but the ability to develop a "product line" of satellites that can accommodate several needs with minor modifications, rather than to focus on an individual program for each satellite, as has characterized much of past DOD acquisition strategy.[5] Advocates of a dual-use strategy argue that a "product line" approach is mandatory. But pursuing this type of strategy will require changes in the program specific way in which DOD organizes its funding and Congress oversees it.

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1 Richard Engwall, briefing on Designing for Dual-Use Electronics, Westinghouse Electric Corp

2 Ibid The Electronics industries Association dual-use technology study estimates that "85 PerCent of product life cycle cost is 'locked in in the original systems engineering design approach "

3 Office of the Under Secretary of Defense for Acquisition, Defense Science Board Task Force Report, *Engineering in (he Manufacturing Process,* Aug 21, 1992, ch 3, p 7

4 John A Alic et al , Beyond *spinoff* *Military and Commercial Technologies in a Changing World* (Boston, MA Harvard Business School Press, 1992), pp 179-180

5 Engwall, Op cit , footnote 1

perhaps leading to a situation where services are bought from either commercial or segregated entities, but not those in between.

Benefits and Costs of Facility-Level Process Integration Policies

There have been numerous attempts to quantify the potential benefits of facility-level integration. There is considerable evidence that there are cost savings to be derived from facility-level integration and that such integration will probably enhance technology transfer. But estimates of the amount of potential savings are largely based on extrapolation from findings of individual case studies.

Previous case studies reviewed for this assessment, for example, provided estimates of savings on individual items of equipment resulting from integrating R&D and manufacturing processes ranging from 20 percent to as high as 60 percent .[53] Case studies reported in the 1991 CSIS study on CMI provided estimates of about 25 percent savings from integration of the production process. The Process Action Team on Military Specifications and Standards estimated that some $550 million might be saved over a period of two years if many of the military specifications and standards were eliminated.

Most previous estimates are made on the basis of examination of portions of the DTIB. The 1994 DSB Task Force on *Defense Acquisition Reform* looked at the entire base and estimated that in general, savings from integrating the production processes of defense systems might range from 10 to 25 percent. Further, the Task Force attempted to estimate the amount of savings that would occur after a five-year implementation period.[54]

Table 5-4 illustrates a range of potential cost savings in the private portion of the DTIB derived from implementing the process integration policy options discussed in this chapter. These estimates are based on data from OTA's industry survey, and include only facility-level integration, excluding any savings from sector- or firm-level integration.

Because the policy options for increasing process integration affect a relatively small portion of national defense spending—a 15-percent increase estimated in our survey-the net savings from process integration will be relatively small. Cost savings derived from potential savings of O to 30 percent might range from O to 5 percent of total national defense spending in the private sector. Although smaller than sometimes considered. these savings are still significant.

Additional savings might, of course, accrue from industrial sector-level integration that involved reduction of any duplication between the private and public sectors, and closing redundant facilities. These savings have been estimated to be several bill ion per year, depending on the amount of estimated reduction.

TABLE 5-4: Budgetary Impact of Increased Facility-Level Process Integration[a]

Estimated average savings	Impact on total private DTIB budget
0%	0%
5 %	1 %
10%	2%
15%	2 %
20%	3 %
25 %	4 %
30 %	5 %

[a]Based on OTA's industrial sector survey and a shift of 15 percent from segregated to Integrated for a total of about 30 percent in the integrated category

While savings are important, in the longer term, increased technology transfer between the defense and commercial bases may be the greatest benefit derived from integration of processes. The increase in technology transfer may occur within a single facility—but it will also come from the activities, such as consortium and TRP research activities, at the sector and firm level described in this chapter. Developing a method to track projects and their results is an important step necessary to support government initiatives at these levels. The metrics outlined in this chapter might be considered.

The benefits of these policy changes will not be immediate. Actual savings from changes in military specifications and standards depend not on changing the rules but on making new purchases of commodities, components, or new systems. Savings from changes in cost accounting requirements will come from oversight jobs eliminated.

[53] The Modular Avionics Radar developed by Westinghouse uses all commercial parts but was built in facilities primarily used to support DOD. The radar costs 60 percent less than a comparable defense radar. and was developed in 50 percent of the time.

[54] Defense Science Board Task Force, *Defense Acquisition Reform*, *Op.* cit.. footnote 7, p. C-8.

facilities consolidated, etc. Significant savings might begin appearing in three to five years. Access to new technology is unlikely to be any quicker. The possible time phasing of benefits is considered in the discussion of alternative integration strategies in chapter 2.

Costs of increasing process integration include: training of government and private sector personnel to operate in a new quality environment, training in examining alternative technologies, and costs of implementing different cost accounting procedures. There would also be expenses associated with closing any government facilities and eliminating jobs.

There are also risks involved in implementing policies that enhance facility-level integration. One of the most often mentioned is concern over the possibility of increased waste, fraud, and abuse, as a result of any change in cost accounting requirements at a facility.[55]

Concerns include the possibility of unfair allocation of costs towards the government. The R&D necessary for a dual-use product, for example, could be charged against the government's accounts, rather than against a corporation's commercial activities (although fixed-price R&D contracts may well resolve that issue). Similarly, costs associated with the construction of production facilities, tooling, etc. might also be allocated against DOD, rather than against the commercial consumers. In particular, in the absence of current, relatively strict accounting requirements, and without a commercial market for the militarily unique products produced in a facility, there are questions raised about how actual costs would be determined.

Government agencies report the overall amount of questionable contractor billing, but the OTA assessment team could find no good studies on the costs of the current regulatory system, nor comparative studies of alternative oversight structures. It has been suggested that the amounts saved by the current U.S. system may well be less than the costs generated in the system as a result of actions to prevent and prosecute identified abuses. Critics do not advocate overlooking abuses, but rather argue that most of these abuses can be identified in other, less intrusive ways.

Quality control is another concern. Critics note that as a result of the elimination of military specifications and standards, knowingly or unknowingly, substandard parts and components may be used, possibly due to lower quality control standards imposed by the commercial sector. There have been several reports in recent years, for example, of the proliferation of counterfeit, substandard fasteners in various commercial processes, including those within the aircraft industry. Process integration and the use of commercial items might make DOD more susceptible to these problems.

There is also the possibility of proliferation of advanced weapons technologies to other nations. To the extent that integration and commercialization are successful, American exports of manufacturing processes and technologies common to both commercial and military products may spread military technologies to other parties.

SUMMARY

There is potential for increased process integration with potential cost savings and increased technology transfer. Savings resulting from integration in the private sector ranging from 1 to 5 percent of future DTIB spending do not appear unreasonable. The full impact of these savings will not be realized for several years.

The greatest potential benefit of increased process integration may not be cost savings, however, but rather the potential for technology transfer. Future defense design and engineering teams will be more dependent on developments in fast moving commercial sectors, such as software and electronics. Integration at all three levels might enhance defense access to technology,

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[55] For example, "Congress To Consider Acquisition Pilot Efforts Next Month," *Defense Daily*, Dec. 9, 1993, p. 353.

Congress has played a critical role in developing the current process integration policies aimed at technology development and diffusion. These policies may be extremely important in the long term, but Congress may want to consider the development of measures to evaluate and compare the returns on investments for efforts such as the TRP, CRADAs, and other activities. Future metrics need to be output-oriented, rather than measuring input activities, as is often done today.

At the industrial sector level, process integration also requires rationalization of public and private capabilities, and increased defense access to commercial technology. Rationalization of the public and private R&D and maintenance facilities, discussed in more detail in chapter 6, might provide the most significant near-term returns, but is also likely to face the greatest opposition. Congress will need to consider the rationalization of the DTIB and the closing of facilities, if significant savings are to be achieved.

Process integration at the firm-level is designed to retain world class product development and manufacturing firms in defense work. This is important, even if the defense operations in those firms remain separated. Defense work will have to be made sufficiently attractive, either by profitability or by research, development, and testing in new technologies and ideas. Advanced Technology Demonstrators may provide a means to keep firms technologically engaged. Congress will need to be supportive of long-term technology programs that may produce few immediate results.

Process integration at the facility level depends not only on actions directed at the sector and firm that produce common technologies, but also on substantial acquisition reform. Only by altering the current government cost accounting requirements, modifying demands for rights in technical data, and minimizing the use of military specifications and unique contracting requirements will the full benefits of designing for dual-use be likely to accrue.

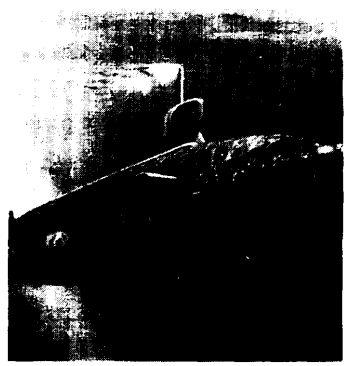
Continued Segregation 6

The future size and character of the segregated portion of the defense technology and industrial base (DTIB) will depend largely on the degree to which policy options discussed in chapters 4 and 5 are implemented. Even with dramatic changes in defense acquisition laws and regulations, however, a significant portion of the DTIB will continue to be segregated from the Commercial Technology and Industrial Base (CTIB). This segregated portion will include activities providing goods and services that: 1) have no commercial counterpart, 2) largely use noncommercial processes, and 3) involve highly classified and controlled technologies and weapon systems.

Secretary of Defense Perry has stated that the government must plan to preserve certain militarily unique capabilities. The Secretary and others have suggested that this might include shipyards that build nuclear submarines and aircraft carriers, production plants for tanks and other armored vehicles, facilities that design and produce high-performance fighter aircraft and bombers, ammunition plants, and nuclear weapons facilities.[1]

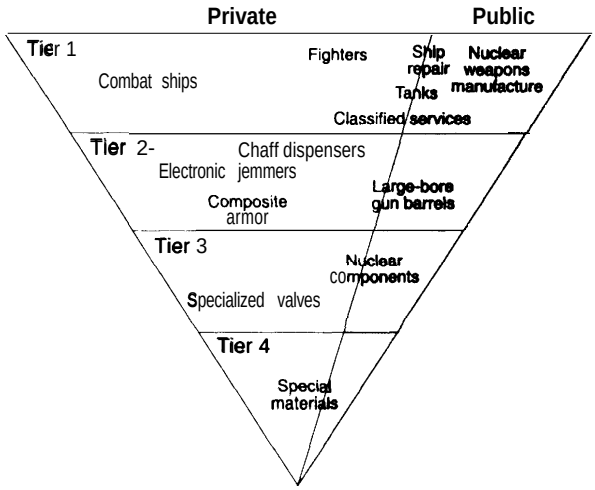
The future segregated portion of the DTIB will also likely include divisions of private firms or small vendors that develop and manufacture militarily unique subsystems, components, and materials that go into larger systems.

The portion of the DTIB that resides in public facilities is segregated by definition. These public sector facilities include military



[1] See, for example, Office of the Under Secretary of Defense for Acquisition, Defense Science Board repon on *Defense Acquisition Reform,* June 1993; and Anthony L. Velocci, Jr.. "Perry Forges New Shape for Industry," *Aviation Week& Space Technology), Nov. 15, 1993,* pp. 52-57.

FIGURE 6-1: The Segregated DTIB



SOURCE Off Ice of Technology Assessment, 1994.

depots, arsenals, Navy shipyards, and defense research, development, and testing facilities.

Although civil-military integration (CMI) is at odds with the preservation of the critical military technologies in the segregated portion of the DTIB, it can still have a positive effect on management efficiency, and promote cost reduction and technology transfer.

This chapter considers the size and nature of the future segregated portion of the DTIB—analyzes CMI policies that might increase management efficiency within the segregated DTIB, reduce costs, and promote process and product technology transfer with the CTIB.

THE CURRENT AND FUTURE DEGREE OF SEGREGATION

A substantial amount of the DTIB is currently segregated from the CTIB. Some of the segregation is the result of acquisition laws and regulations developed during the Cold War. But substantial segregation results from decisions to establish a public sector capability to fulfill some DTIB missions. The Services, for example, have an array of government laboratories to develop military technology, specialized plants to produce ammunition and military equipment, and a network of depot-level facilities to conduct maintenance and repair.

This section describes the segregated portion of the DTIB. It provides an estimate of its current and potential size, and briefly discusses trends affecting this portion of the base.

Description of Segregated Portion of the DTIB

Like the bulk of the DTIB, most of the segregated DTIB is in the private sector. Much of the current segregation in the private sector occurs at the highest tiers of industry, including the major systems integrators who conduct the research and development on complex weapons systems, perform the final assembly of those weapon systems, or produce other militarily unique items. (See figure 6-1.)

For example, as a result of the almost total collapse of the U.S. commercial shipbuilding industry, large naval vessels are built for the most part in segregated private-sector facilities. High-performance fighter aircraft and armored vehicles are also assembled in segregated, private-sector facilities dedicated to the production of these specialized systems. The activities in these facilities may account for 30 to 50 percent or more of the total value added in a large weapon system. (See table 6-1 .)

A great deal of anecdotal evidence suggests that some segregation exists at the lower industrial tiers. OTA interviewed firms in the gear, electronics, aircraft parts, and power systems industrial sectors. OTA found that as a result of defense acquisition laws and regulations, firms often produced military and commercial components in separate facilities even though the components were similar.

Segregation can take a variety of forms. Some firms may concentrate their defense production on a dedicated line, separated from their commercial operations. These same firms may also maintain special parts tracking (including maintaining sep-

TABLE 6-1: Estimated Value-Added by the Prime Contractor for Selected Weapons Systems*

Naval ships	35- 40%
Fighter aircraft	40- 50%
Combat helicopters	40- 50%
Armored vehicles	>50%

'Estimates exclude the government-furnished equipment supplied to the contractor

SOURCE Off Ice of Technology Assessment, 1994

arate capabilities for government parts even though these are the same as the commercial parts) to ensure cost accountability.[2]

Although most of the DTIB is in the private sector, public sector activities in R&D, testing, manufacturing, maintenance, and other services are extensive and, by definition, segregated from the CTIB. The total number of government employees involved in these activities is estimated to be about 369,000 people. (See table 6-2.) In some cases, these government facilities provide unique capabilities. In other cases, they duplicate private-sector capabilities.

The degree of actual government involvement in these activities varies. There are two types of government ownership structures: government-owned/government-operated (GOGO) and government-owned/contractor-operated (GOCO).

The government directly controls GOGO facilities. and the workforce is composed of government employees. GOGO facilities include Service R&D laboratories, Service maintenance depots, air logistics centers, shipyards, and manufacturing facilities, such as Watervliet Arsenal (which makes large caliber gun tubes) and the Rock Island Arsenal (which makes portions of large caliber guns and repairs military equipment).

As a group, the current GOGO facilities are oriented toward the development, production, and testing of specialized military systems or their repair and maintenance. The complex is inefficiently structured, large, and expensive to maintain. The public sector depot-level maintenance system, for example, employs about 181,000 personnel, and billions of dollars are invested in physical plants. On an annual basis, this complex may cost in excess of $5.5 billion in government salaries and several hundred million dollars in infrastructure upkeep costs.[3]

TABLE 6-2: Number of Employees in Government RDT&E, Manufacturing and Maintenance*

DOD RDT&E	
Army	33,000
Navy	68,000
Air Force	20,000
DLA	17,000
Total	138,000
DOE Weapons RDT&E and Production**	
DOE RDT&E	8,000
Production	42,000
Total	50,000
DOD Depot Level Maintenance	
Army	18,000
Navy/USMC	86,000
Air Force	36,000
DLA/Depot	41,000
Total	181,000
Total	369,000

'Rounded to nearest thousand

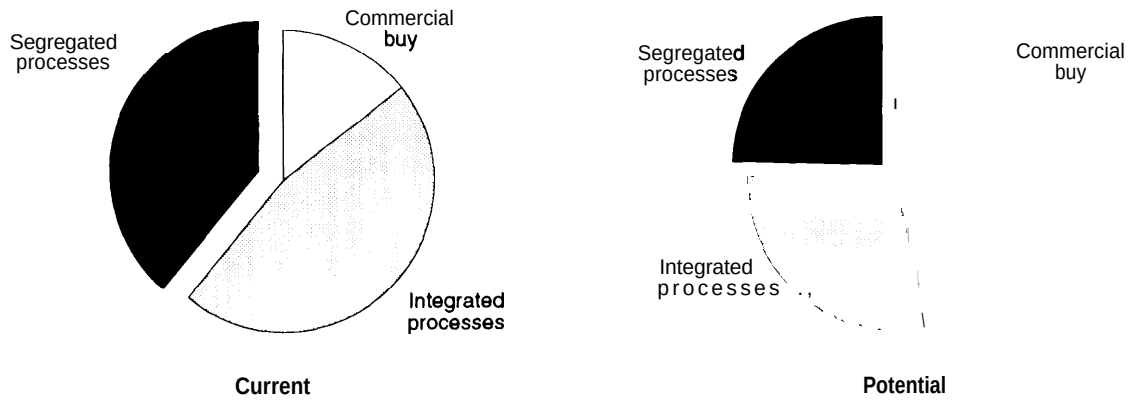
*' Personnel costs here are largely contained in the private sector DTIB totals

SOURCE Off Ice of Technology Assessment, 1994 from Information furnished by OSD, DLA, DOE, and the Military Services

[2] In this situation there is not only a cost for developing and using the accounting systems but also a cost for maintaining a larger inventory because parts cannot be transferred between programs as needed.

[3] *The Defense Science Board Tusk Force on Depot Maintenance Management,* April 1994, repented that "an organic depot with several thousand employees incurs fixed overhead costs in the range of $50 to $100 million annually," p. 17; also see U.S. Congress, Office of Technology Assessment, *Building Future Security: Strategies for Restructuring (he Defense Technology and Industrial Base,* OTA-I *SC-520 @lash* ington, DC: U.S. Government Printing Office, June 1992), pp. 131-132.

FIGURE 6-2: OTA Estimates of Current and Potential National Defense Spending at All Tiers on Private Goods and Services from the Segregated DTIB



SOURCE Industrial survey conducted by the Off Ice of Technology Assessment, 1994

GOCO facilities involve less government control. While the government owns and maintains these facilities, private sector contractors operate them. For example, private firms operating GOCO facilities usually perform the final assembly of conventional artillery rounds. The Department of Energy (DOE) weapon laboratories are operated and managed by the private sector or by a nonfederal government entity. For example, the Martin Marietta Corp. manages Sandia and Oak Ridge National Laboratories, and the University of California manages Los Alamos and Lawrence Livermore National Laboratories. Many of the DOE production facilities are also GOCOs.

OTA Estimates

OTA's industrial sector survey suggested that about 40 percent of the value added to defense goods and services is accomplished in segregated private sector facilities or operations. (See figure **6-2,** left.) This estimate includes direct and indirect purchases of goods and services, thus reflecting activities in all industrial tiers.

The OTA industrial sector survey asked respondents to estimate the percentage of their sectors that are likely to remain segregated even after significant procurement reform (i.e., implementation of policies like those discussed in chapters 4 and 5). Survey results indicated that about 25 percent of the private sector value added might still come from segregated facilities (figure 6-2, right)—about two-thirds of its present size.

This estimate does not include the value added in the public sector DTIB. OTA estimates that about $13 billion is spent on salaries for government employees in largely segregated public-sector facilities.[4]

The policies in this chapter address both the private portion of the DTIB that is likely to remain segregated in the future and the public sector portion of the DTIB.

Relevant Trends

A number of trends will affect the segregated portion of the base. The most important is the ongoing reduction in defense budgets. This spending

[4] Uses a $40,000/year average compensation level provided by the DOD comptroller.

cut is driving a second trend—the consolidation and rationalization occurring in both the private and public sectors of the DTIB. A third trend encompasses the advances occurring in product and process design and development. Increased centralization of planning in DTIB management is the fourth and final trend.

Effects of Falling Budgets

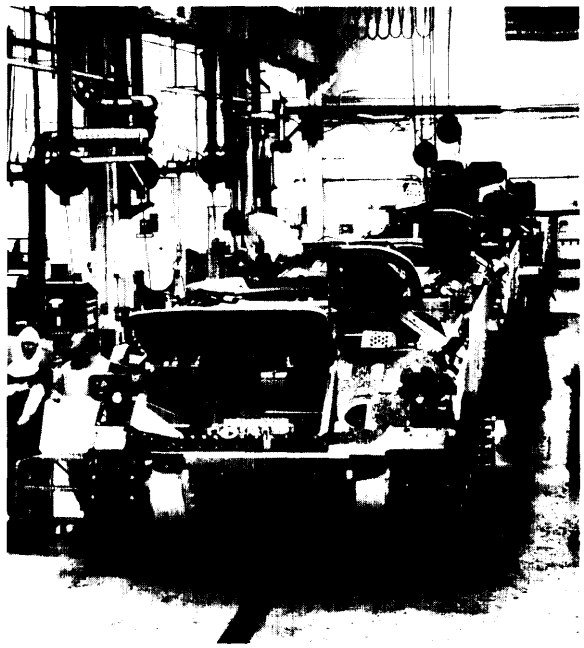
In real terms. defense procurement fell 66 percent between fiscal years 1985 and 1994, including a 51 percent drop between fiscal years 1990 and 1994 alone.[5] R&D fell by 15 percent during that latter period. Procurement of fewer major weapon systems has been a factor in driving up unit costs and driving down the number of vendors willing or able to compete for fewer total defense dollars.

As the number of potential vendors for an item decreases to the point where only one source exists, or the production volume becomes uneconomical, the prospect for using competition to assist in establishing price information begins to disappear. The Department of Defense (DOD) is then faced with maintaining controls over that portion of the DTIB, thus ensuring its segregation.

Consolidation and Rationalization

The extensive consolidation and rationalization occurring in the private and public sectors of the DTIB has had several adverse consequences. DOD planners have been forced to eliminate some of their surge and mobilization hedges, and to make choices between a redundant capability in one area and no capability in another.

There are numerous instances of consolidation among first tier aerospace and defense electronics companies. Loral Corp. has purchased LTV's Missile Division, Ford Aerospace, and IBM Federal Systems. Martin Marietta has purchased GE Defense Systems. General Dynamics sold its aircraft capabilities to Lockheed, its tactical missile capabilities to Hughes, and its space-launcher operations to Martin Marietta. Northrop recently won a bidding war for Grumman Aerospace Corp. Lockheed and Martin Marietta have just announced plans to merge into Lockheed-Martin. More aerospace consolidations are expected as the industry slims down in anticipation of reduced commercial and defense sales. (See figure 6-3.)


UNITED DEFENSE

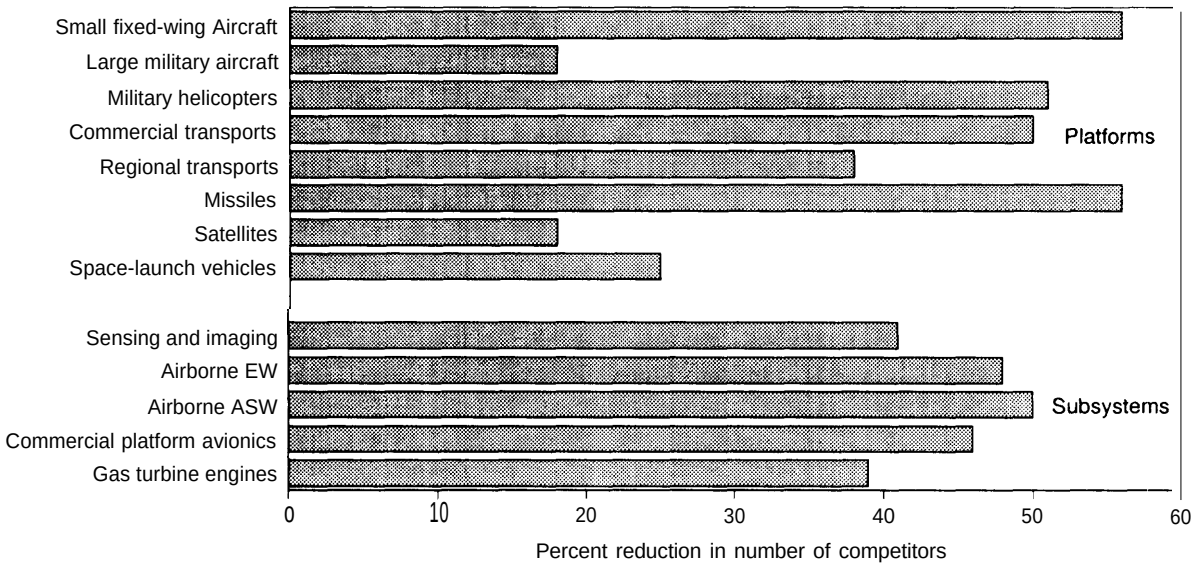
The joint partnership of FMC's defense division and *HARSCO's BMY Combat System Division provides an opportunity for higher utilization rates of facilities and personnel in the face of declining defense sales*

In the armored-vehicle sector, FMC Corp. and HARSCO Corp. recently formed a joint partnership, United Defense. The partnership, which consists of all FMC's defense business and HARSCO's BMY Combat System Division, is consolidating much of its armored-vehicle production at a single site.

Consolidation among the large defense firms is mirrored among the smaller subtier producers, as prime contractors move to reduce the number of their suppliers. Estimates of the aerospace supplier base, for example, indicate a reduction of 60 to

[5] Steven Kosiak, *Analysis of the Fiscal Year 1995 Defense Budget Request*, Defense Budget Project, February 1994, table 7.

FIGURE 6-3: Potential Reduction in the Number of Competitors by Industrial Sector



SOURCE Aviation Week& Space Technology, 1993

70 percent in the number of companies supplying production parts and services.[6]

Some of these smaller firms are leaving the defense business. Others are being purchased by larger firms that are vertically integrating their operations. One result of this consolidation is a reduction in potential competitors in the defense marketplace.

Some observers have argued that necessary consolidation in the private sector of the defense base has been inhibited by the threat of antitrust action on the part of the Justice Department and the Federal Trade Commission (FTC). The August 1992 decision blocking a merger between Alliant TechSystems and Olin Corp. 's Ordnance Division has been cited as an example of inhibiting action by regulatory agencies. There have been only a few cases in which the Justice Department or the FTC has blocked a defense industry merger or charged a violation of antitrust laws. Aerospace executives nevertheless have argued that even though the government may not have actually blocked many proposed mergers, possible consolidations have not proceeded due to concerns over the potential reaction of regulators. Some commentators have argued that U.S. national security objectives may sometimes be diametrically opposed to the competition objectives that underpin U.S. antitrust laws.[7]

Partly in response to these concerns, the DOD formed a Task Force on Antitrust under the auspices of the Defense Science Board "to provide the background that will enable [the DOD] to give the Justice Department and the FTC informed advice on the specific issues that come up."[8] The

6 Anthony L. Velocci, Jr., "U.S. Shakeout Tests Suppliers' Flexibility," *Aviation* Week& *Space Technology,* Feb. 14, 1994, p. 48.

7 Anthony L. Velocci, Jr., "Industry Plight Driving Antitrust Policy *Review,*" *Aviation Week& Space Technology,* Aug. 30, 1993, pp. 45-47.

8 Ibid.

Task Force issued a report on April 4, 1994. It concluded:

> . . . that competition among firms in the defense industry is significantly different from competition among firms in other sectors of the economy, but that the Antitrust Merger Guidelines are flexible enough to take into consideration the special circumstances of downsizing in the defense industry.[9]

The report concluded that DOD must take a more active role in the consolidation process. The Department should provide antitrust regulators with the information required to make informed decisions that will not adversely affect national security.

Consolidation is occurring in the public sector too. Consolidation in DOD research, development, test, and evaluation (RDT&E) agencies has been underway since at least 1989. This process has been reinforced by congressional direction to cut back the civilian acquisition workforce (including RDT&E personnel) by 20 percent between 1991 and 1995, and by the Base Realignment and Closure (BRAC) process.[10] Congress also created the Federal Advisory Commission on Consolidation and Conversion of Defense Research and Development Laboratories to recommend ways to improve their operation. The Commission recommended that: some or all DOD laboratories be converted to GOCO laboratories; the missions and functions of some or all the laboratories be modified; and some of the laboratories be consolidated or closed.[11]

The Army has created a corporate Army Research Laboratory, consolidated several laboratories, and closed others. The Service has eliminated 4,000 to 6,000 positions, leaving a total of 32,579 personnel in its RDT&E activities for fiscal year 1992.[12] The Army funds a federated network of university laboratories and plans to make greater use of civilian developments. Further, it and the other Services have a growing list of cooperative research and development agreements (CRADAs), as well as other activities, directed at increasing technology transfers between the public and private sectors.

There were 67,552 personnel engaged in Navy RDT&E activities in fiscal year 1992. The Navy plans to close several R&D facilities and expects several thousand positions to be eliminated. The Service is examining which technologies might be sourced from the private sector and which will need to be fostered in the defense sector.

The Air Force has reorganized its 14 laboratories into four "super-laboratories," and eliminated more than 2,000 RDT&E positions since 1991. There are now an estimated 20,188 personnel involved in RDT&E activities. The super-laboratories correspond to the Air Force Materiel Command's four product divisions: Aeronautical Systems, Electronic Systems, Space Systems, and Human Systems.

All three Services are pursuing inter-Service consolidation activities through the Defense Science and Technology Reliance Program, which seeks to leverage increasingly scarce science and technology funds through formal agreements that govern planning and research, and designate a lead Service and agency in technology development.

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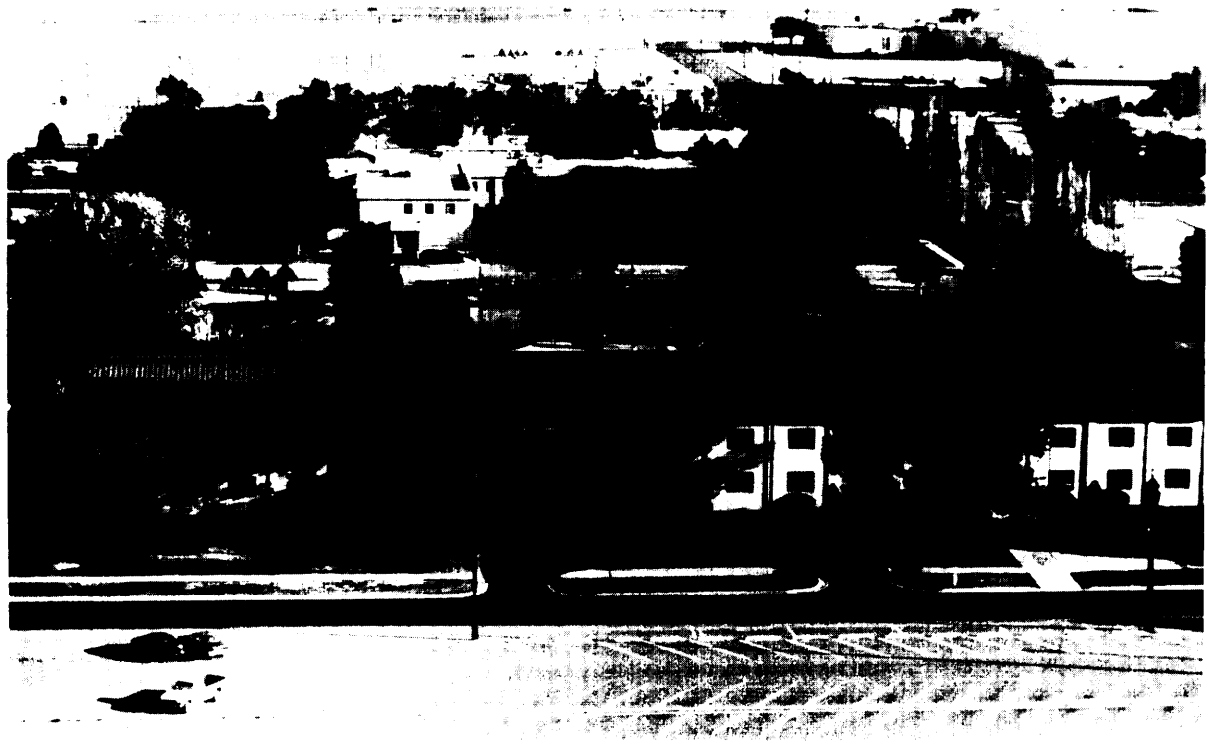
9 Paul C. Kaminski, Defense Science Board, Memorandum for the Under Secretary of Defense (Acquisition & Technology), *Report of the Defense Science Board (DSB) Task Force on Antitrust Aspects of Defense Industry Consolidation,* Apr. 4, 1994.

10 The 1989 DOD Defense Management Review directed the Services to increase efficiency and reduce unwarranted overlap in their RDT&E activities. The congressional action came in U.S. Congress, National Defense Authorization Act for Fiscal Year 1991, conference report to accompany H.R. 4739, Oct. 23, 1990, p. 143.

11 Federal Advisory Commission on Consolidation and Conversion of Defense Research and Development Laboratories, report to the Secretary of Defense, September 1991.

12 U.S. Department of Defense, Office of the Secretary of Defense, Director, Defense Research and Engineering, *Department of Defense in-House RDT&E Activities Report*, (able 1, pp. 1-2, 1993.



One of the Air Force's four super laboratories, Phillips focuses on the transition of space research technologies into operational systems

The Reliance Program has established six categories of inter-Service and interagency cooperation: coordination, joint efforts, collocation, consolidation, competition, and Service-unique. Thirty-one broad technology areas have been identified as important to two or more participants. Program officials have reported a number of successes in eliminating duplication of effort and in coordinating research. The Services report they have moved beyond coordination in many research areas to joint efforts and collocation, The percentage of DOD science and technology funds managed under the Reliance Program reportedly grew from 34 percent in fiscal year 1993 to 46 percent in fiscal year 1994.13

Critics of the Reliance Program argue that the program allows the Services to show cooperation while avoiding real consolidation. The Aerospace Industry Association, for example, has argued that although the program has been billed as:

> . . . one of the most comprehensive restructuring efforts involving the technology base in over 40 years, few have crossed Service boundaries, and virtually none of the Reliance Panels have coordinated their plans with relevant industry R & D.[14]

DOE laboratories involved in nuclear weapons research and development are consolidating and moving toward more interaction with the com-

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13 Joint Directors of Laboratories, *Defense Science and Technology,* December 1993, p. 5. Reliance also includes the Defense Nuclear Agency, the Ballistic Missile Defense Office, and coordination with Advanced Research Projects Agency.

14 Aerospace Industry Association, background paper, undated, *Nationalization of (he Aerospace Industry "R&D Laboratories. '*

mercial sector.[15] Although weapons research remains a high priority, other missions, such as economic competitiveness and environmental cleanup, are gaining in importance. Proposals recommend that as much as 20 percent of these laboratories' R&D budgets be allocated to technology transfer.[16] In addition, the laboratory directors have indicated that as much as 20 percent of the funding will be allocated to the pursuit of common commercial and defense--dual-use--objectives.

Budget cuts are forcing changes in the DTIB maintenance structure. The Services have begun to reduce the size and number of government facilities and to focus similar technologies or systems for all Services at a single site. To reduce and control costs, a greater emphasis is being placed on competition.

Some of these changes may have a direct impact on CMI, The Navy's announced Aviation Depot Policy, for example, has reduced inhouse work and transferred it to private industry. The Navy anticipates closing excess depots as rapidly as possible, consistent with the 1993 BRAC guidelines. It will retain a minimum core capability to maintain fleet readiness.[17]

But other changes may not increase the use of the commercial sector. For instance, Air Force commanders believe that open competition for depot-level maintenance will result in the transfer of much of the military aviation work to Air Force Air Logistics Centers, which Air Force commanders have claimed are the most efficient providers of such maintenance work.

There are a number of obstacles to increasing private-sector maintenance. Fluctuations in the size of workload and the need to retain a capability to repair items long after they had ceased being produced are two of these.

Depot consolidation also faces challenges in Congress. The Services have argued that the legislatively mandated workload limit (no more than 40 percent of the workload can be accomplished by nonfederal employees) has reduced DOD's ability to eliminate inhouse capabilities and to rationalize the private/public base. The DOD Task Force on Maintenance Management, established in the 1994 Defense Authorization Act, recommended retention of a required "core" capability that is not tied to any mandated workload limit. Congress, however, has continued to support a mandated federal workload of 60 percent.

Advances in Product and Process Technology

New product and process technologies with both defense and civilian applications are being developed and perfected at a rapid pace. Commercial companies are making large advances in many product and process technologies, including rapid design and prototyping, quality control, and flexible manufacturing. But current organization and funding arrangements make it difficult to incorporate many of these technologies into the operations of the segregated DTIB. For example, the general lack of available funds (the 1980s were an exception) and the lengthy government acquisition cycle has often inhibited the public sector from updating its process technology in a timely fashion. It often takes at least two budget cycles to justify a request, get the Service authorization, acquire congressional funding, let a competitive bid, evaluate that bid, buy the equipment, and, finally, install it. Incorporation of new manufacturing technology in the private sector has been inhibited partly by a cost-based accounting system that linked profits with total costs and by short contracts that provided few incentives to make such investments.

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[15] These include Lawrence Livermore National Laboratory, Sandia National Laboratory, Los Alamos National Laboratory, Savannah River Technical Center, and Savannah River Ecology Laboratory.

[16] "Energy Labs' Fate, "Al *iation Week & Space Technology,* Apr. 25, 1994, p. 17.

[17] /,l,$,(/t, *the Pentagon,* May 3, 1993.

The private and public sectors have started to remedy these problems. The Technology Reinvestment Project (TRP), for example, seeks to promote the transfer of process and product technology into the segregated DTIB. CRADAs and consortia also aim to foster technology transfer.

Both the Navy and the Air Force have expressed interest in dual-use programs, modeled on the TRP program, that bring together industry, universities, and Service laboratories for research on selected topics. But, ultimately, widespread adoption of new product and process technology by the segregated portion of the DTIB will require changes in acquisition approach and in the government incentive system.

Changes in Government Management

Government management of both private and public sector DTIB resources continues to be criticized as too decentralized and uncoordinated. One result is a DTIB filled with redundancies. Yet here, too, change is occurring. For example, although the Reliance Program still only affects part of R&D funds spent by the Services ($3.6 billion of a total $7.9 billion DOD science and technology investment), there has been an increase in the percentage of such funding in the last year. Service planners now acknowledge that funds "to go it alone" are simply not available and that they must find ways to leverage funds in areas of common interest.

It is unclear how much unwarranted redundancy of research exists among the Services. Because DOD's Director of Defense Research and Engineering (DDR&E) has had only limited involvement, the Reliance Program has been criticized as a "rule of committee" effort in which Service interests, rather than overall DOD interests, are served. [18] Further, even those who support the Reliance Program and believe that it has succeeded in eliminating redundancies criticize its lack of a mechanism for developing a longer range science and technology strategy. They have called for better investment planning. To address this issue, the DDR&E has established a number of boards to identify future defense technology needs and ways to meet them.

Similar inter-Service management problems inhibit consolidation and rationalization in maintenance. Despite efforts to consolidate and provide cross-servicing, the amount of inter-Service maintenance remains small. In 1989, less than 6 percent of the total work was conducted on an inter-Service basis, while it is estimated that 60 percent of maintenance could be conducted across Services. [19] The effort toward more centralized management of depot-level maintenance inched forward with the report of the Depot Maintenance Management Task Force and the publication of a DOD finding that "a DOD-wide core provides greater flexibility to eliminate duplicate resources, increase cross-servicing, and implement efficiency measures." [20] DOD said that it had decided to maintain a DOD-wide core maintenance capability.

Government oversight of the private sector of the DTIB also remains concentrated along Service lines. This results in numerous inefficiencies and redundancies, and leaves DOD without a coherent view of the DTIB as a whole. What appears necessary is a government management structure with good oversight not only across Services, but also across the private and public sectors.

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18 Michael E. Davey, Library of Congress, Congressional Research Service, memorandum, "Current Status of Project Reliance," May 4, 1993.

19 OTA, *Building Future Security*, op. cit., footnote 3, p. 128.

20 John Deutch, Deputy Defense Secretary, letter to Congress, reported in *Defense Daily*, "Task Force Recommends Lifting Rule on 60/40 Depot Split," Apr. 11, 1994, p. 51.

BOX 6-1: The AMRAAM Part III: Segregation

Previous discussions (boxes 4-1 and 5-1) noted that the manufacture of the AMRAAM is largely segregated from commercial production and that segregation is likely to continue at the system-assembly level for the AMRAAM. At the next tier, segregation is likely to continue for militarily unique components such as rocket motors, propulsion systems, and explosives, However other components, subcomponents, parts, hardware, and materials may be produced on integrated production lines and some of these components and subcomponents will probably be commercial.

While the expansion of the use of commercial items or Integrated processes in the AMRAAM may be limited, future missiles may have greater potential for integration. A government-sponsored study group examining the technology and Industrial base for missiles concluded that there were several commercial product and process technologies available for missiles. But many of the necessary technologies are likely to remain segregated.

TABLE 6-A: Commercial Availability of Critical Technologies and Manufacturing Processes

	Critical technology	Critical manufacturing process
IR / radar domes	❑	
Warheads	❑	□
S&A devices	1	□
Fuzes	El	❑
Rocket motors	❑	❑
Control activation system	□	○
Thermal batteries	□	□
Composites	○	○
Microwave devices/ assembles	❑	○
TWTs	○	0
IR detectors	□	□
VHSIC / ASIC	■	■
Multichip modules	■	■
MMIC /MMIC modules	❑	0
Fiber optics	■	■
Displays	■	■
Low observable	❑	□
Counter stealth technology	❑	❑
Image processing		
Homing guidance autopilots	0	
ECCM	❑	
Data fusion	□	
Simulation / modeling	○	
Ada software	❑	
Super computers	■	

■ Available O Somewhat available Not available

TABLE 6-3: Sources of Continued Segregation

- Militarily unique product or process.
- Insufficient demand.
- Highly classified product or process.
- Specialization on core competencies.
- Public sector facility.

SOURCE Office of Technology Assessment, 1994

The need for a more centralized oversight and planning for the use of available technology and industrial resources, however, should not be mistaken for a general demand for greater centralization in the execution of decisions. As chapters 4 and 5 indicated, a key to further CMI includes the willingness to decentralize contracting and oversight authority and to allow personnel in the field more latitude in implementing policy.

WHY SOME DTIB SEGREGATION WILL CONTINUE

No matter how successful commercialization and integration of processes may prove to be, a portion of the DTIB is likely to remain segregated. Key reasons for continued segregation are listed in table 6-3.

Militarily Unique Product or Process

While commercialization or integration of military production may make economic sense for the base as a whole, sound business practices may dictate, in at least some cases, segregated R&D, production, and maintenance regardless of changes in acquisition laws and regulations. This is especially true where military needs are unique, and the products required to meet them substantially differ from those necessary to fulfill commercial requirements.

The conventional ammunition industry, for example, is likely to remain segregated. Most military ammunition is significantly different from what is sold commercially. The associated military tooling and processes are also dissimilar. The manufacture of military ammunition, for example, requires working with exotic materials (e.g., boron alloy and depleted uranium); mixing, blending, drying, and packaging energetic (e.g., TNT, RDX, HMX); and melting, pouring, and pressing explosives.[21] Further, firms that deal with explosives and propellants face very stiff safety and environmental requirements. Large real estate investments are needed to ensure adequate safety in case of accidental explosions, special buildings are required to mitigate the effects of any accidents, and an increased investment in environmental control equipment is necessary. The combination of unique products and specialized processes makes it unlikely that either commercialization or process integration can succeed in this sector.

Other systems and operations likely to remain segregated because of their uniqueness are the production and final assembly of major combat systems such as submarines, aircraft carriers, and other large naval combat vessels, and the assembly of high-performance fighter aircraft, combat helicopters, and ground-combat vehicles (tanks, armored personnel carriers, and their follow-on systems). Although many of the components and subcomponents of these systems can potentially benefit from the use of commercial items and commercial buying practices, the systems integration and final assembly of these expensive items are sufficiently costly and unique to demand continued oversight. The adoption of Activity Based Cost Accounting might reduce some of these problems.

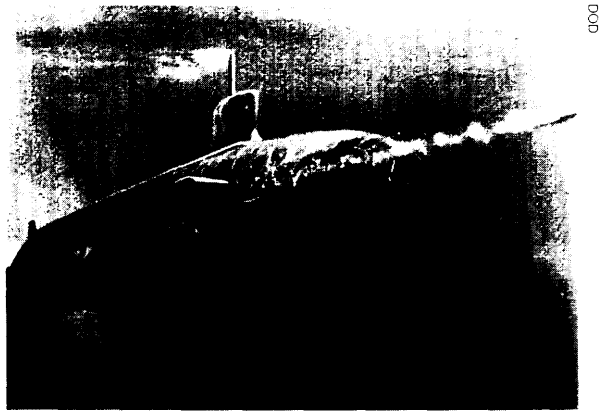
Insufficient Demand

The tremendous reduction in defense items likely to be developed and produced in the foreseeable future lessens the opportunities for competition to

[21] James Blackwell, *Munitions industrial Base Forecast*, a study prepared for the Munitions Industrial Base Task Force, Science Applications International Corp., October 1993, p. 25.

control costs in many areas. Even now, many military systems are procured in such low numbers that multiple producers do not exist.

Once a system is fully developed, the government might buy it on a firm fixed-price contract, and thus reduce the need for oversight. But the combination of high cost, large technological risk, and low demand make it likely that the government will continue to require the type of cost-accounting and oversight for these systems that interfere with commercial work and prompt continued segregation.



Although final assembly operations on systems such as nuclear submarines are likely to remain segregated, subsystems and components may come from integrated firms and facilities

Highly Classified Product or Process

In some cases, segregation will continue because the national interest would not be served by making certain products or processes openly available. One of the most obvious examples is nuclear weapons. Not only are nuclear weapons militarily unique, but also their development, production, and maintenance involve technologies over which the government needs to retain tight control.

Other technologies likely to remain highly classified and therefore segregated, include those relating to the fabrication of stealth materials and electronic warfare computer codes. Although some of these technologies could be developed and produced in a commercial firm, the classified portions of the process would need to be segregated from nonclassified activities.

Specialization on Core Competencies

Segregation may not always be due to the nature of the products and processes. In some cases, segregation may result from a manufacturer's *choice* to concentrate on defense work, to the exclusion of commercial, nondefense activities.

Studies indicate that the diversification patterns of successful businesses stress the exploitat ion of similar "core capabilities" for both new and old products.[22] Accordingly, firms tend to focus on developing a core of similar technical competencies, rather than on manufacturing disparate products. These competencies might include a detailed knowledge of military threats and missions, something a commercial firm is less likely to have.

Even with increased use of flexible manufacturing and diversification into dual-use sectors, this situation is likely to continue. From the perspective of some firms, there are advantages to dealing mainly with government customers—the DOD or others. These advantages include the ability to focus marketing efforts on a narrow range of potential customers and to exploit customer contacts developed over years or decades. Loral Corp., for example, appears to be successful in using a strategy of specialization.

Public Sector Facility

Another reason for continued segregation of some facilities is a deliberate government decision to maintain separate government capabilities for activities that could otherwise be conducted in the private sector. In particular, the military has argued that a core maintenance capability, sufficient to support a crisis or conflict, should be retained within the Services, rather than depend entirely on

22 David p. Leech, "Conversion, Integration and Foreign Dependency: Prelude to a New Economic Security Strategy} ', " *GeoJournal*, 31.2 (Boston, MA: Kluwer Academic Publisher, October 1993), pp. 193-206.

private contractors. This core includes Service air logistics centers, depots, and shipyards.

While industry has generally supported the retention of a core Service capability, it has favored a smaller capability than that proposed by the Services. The congressionally mandated Depot Maintenance Management Task Force's April 1994 report recommends a general reduction in the size of the retained core and a reduction in the excess depot capacity that would result from this smaller core.

DOD RDT&E centers provide a valuable service exploring militarily relevant technology. They offer the expertise to make DOD a "smart buyer" of technology. In the past, DOD laboratories have used about 30 to 40 percent of their funds in-house, while the remainder has flowed to the private sector. That split is unlikely to change radically. Although many of these facilities are likely to be closed or reduced, and the rest will probably conduct more business with the private sector, it remains likely that a significant, segregated public sector capability will remain.

CMI POLICY OPTIONS FOR THE SEGREGATED BASE

CMI policies might help reduce costs within the segregated portion of the DTIB and promote technology transfer with the larger CTIB. Indeed, because weapon systems are likely to be developed and assembled within the segregated portion of the DTIB, CMI policies in this segment of the base are critical in determining both the character of future forces and the overall size of CMI cost savings that can be realized.

Many of the acquisition reforms (discussed in the preceding chapters) that allow for increased commercial purchases (elimination of military specifications) and integration of processes (elimination of military standards) could be applied to the segregated DTIB. Moreover, an emphasis on CMI could help guide DTIB rationalization and consolidation, producing added benefits.

This section examines three broad CMI policy areas. They are policies aimed at: eliminating redundancies and rationalizing capabilities within the segregated DTIB, and between the segregated and integrated portions of the DTIB; applying the acquisition reforms discussed in chapters 4 and 5 to the segregated DTIB; and promoting technology transfer into and out of the segregated portion of the DTIB.

Eliminate Redundancies

As the defense budget declines, DOD may realize some of the biggest cost savings in eliminating redundancies in the segregated portion of the DTIB. The value added in the private and public portions of the segregated DTIB may have totaled about $56 billion in 1992.[23] Cost savings could be achieved if redundant operations were eliminated, facilities closed, personnel reduced, and future infrastructure investments avoided. The 1993 Defense Science Board Task Force on Acquisition Reform estimated that a 25-percent reduction in DTIB government personnel might be possible. This degree of reduction, if applied to the public sector RDT&E, manufacturing, and maintenance base, might eventually result in a savings of several billion dollars per year.[24]

The moves to consolidate and eliminate redundancies in the DTIB mirror changes in the national economy. The broader CTIB is undergoing extensive restructuring. This involves eliminating layers of management, closing redundant manufacturing facilities, and cutting overlapping R&D programs. As a result of these changes, firms are stronger and more globally competitive.

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23 Based on Department of Commerce data and a 1992 level of $314 billion on all national security. OTA'S industry survey estimated that about $43 billion of the approximately $180 billion spent for national security in the private sector in 1992 might remain segregated. In addition, another $13 billion might be spent for the public sector workforce involved in R&D, production. and maintenance activities.

24 When such savings might appear is not clear since there is a significant up-front cost associated with personnel reductions and facilities closures. Critics, for example, argue that the current BRAC is fiscally unexecutable.

DOD can guide the DTIB consolidation process. The Reliance Program, for example, has allowed the Services to turn over research responsibilities for selected topics to lead Services or collocate personnel working on these topics. Changes at the Services' depot-level maintenance facilities have increased cross-servicing of selected items, although this activity is still taking place on a small scale in comparison to its projected potential. The Services also plan to increase reliance on selected elements of the private sector for production and maintenance.

But DOD efforts at consolidation are only beginning. They will have to increase significantly if a viable capability is to be retained. Otherwise, there will be too many facilities, with the bulk of funding spent on infrastructure and salaries rather than on R&D and maintenance.

Congress has given little support to most of DOD's consolidation efforts. DOD facilities represent high-paying jobs in many parts of the United States, and the loss of employment is a matter of congressional concern. Wartime readiness is another concern. The principal justification for a strong, redundant, in-house maintenance base is the need for a quick-response capability. This justification is explicitly stated in the fiscal year 1994 Defense Authorization Act in a "Sense of Congress" statement supporting in-house DOD depot-level maintenance and repair activities as "uniquely suited to responding to the increased need for repair and maintenance of weapon systems and equipment which may arise in times of national crisis."[25]

The upcoming 1995 BRAC review appears to be particularly important for the consolidation effort. The BRAC review helps raise the defense reduction effort from a local to a national effort. The Services appear to be working hard to prepare for it. Several officers predicted, however, that the necessary base closures and realignments (expected to be far greater than in previous efforts) would not be made in 1995.

These concerns appear warranted. Newspaper accounts in May 1994 indicated a reluctance in both the White House and Congress to make major closures. Deputy Defense Secretary John Deutch announced that delay of some planned closures for two years is under study. Some in Congress have recommended delaying all 1995 base closings until 1997. Reasons cited include the immediate costs associated with closings, such as environmental cleanup and severance pay, and concerns about the loss of jobs at a time when alternative employment appears unavailable. However, any delays would adversely affect projected long-term cost savings.

Private sector mergers, acquisitions, and bankruptcies, especially in manufacturing, are eliminating redundancies more rapidly than activities in the public sector. Here too, however, there is resistance to the rapid loss of jobs. One of the responses has been to fund the manufacturer of weapon systems that no longer have military mission requirements. And, as mentioned earlier, antitrust action or the threat of such action, may have slowed consolidation within the private sector.

The process of eliminating redundancies between the private and public sectors is just beginning. DOD and the Services are attempting to identify private R&D capabilities that can be used in lieu of government capabilities. Studies aimed at identifying such capabilities must be accelerated.

Not all redundancies can or should be eliminated. Some overlap in R&D, manufacturing or maintenance ensures that the government does not become dependent on a single source for support, has the capability to respond to crisis, and can promote innovation. Redundancy in research, for example, can promote innovative solutions to technical problems. Scientists see the resulting "competition of ideas" as key to arriving at the best solution. Yet budgetary constraints are forcing a reevaluation of acceptable changes.

25 10 USC 2466, Sec 345.

Direct Consolidation

During the Bush Administration, the stated DOD consolidation policy was to allow market forces to shape the private sector defense base. The Administration acknowledged, however, that some sectors—for example, nuclear submarines—might require direct government intervention. The Clinton Administration has been more expansive in its concerns about special sectors, including armored vehicles and high-performance fighter aircraft. It has favored taking action to ensure the viability of important defense industrial sectors.

DOD influences the DTIB through the award of contracts. DOD may wish to place greater weight on DTIB preservation issues in contracting. To foster maximum CMI, however, these efforts should be selectively applied to the industry in question. DOD must also be prepared for bid protests, particularly in those situations where one bidder will be awarded an entire contract and the other will be put out of that business. "Managed competition" between two producers is an alternative. But this would require a coordinated policy with several product lines. Split awards of varied percentages might serve as an incentive for lowering costs. Congressional support for DOD decisions is essential.

DOD has yet to provide convincing arguments for much of its spending on the technologies or industrial sectors it decides to support. Despite several years of requests and directives from Congress to outline the Nation's DTIB needs and to develop an investment plan to serve those needs, DOD has failed to respond. Not only are key sectors only hazily identified, but there are few metrics for determining how much should be spent to retain a required capability.[26] DOD has several study groups assessing the problem, but their progress may be too slow to affect the consolidation significantly.

As noted earlier, the Justice Department and the FTC also have direct interest in private sector industrial consolidation, particularly in the area of antitrust policy. Antitrust policy is particularly important to the consolidation of the segregated portion of the DTIB. Monopolies are more likely to arise in cases where militarily unique systems are procured in low numbers.

The Justice Department and the FTC have argued that current merger guidelines are adequate to protect national security and the public's financial interests. The Deputy Assistant Attorney General in the Justice Department's Antitrust Division, for example, has stated that "[c]urrent guidelines are fully flexible enough to deal with defense industry mergers."[27] This attitude is echoed in the FTC, which argues that "[t]he flexible approach of the current Merger Guidelines is adequate and appropriate for analyzing defense industry mergers in a reasonable and informed manner."[28]

The Defense Science Board Task Force on Antitrust Aspects of Defense Industry Consolidation supported these conclusions. Although the report argued that competition among firms in the defense industry is significantly different from competition in other sectors, it concluded that the merger guidelines are flexible enough to take into consideration the special circumstances of downsizing in the defense industry. The Task Force also argued that the enforcement agencies are receptive

[26] Some work has been done to assess the relative value of closing or mothballing a facility versus keeping a production line warm despite a lack of a current requirement for the product.

[27] Velocci, "Industry Plight Driving Antitrust Policy Review," op. cit., footnote 7, p. 46.

[28] Laura A. Wilkinson and Steven K. Bernstein, "Mergers in the Defense Industry: Application of the 1992 Horizontal Merger Guidelines." draft paper provided OTA, p. 19.

BOX 6-2: Alliant TechSystems/Olin Corp. Ordnance Division

Many in Industry cite the FTC's decision to block a merger between Alliant TechSystems and Olin Corp.'s Ordnance Division as an example of the impediments facing defense industry acquisitions and mergers The two contractors planned to merge before the DOD concluded a competitive multiyear contract for the procurement of 120mm tank ammunition The contract was designed to eliminate one of the two as a supplier of that ammunition to the Army

The FTC attorneys argued that even though the tank ammunition in question could be purchased in Germany, DOD policy made such purchases unlikely; therefore, in practice the market was limited to the United States Because of declining DOD needs, a new producer was unlikely to enter the market and a merger of the two firms would effectively eliminate competition, The attorneys also reported that there was some evidence that the cost of the rounds might Increase as a result of the merger, Although some of DOD witnesses testified in support of consolidation on the grounds of efficiency, DOD took no formal position on the merger The FTC argued that, based on all the expert Information available, "[T]he overwhelming conclusion from all of these sources was that DOD would obtain the best quality and prices for ammunition under a competitive scenario versus the proposed merger,'"

The court eventually decided not to allow the merger to proceed It found that the elimination of competition between Alliant and Olin could "raise the cost of the contract for the Army between 5 percent and 23 percent, or $25 million to $115 million."[2] Moreover, the court rejected the claim that national security might be Impaired if the merger were stopped,

The potential increase in cost and the lack of solid DOD support appear to have been key reasons for the decision.

[1] **Defense Science Board Task Force on Antitrust Aspects of Defense Industry** Consolidation, p 5

2 FTC v Alliant TechSystems **Inc** 808F, Supp 9 (D D C 1992)

to information from DOD on national security and other special concerns .29

The Task Force concluded that the DOD did not have to take a position on every transaction, but it recommended establishing an "institutional capacity to assemble and transmit information."[30] The Task Force argued that DOD could work with enforcement agencies to ensure that its national security views on proposed mergers or joint ventures are known. The consensus among DOD and enforcement agencies appears to be that legislative changes on defense antitrust are not required.

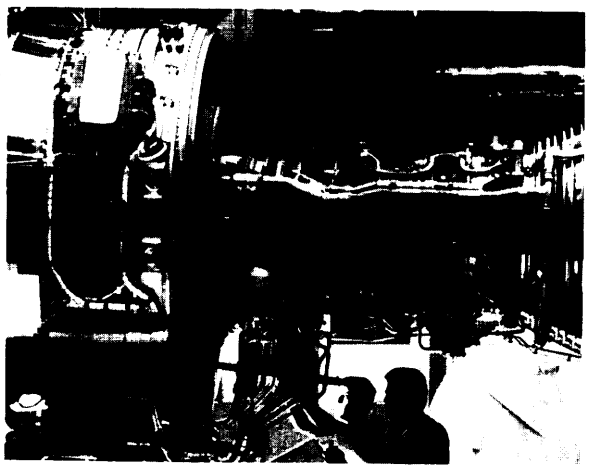
Still, anecdotal evidence suggests that many industrialists have come to a different conclusion. They see a significant risk that mergers will be halted on the basis of antitrust concerns. This could make corporate merger attempts less attractive. DOD will need to work more closely with industry to promote flexibility in this area.

Government vs. Private Ownership Issues

Eliminating redundancies between private and public sectors will inevitably force decisions concerning the public sector's role in defense. It is here that an emphasis on CMI may have its greatest effect on consolidation of the segregated DTIB. A consolidation strategy designed to maximize the benefits of CM I would tend to favor private over public ownership and operations. The

[29] Office of the Under Secretary of Defense (Acquisition), *Report of the Defense Science Board Tusk Force on Antitrust Aspects of Defense Industry Consolidation*, April 1994, p. 4.

[30] Ibid., p. 5.


PRATT & WHITNEY

Original manufacturers of equipment, such as Pratt & Whitney, also have the ability to perform depot-level maintenance.

result is a preference for private companies over GOCOs, and GOCOs over GOGOs, unless more pressing factors override the desire for CMI.

U.S. government policy has stressed the use of private firms whenever possible. Advantages of private ownership include greater labor flexibility, more responsive capital investment capabilities, greater breadth of management, and the potential for greater access to commercial technology.

DOD has minimized private sector participation in maintenance. Even when private companies are supremely capable of providing maintenance on a weapon system--often because they produced it—DOD goes to great length to transfer maintenance responsibility to the public sector. While some argue that this transfer is vital for crisis responsiveness, it can be expensive. For example, in the case of some electronic equipment, developing the testing equipment and the technical data packages to allow the Services to perform maintenance reportedly adds 25 percent to the total cost of a contracts[31] Again, this transfer often means the replication of capabilities possessed by the original manufacturer. Commercial support would appear to be preferable.

Still, in a period of reduced defense spending, the private sector may be unable or unwilling to maintain capabilities that the military deems essential. For example, firms will maintain surge production capability only if the government is willing to pay for it.[32] In such cases, government ownership may be required. Table 6-4 presents several reasons for government ownership.

Industries that meet several of these criteria include: the large-caliber ammunition industry, submarine and shipbuilding, and the armored vehicle and fighter aircraft industries. To date, the private sector has been willing to retain a capability to develop and produce many of these items, albeit with extensive government-supplied special tools, facilities, and equipment. Given current budget trends, however, it is uncertain whether there will be sufficient business to provide financial incentives for private sector work in these areas. Should demand fall sharply, government ownership might prove less expensive than creating an artificial demand.[33]

Many government arsenals and maintenance facilities were upgraded during the 1980s defense buildup. To take advantage of the upgrades, some officials suggest putting these facilities under

TABLE 6-4: Factors in Government Ownership

- High capitalization and replacement costs,
- Long replacement time.
- Uneven demand for product or service.
- No commercial counterpart,
- Need for responsiveness.
- Critical security controls,
- Extreme hazards (safety or environmental)

SOURCE Off Ice of Technology Assessment, 1994

31 Office of Technology Assessment discussions with industry.

32 Industry argues that DOD currently has no plans for surging production and therefore no plan for funding the capability.

33 U.S. Congress, Office of Technology Assessment, *Building Future Security*, op. cit., footnote 3, anticipated combining all types of armored vehicle production into two sites.

BOX 6-3: Ownership Alternatives of Other Nations

Other nations have taken a variety of approaches to defense ownership Two allies, France and Japan, manufacture a relatively full range of defense items. They have taken very different tacks on ownership,

France

Nearly four-fifths of the French defense industry is owned directly or Indirectly by the state, either in the form of government-owned and -operated arsenals **and** nationalized companies (e.g., Aerospatiale, GIAT Industries, and SNECMA), or as firms in which the government owns a large share of the stock (e.g., Dassault Aviation, Matra, and Thomson-Brandt Armaments). These nationalized defense firms do not face the same pressures as private firms to provide a short-term return on Investment, but because they may be only partially nationalized they have access to private capital market as well as to government subsidies.[1]

Japan

The Japanese, by contrast, rely almost totally on the private sector for defense R&D, production, and maintenance Japanese firms are responsible for the development of new technologies and systems, as well as providing subsequent depot-level maintenance for their products throughout their service life.

[1] U S **Congress, Off Ice of Technology Assessment,** *Lessons in Restructuring Defense Industry The French Experience,* OTA-BP-ISC-96 (Washington DC U S Government Printing Off Ice, June 1992) p 8

GOCO ownership. A GOCO structure might ensure that a facility is available when needed, while providing more flexible personnel policies and greater efficiency. GOCO facilities have become commonplace in the ammunition manufacturing industry, and should be equally acceptable in maintenance.

When established, government ownership of nuclear weapons-related facilities was considered essential because of their critical role in national security, the need for secrecy, the extensive facilities required, and the hazards involved. But DOE weapons laboratories were specifically organized as GOCOs to ensure the availability of the scientific and engineering talent needed to develop, test, and monitor the U.S. nuclear weapons arsenal. A GOCO relationship provided a flexible personnel policy with more attractive wage scales and more flexibility in organization and job categories than would have been the case in a GOGO facility.

Although government ownership is touted as a way to ensure the preservation of capabilities unlikely to be supported by the private sector, the government has not always made the necessary investments. Faced with a choice between funding force readiness and funding industrial mobilization capabilities, the Services tend to favor the former.

For example, despite recommendations to ensure future ammunition capabilities in the DTIB. at the start of U.S. involvement in Vietnam, defense ammunition plants were antiquated and in poor condition. Nothing had been done to update the facilities, let alone maintain them. Millions had to be spent to bring all but two of 24 ammunition plants from the Korean War era back into production for the Vietnam War.[34]

Take Advantage of Acquisition Reforms

Although the segregated portion of the DTIB is unlikely to take advantage of all the reforms pro-

[34] Roderick L. Vawter, *Industrial Mobilization: The Relevant History* (Washington, DC: National Defense University Press, 1993), p. 55.

posed in chapters 4 and 5, its operations can be improved and its costs lowered by adopting commercial specifications, standards, and practices. Incentives to incorporate commercially available components rather than those specified by military description could increase the number of available suppliers and reduce or control costs. This would also reduce the need for flowdown of cost and pricing data.

The increased use of commercial standards and participation in commercial standards bodies will narrow the difference between factory operations in segregated facilities and those in the private sector. Similarly, an emphasis on form, fit, and function specifications will give suppliers an opportunity to apply their best practices to meeting a contract.

Other practices that may be applicable to the segregated DTIB include replacing government quality inspection with statistical process control or other modem quality control processes. But there is some skepticism about alternative quality control methods. Investigations periodically report instances of fraudulent and forged certifications of quality tests.[35]

Because of the lack of available pricing data, elimination of cost accounting requirements appears highly unlikely. Longer term contracts with commercial component suppliers that provide better forecast or parts requirements and shorter parts delivery times can reduce the need for parts inventory and eliminate storage costs. The increased use of commercial parts might lower the costs of individual items. The use of modern procurement practices, such as the use of Electronic Commerce and Electronic Data Interchange, can increase efficiency in purchasing all of these items and have a positive impact on the segregated base. But savings in this area are likely to come from the lower tiers, not prime contractors.

Regulated Industry

Periodically, suggestions are made that the defense industry be treated as a regulated industry, like the electric power industry. Proponents argue that such a change would allow defense companies to operate more efficiently, with less day-to-day oversight. But the potential for such use in the defense industry appears limited. The regulation of the electric utility industry, for example, is facilitated by the fact that it produces a common product for which fair production costs can be calculated. The same applies to other utilities. The defense DTIB, with its complex set of products and processes, is far less amenable to regulation using similar methods.

Increase Technology Transfer

Ensuring technology transfer between the segregated portion of the DTIB and the CTIB is even more important in a period of greater dependence on commercial technology. The Services are developing programs to increase interaction between their R&D community and the commercial sector. In some cases, however, mandates might be necessary to promote the use of commercial technology in component and system designs. Secretary of Defense Perry's recent directive on military specifications and standards is a step in this direction. Such a mandate would force government R&D activities and private sector firms to assess commercial technological developments.

If the Nation is to rely on commercial specifications and standards, the government R&D community will need to be active in the organizations that set standards. Such involvement will ensure that defense stays current with developments in critical sectors.

35 Andy Pasztor, "Unit of Lucas Says 1[Falsified Weapons Data," *The Wall Street Journal*, May 17,1994.

The TRP dual-use research projects and CRADAs might also improve access to commercial technology. But the TRP appears to have little relevance to important militarily unique items such as ammunition.[36] The CRADA process promotes technology transfer out of public sector defense organizations, but CRADAs have potential problems. One concern is that as laboratory-developed technology is transferred out, there will be insufficient investment dollars to assure that defense-oriented laboratories remain on the leading edge of R&D. In the longer term, there may be no more useful technology to transfer. Critics fear that too much attention is being paid to the commercial market and that limited defense R&D funds should be directed primarily to critical defense technologies. To preclude this possibility. laboratories will have to carefully select CRADA partners to ensure the two-way flow of useful technology. The laboratories will have to develop a sustainable, long-term science and technology investment program.

SUMMARY

A significant portion of the future DTIB is likely to remain segregated from the larger CTIB, despite changes in acquisition laws and regulations. The OTA industry survey, for example, estimated that about 25 percent of funding for private sector DTIB activities might remain segregated.

The products likely to remain in the segregated DTIB include a wide range of militarily unique items such as conventional ammunition, fighter aircraft, tanks, submarines, and nuclear weapons and their delivery systems. Because of a lack of commercial overlap or uneconomical production rates, the development, production, and maintenance of these items will likely remain segregated. Further. while many of the subsystems, components, parts, and services going into these products might be procured commercially or from integrated firms, some of these will probably also continue to be developed and produced in segregated facilities.

Despite continued segregation, however, implementation of some of the acquisition reforms discussed in this report can have a positive effect on this portion of the base. In both the private and public sectors, costs may be reduced by the use of more commercial buying practices, the increased use of commercial products, and the reduced use of military standards. The incorporation of commercial manufacturing technology (where possible) and modern quality control systems will also have a positive impact on costs. In the private sector, the challenge will be to devise incentives for segregated contracts to adopt new manufacturing technology. In the public sector, the challenge will be to convince the Services that industrial modernization is critical to their defense mission.

CMI can also affect the segregated portion of the DTIB by helping to guide consolidation and rationalization. Where possible, policy makers should emphasize private ownership and operations over public ones. This would maximize the benefits associated with integration with the CTIB.

The elimination of redundant R&D, manufacturing, maintenance, and testing capabilities, and stronger reliance on private ownership and operation, can potentially produce cost savings. Savings on the order of several billion dollars per year or more appear possible—but such savings require the closing of facilities and the elimination of jobs. Neither of these steps is popular. Further, any savings will take several years to appear.

But not all redundancies are bad—some serve as hedges against future uncertainties. Further, there is a consensus that a public sector role is essential to help maintain government expertise. There is no consensus, however, on how large that public sector portion of the base must be. In the past, Congress has been reluctant to reduce public-sector capabilities and close facilities. A re-

[36] The Munitions Industrial Base Task Force reports, for example, that ammunition firm\ associated with the Task Force submitted 30 TRP proposals and received no awards.

consideration of the role and size of the public sector RDT&E, manufacturing and maintenance base is increasingly important in the face of more fiscal constraints.

As in the preceding chapters, OTA developed a table for considering the cost-savings that might be gained from implementing CMI in the private sector element of the segregated base. Because the segregated DTIB is less amenable to CMI policies, OTA limited its range of possible savings from O to 10 percent. Table 6-5 shows how different savings assumptions could affect overall defense spending.

These savings, however, are additive to those potentially gained in the public portion of the DTIB through the acceptance of commercial practices, use of commercial products, and the elimination of redundancies between the private and public sectors of the base.

Reforming the segregated portion of the DTIB will present considerable challenges to policymakers. Many of these reforms are directly tied to jobs (closing facilities, reducing private or public workforce). Policy makers need to recognize, however, that CMI steps applied in this portion of the base can help extend the buying power of increasingly limited defense dollars, as well as invigorate the national economy as a whole.

TABLE 6-5: Budgetary Impact of Chapter 6 Policies on Private, Segregated Facilities[a]

Estimated average savings	Impact on total private DTIB budget
0%	0%
5%	1%
10%	2%

[a]Based on OTA's estimate that 24 percent of private DTIB spending is affected by these policy options These savings do not include those obtained from consolidation, rationalization, and an increased reliance on private ownership/operation

SOURCE Off Ice of Technology Assessment, 1994

Appendix A: Abbreviations, Acronyms, and Terms

A

Acquisition and Distribution of Commercial Products (ADCP)	DOD program launched in 1983, partly as a result of the Commercial Commodity Acquisition Program.
Acquisition Law Advisory Panel (ALAP)	Congressional panel established in 1993 to recommend procedures to streamline procurement procedures for small purchases. Also known as Advisory Panel **for Acquisition Law Reform.**
ADCP	**See Acquisition and Distribution of Commercial Products.**
Advanced Medium-Range Air-to-Air Missile (AMRAAM)	Advanced medium-range air-to-air missile; slated to replace the AIM-7 *Sparrow* in the U.S. Air Force and Navy; developed and manufactured by Hughes; Raytheon is a designated second source.
Advanced Research Projects Agency	An agency within the Office of the Secretary of Defense chartered in 1993 to support dual-use defense products and processes; formerly the Defense Advanced Research Projects Agency.
Advanced Technology Program (ATP)	A Department of Commerce program aimed at developing those technologies likely to bring widespread economic benefits to the Nation.
Advisory Panel for Acquisition Law Reform	**See Acquisition Law Advisory Panel.**
Advisory Panel on Streamlining Acquisition Laws	A joint government/industry panel established by the Defense Authorization Act of 1991, on whose recommendations Congress based many of the changes embodied in the Federal Acquisition Streamlining Act of 1993. Also known as the **Section** 800 **Panel.**

AIM-120A	**See Advanced Medium-Range Air-to-Air Missile.**
ALAP	**See Acquisition Law Advisory Panel.**
AMRAAM	**See Advanced Medium-Range Air-to-Air Missile.**
ARPA	**See Advanced Research Projects Agency.**
ATP	**See Advanced Technology Program.**
BEA	**See Bureau of Economic Analysis.**
B&P	Bid and Proposal. Private sector firms can be reimbursed by the government for B&P. This reimbursement is included with independent research and development funds.
Bureau of Economic Analysis (BEA)	One of four research divisions of the U.S. Department of Commerce.
Buy America Act	41 US Code 10 requires DOD purchases to be oriented towards American suppliers, in order to protect, promote, or support elements of the American industrial base. Other source selection legislation includes: the Cargo Preference Act of 1904(33 Stat. 5 18), governing transport by ocean vessels; the Burns-Tollefson Amendment (PL88-446), governing naval construction; and the Mattingly Amendment (PL99-591, PL1OO-2O24, and PL1OO-463), governing DOD machine tools.
C-17	A four-engine military jet transport aircraft being developed and built by McDonnell Douglas for the U.S. Air Force's Strategic Airlift Command; the contract was awarded in 1980; initial production began in 1993.
C^3I	Command, control, communications, and intelligence
CAD	Computer-aided design
CAE	Computer-aided engineering
CALS	See **Computer-aided Acquisition and Logistic Support.**
CAM	Computer-aided manufacturing
CCAP	See **Commercial Commodity Acquisition Program.**
Center for Strategic and International Studies (CSIS)	Washington, DC-based research organization.
CICA	**See Competition in Contracting Act.**
CID	**See Commercial Item Description.**
civil	**See commercial.**
civilian	**See commercial.**

civil-military integration (CMI)	The attempt to merge the technologies, processes, labor, equipment, material, and/or facilities of the commercial technology and industrial base and the defense technology and industrial base into a single national technology and industrial base. Under civil-military integration, common technologies, processes, labor, equipment, material and/or facilities are used to meet both defense and commercial needs.
CMI	**See civil-military integration.**
Command Utility Cargo Vehicle (CUCV)	A commercially derived, light (1 l/4-ton-class), four-wheel-drive tactical vehicle built by General Motors in five configurations for the U.S. Army to serve in a wide variety of roles. See also High-Mobility Multipurpose Wheeled Vehicle.
commercial	Of or pertaining to that portion of the national technology and industrial base that sells on the open market on the basis of price. See also **commercial item; Commercial Item Description.**
commercial buy	Procured from private facilities on the basis of a commercial market price.
Commercial Commodity Acquisition Program (CCAP)	A program established by DOD in 1976 in response to the report by the Commission on Government Procurement. (See appendix B.)
commercial item:	An item that is sold or licensed to the general public for other-than-government use, or, if not yet sold to the public, is developed primarily for other-than-government use, or is composed of some combination of commercial items generally sold to the public. This definition is derived from that developed by the Acquisition Law Advisory Panel.
Commercial Item Description (CID)	A simplified **federal specification** that describes the key, salient physical or functional characteristics of an acceptable commercial (or modified commercial) product. CIDs were established by DOD in response to recommendations by the Commission on Government Procurement (see appendix B).
commercial off-the-shelf (COTS)	A commercial item sold or configured “as is,” that requires no modification in order to be used by the government.
commercial service	A service that has been or will be offered for sale to the general public for other than government purposes.
commercial technology and industrial base (CTIB)	The combination of people, facilities, institutions, and skills required to design, develop, manufacture, test, and maintain commercial items, chiefly for commercial markets. See also defense technology and industrial base, national technology and industrial base.

Competition in Contracting Act (CICA)	Public Law 98-369, Title VII, passed July 18, 1984. Requires "full and open competition" in federal acquisition programs and requires that federal agencies "promote the use of commercial products wherever practical."
Computer-aided Acquisition and Logistic Support (CALS)	A DOD effort to develop and implement a series of information-management systems to streamline procurement of equipment and spare parts and compress the acquisition cycle.
Continuous Acquisition and Life-cycle Support (CALS)	**See Computer-aided Acquisition and Logistic Support.**
Cooperative Research and Development Agreement (CRADA)	A method of transferring technology from federal laboratories to the private sector. CRADAs were established under the Stevenson-Wydler Technology Innovation Act of 1980.
COTS	**See commercial off-the-shelf.**
CPU	Central processing unit
CRADA	**See Cooperative Research and Development Agreement.**
CSIS	**See Center for Strategic and International Studies.**
CTIB	**See Commercial Technology and Industrial Base.**
CUCV	**See Command Utility Cargo Vehicle.**
DARPA	**See Defense Advanced Research Projects Agency.**
Defense Advanced Research Projects Agency (DARPA)	Agency chartered to support "high risk, high payoff defense research. Became ARPA in 1993.
Defense Federal Acquisition Regulations (DFARs)	Those regulations governing or pertaining to the acquisition of items for DOD.
Defense Logistics Agency (DLA)	DOD agency responsible for acquisition of many common purpose items for all the Services.
Defense Manufacturing Office	A former DARPA-funded program established to improve manufacturing know-how, reduce the cost of end items, and create a production capacity for critical items where one did not exist. The program was eliminated in 1991.
Defense Personnel Support Center (DPSC)	One of five **DLA** centers, the DPSC buys and distributes nearly $4 billion worth of food, clothing, textiles, and medical supplies worldwide each year.

Defense Science Board (DSB)	A group of senior private sector advisors commissioned by the Office of the Secretary of Defense to investigate technical aspects of DOD decisionmaking. (See also appendix B for some reports completed by the DSB.)
defense technology and industrial base (DTIB)	The combination of people, facilities, institutions, and skills required to design, develop, manufacture, test, and maintain weapons and supporting equipment for the U.S. armed forces. Functionally, it comprises three domains: research, and development; production; and maintenance. See also Commercial Technology **and Industrial Base, National Technology and Industrial Base.**
Department of Defense Index of Specifications and Standards (DODISS)	A list of DOD specifications and standards.
DFARs	**See Defense Federal Acquisition Regulations.**
DLA	**See Defense Logistics Agency.**
DOC	Department of Commerce
DOD	Department of Defense
DODISS	See Department of Defense Index of Specifications and Standards.
DOE	Department of Energy
DSB	See Defense Science Board.
DSMC	Defense Systems Management College
DSSP	See Defense Standardization and Specification Program.
DTIB	See Defense Technology and industrial Base.
dual use	Term applied to technologies, goods, services and processes that can be used for both potential defense and commercial purposes.
EC	electronic commerce
EDI	electronic data interchange
facility	A single R&D, production or maintenance complex of a business or government entity.
FACNET	See Federal Acquisition Computer Network.
FARs	**See Federal Acquisition Regulations.**
FASA	**See Federal Acquisition Streamlining Act of 1994.**
Federal Acquisition Computer Network (FACNET)	A computer network established under the Federal Acquisition Streamlining Act to facilitate electronic commerce within the federal government.

Federal Acquisition Streamlining Act (FASA)	Federal legislation aimed at improving the government's acquisition processes. At the time this report went to press, the Act had been passed by both the Senate and the House of Representatives.
Federal Acquisition Regulations (FARs)	Federal regulations governing contracting procedures between private industry and the federal government.
federal specification	A specification developed when an acceptable commercially available product or service exists, but specific design, performance, interface, or other characteristics cannot be adequately described in a Commercial Item Description. See also federal standard, military specification, military standard.
federal standard	A standard covering an engineering or management process, practice, or technique having multiple agency interest. See also federal specification, military specification, military standard.
FED-STD-	The prefix used before a number to denote a federal standard.
firm	A single overall business entity. A firm may be comprised of subsidiaries.
Form, fit, and function specifications	Specifications describing the roles and requirements for a product, rather than denoting method of production. Most current military specifications go beyond form, fit, and function specifications.
GDP	Gross Domestic Product
General Services Administration (GSA)	The principal agency responsible for the procurement of goods and services for the federal government.
Global Positioning System (GPS)	A constellation of 21 geosynchronous navigation satellites (plus spares), deployed by the United States. The satellites can provide those equipped with military-type receivers with highly accurate navigational information. Those equipped with commercial receivers receive degraded, and therefore less precise, information. Also known as Navstar. See also Small Lightweight GPS Receiver.
GNP	Gross National Product
GOCO	Government-owned, contractor-operated entities. Although the government owns the facilities, it is operated, managed, and maintained by private firms, and the employees are considered employees of the firm, rather than of the government.
GOGO	Government-owned, government-operated entities. The government directly controls GOGO facilities, and the workforce is comprised of government employees.
GPS	See Global Positioning System.
GSA	See General Services Administration.

High-Mobility Multipurpose Wheeled Vehicle (HMMWV)	The M-988 series of multipurpose vehicles, also known as the Hummer and the Humvee. A lightweight, diesel-powered, four-wheel-drive vehicle that is built by AM General on a common 1 l/4-ton chassis, designed specifically for military missions, and used by the three Services in a variety of configurations. AM General also has a line of commercial Hummers. See also Command Utility Cargo Vehicle **(CUCV).**
HMMWV	**See High-Mobility Multipurpose Wheeled Vehicle.**
Hummer	**See High-Mobility Multipurpose Wheeled Vehicle.**
Independent Research and Development (IR&D, IRAD)	Research and development conducted by government contractors that may be charged to the government as an allowable expense. IR&D is conducted under the supervision of DOD.
Index of Specifications and Standards	**See Department of Defense Index of Specifications and Standards.**
industrial sector	A portion of the economy involving related technologies, specialized assets and processes. See also **tier.**
IR&D	**See Independent Research and Development.**
integrated processes	Procured from private facilities that predominantly use common processes for both defense and commercial goods or services. This sharing of processes might occur in R&D, production, maintenance, or administration. It might involve the use of common equipment, labor, management, or inventory.
International Organization of Standards (ISO)	A Geneva-based organization that has promulgated a set of quality assurance standards, utilized by many European states and now by DOD.
ISO	**See International Organization of Standards.**
ISO 9000	A series of documents on quality assurance published by the International Organization of Standards.
J-CALS	**See Computer-aided Acquisition and Logistics Support.**
Joint Computer-aided Acquisition and Logistic Support (J-CALS)	**See Computer-aided Acquisition and Logistics Support.**
Manufacturing Technology Program (MANTECH)	A DOD and Service program to develop improved manufacturing processes and technologies, and to diffuse those efforts throughout the DTIB.
market investigation	The second of two phases of DOD market analysis, in which DOD determines how suitable an item is for a particular defense use once an initial need is identified. See also **market surveillance.**

market surveillance	The first of two phases of DOD market analysis, in which all acquisition and development activities inside and outside of government seek to remain technically current in their areas of expertise in order to provide, on demand, initial information on the general availability of items to fill a need. See also market investigation.
metric	A unit or method of measurement.
MIL-	The prefix used to denote a military specification or standard, e.g., MIL-Q-9858A.
military specification (Mil-Spec)	A complete description of a product that is intrinsically military in character or a significantly modified commercial product requiring special features, design, packaging, or quality assurance to satisfy military needs. See also federal specification, federal standard, military standard
military standard (MIL-STD)	A standard describing an engineering or management process, practice, design criterion, data-generating requirements, testing technique, or definition. See also federal specification, federal standard, military specification.
MIL-SPEC	**See military specification.**
MIL-STD	**See military standard.**
National Institute of Standards and Technology (NIST)	The organization responsible for investigating technological issues and standards. Formerly National Bureau of Standards (NBS).
national technology and industrial base (NTIB)	The domestic economy, including the DTIB and CTIB.
NDI	**See nondevelopmental item.**
NIST	**See National Institute of Standards and Technology.**
nondevelopmental item (NDI)	An existing item, either defense or commercial.
NTIB	**See national technology and industrial base.**
O&M	**See operations and maintenance.**
operations and maintenance	A DOD purchasing account used to procure most of the day-to-day supplies needed by the military in peacetime, such as housing, food, clothing, fuel, office supplies, and general maintenance.
OSD	Office of the Secretary of Defense
OTA	Office of Technology Assessment

prime contractor	A contractor that sells or licenses a good or service directly to the government. Typically, the prime contractor adds value (e.g., assembly, systems integration, or manufacturing) to goods and services it procures from **subcontractors.**
private	Referring to a privately owned (as opposed to government-owned) business or sector.
production base analysis (PBA)	Any of a series of analyses by which DOD manages defense-industrial responsiveness planning. PBAs support industrial-preparedness planning for force regeneration over a wide range of crises and emergency situations. The process complements the strategic planning system used by the U.S. Joint Chiefs of Staff, who develop requirements on the basis of critical items lists, prepared by U.S. military commanders throughout the world.
Program Executive Officer **(PEO)**	Officials responsible for administering a defined number of major and/or nonmajor acquisition programs who report to and receive direction from a Service Acquisition Executive.
program manager	A DOD manager overseeing an acquisition program. Each program manager reports to a Program Executive Officer.
public	Of or pertaining to those activities conducted by the government.
R&D	Research and development. Conducted primarily in the private sector, it is also a responsibility of government laboratories and test facilities run by the DOD, DOC, DOE, and NASA, as well as university laboratories conducting research relevant to defense.
RDT&E	Research, development, testing, and engineering; a term used primarily by DOD.
SDIO	Strategic Defense Initiative Organization
Section 800 Panel	**See Advisory Panel on Streamlining Acquisition Laws.**
segregated processes	Procured from public or private facilities that have largely or completely segregated their defense work from any commercial work. Public facilities are by definition segregated, because they do not do commercial work.
segregation	The act of separating the development, production, and/or maintenance of commercial and military goods and services. Segregation maybe due to a number of factors, including separate cost-accounting requirements, unique requirements, or uneconomical production volumes, and may occur at the industrial sector, firm, or facility level.
Service	Any of the three main branches of the U.S. Armed Services: Air Force, Army, and Navy/Marines.

Service Acquisition Executive	The senior acquisition executive with each military department, designated by the Component Head, responsible for administering acquisition programs in accordance with DOD policies and guidelines.
SLGR	See Small Lightweight GPS Receiver.
Small Lightweight GPS Receiver Program (SLGR)	An Army program begun in 1986 to determine whether a lightweight, preferably handheld, low-cost, existing commercial GPS receiver could be used by a wide variety of Army personnel with minimum training.
smart buyer	A procurement official who has the training, expertise, and authority to buy goods and services using commercial buying practices, such as **market surveillance** and **market investigation.**
spin-off	**The** transfer of technology, processes, or capabilities from military programs or the DTIB to the CTIB.
spin-on	The transfer of technology, processes, or capabilities from commercial programs or the CTIB to the DTIB.
subcontractor	A contractor that sells or licenses a good or service to a prime contractor or another subcontractor. A subcontractor on one project may be a prime contractor on another.
technical data rights	A contractual requirement to provide DOD with detailed information about the manufacture, installation, operation, and maintenance of a product.
Technology Reinvestment Project (TRP)	An ARPA managed program aimed at developing and diffusing dual-use technology.
tier	A link in the economic "food chain." Prime contractors occupy the first tier. Second-tier subcontractors supply the prime contractors. Third tier subcontractors supply the second tier, and so on.
TINA	See Truth in Negotiations Act.
TRP	See Technology Reinvestment Project.
Truth in Negotiations Act (TINA)	Public Law 87-653, as implemented by FAR 15.804. Requires vendors to assure that the price quoted for a good or service sold to the federal government is in fact the lowest price offered any customer. Applies to subcontractors at any tier on contracts exceeding $100,000.
USD(A)	Under Secretary of Defense for Acquisition Now the Under Secretary of Defense (Acquisition & Technology).

Appendix B: Selected Commissions, Studies, Findings, and Recommendations

B

Date	Commission/study	Findings	Recommendations
949	Hoover Commission on the organization of the Executive Branch of Government	Substantial duplication exists in cataloging and identifying material	Standardize specifications Continue use of civilian advisory boards Have the NSRB develop economic warfare program aimed at supporting national security in peace and war
955	Hoover Commission on Business Organization of DOD	Standardization of material and improved accounting procedures would improve DOD acquisition	Establish business-tested accounting systems Establish separate civilian-managed agency to administer common supply and service activities Promote standardization
1970	"Fitzhugh" Blue Ribbon Defense Panel	The government's technical data rights policy "tends to discourage the best-qualified companies from accepting or, in some cases, competing, for contracts"	Save money by adopting commercial practices Improve the requirements process Increase the Services' analytical capability to evaluate alternatives early Correct the use of specifications to minimize obsolete specifications and demands that exceed state-of-the-art Address increasing industry reluctance to commit resources to defense work Develop analytical capabilities to improve requirements generation and changes in the rights to technical data policy

Date	Commission/study	Findings	Recommendations
1972	Commission on Government Procurement	Government specifications tend to be overly detailed, or unique, and tend to duplicate existing commercial distribution systems	Take greater advantage of the efficiencies of the commercial marketplace Shift toward use of commercial product procurement Establish oversight over agency policy and procedures in this area Place greater reliance on off-the-shelf products and use established commercial distribution channels to support them
1977	DSB Shea Report on Specifications and Standards	Military specifications are required Military specifications should incorporate lessons previously learned Misapplication & over application of military specifications adds costs Identified 114 specifications and standards as "cost-drivers"	Available flexibility in specifications and standards are under-utilized Address the eight general groups of "cost drivers," including General Design Requirements; Environmental Requirements and Test Methods; Quality Control, Inspection, and Calibration; Reliability and Maintainability Requirements; Human Engineering and Safety Requirements; Documentation and Standardization Methods; Configuration Controls; and Packing, Packaging, Preservation, and Transport Measures
1983	Grace Commission, OSD Task Force	Service autonomy and congressional restrictions impede efficient management of DOD Changes could save 13% on procurement, 6% on O&M	Consolidate acquisition functions Simplify regulatory constraints Limit overly rigorous military specifications Contract for demilitarization of ammunition Improve POL bidding
1984,	Toth Report on Standardization	Defense Material Standardization and Specification Board's span of control is too great The emphasis is often on creating standards, rather than adhering to them	Establish objectives & priorities Involve users in standardization process Develop management information system

Date	Commission/study	Findings	Recommendations
1986	Packard Commission	There is little coordination or reconciliation in the budget process between currently executed budgets, currently debated budgets, and planning for future budgets The government frequently has promulgated very rigid custom specifications, despite the existence of commercial alternatives Cost allocation procedures often produce very high spare part prices Laws correcting past problems with defense acquisition have often only exacerbated problems, as flexibility is further reduced A user-pull acquisition process is likely to produce excessive costs, as cost-performance tradeoffs are ignored or downplayed	Make greater use of "off-the-shelf components, systems, and services Develop new or custom items only after determining the inadequacy of commercial items Require Service Defense Acquisition Executives to take the lead in increasing the use of commercial products Streamline military specifications
1986	OUSD(A), DSB "Use of Commercial Components in Military Equipment"	Change occurs more rapidly, in general, in commercial technology than in defense technology DOD procurement processes often differ greatly from commercial ones Even if DOD's use of commercial items rose, there would be little effect, unless the procurement and acquisition processes were to be changed	Use commercial products (especially microelectronics) and practices to save money Provide incentives for use of commercial products and practices Participate in nongovernmental standards bodies, for use in lieu of military standards

Date	Commission/study	Findings	Recommendations
1988	OUSD(A), DOD "Bolstering Defense Industrial Competitiveness"	Many critical defense industries in 1980-1985 had below-average productivity growth, but had average or above-average profitability DOD procurement policies emphasize low prices to the exclusion of improvements in quality and production processes, and value performance much more than productivity and reliability There is little risk-sharing or other incentive for innovation on the part of critical defense industries	Forge the right relations with industry Establish strategic planning task force Form a Defense Industrial Base Information Administration Develop information on foreign-source dependencies of critical systems Emphasize quality control Emphasize process technology Enhance tech skill base Increase use of commercial process & product specs
1988	OUSD(A) "Enhancing Defense Standardization"	About 400 FSCs with commercial potential identified	Revise DOD 4120.3 to assign accountability Review Lead Standardization Activities Pursue nongovernmental standards Review specs Pilot development of "Living Specs" Adopt more NGSs
1989	OUSD(A), DSB "Use of Commercial Components in Military Equipment"	Despite verbal support, greater use of commercial products and practices has been slow Legislative and regulatory reforms (oversight, audits, civil and criminal liability) have further distanced DOD procurement from commercial	Specifications should be set in terms of "form, fit and function," rather than production methods There should be a standard form for all solicitations, which would include technical data rights, software rights and pricing data requirements

Date	Commission/study	Findings	Recommendations
1991	CSIS "Integrating Commercial and Military Technology for National Strength"	Accounting requirements are a primary barrier to integration Military specifications and standards discourage use of commercial products, practices and standards Questions of ownership of technical data rights discourage commercial sector cooperation Unique contracting requiremerits raise additional problems	Exempt commercial products from re - quirements for competitive bidding Create incentives to use commercial products, practices and standards Modify government demands for rights in technical data Exempt commercial products and suppliers from unique contract requirements
1993	Report of the Acquisition Advisory Law Panel to the US Congress	Existing law has not achieved the benefits of commercial-military integration Existing law has not resuited in broad use of commercial items in DOD systems Procurement statutes (and implementing regulations) themselves are a major barrier	Formulate stronger policy language in support of use of commercial items and NDI Create a new definition of commercial items Execute changes in TINA Create new exemptions in technical data requirements; Restructure Buy American restrictions Create a new rule structure that provides exemptions from statutes that create barriers to use of commercial items
1993	DSB Task Force on Defense Acquisition Reform	The current system was intended to monitor costs and ensure fair pricing The current system actually discourages efficient production and exacerbates contention between government and industry	Utilize commercial functional specifications where possible Emphasize competition as a means of price control, rather than the current cost-based accounting system Involve users early in the program definition process Take into account past performance of contractors Use the general regulatory environment governing commercial business, especially in the area of accounting

SOURCE: Office of Technology Assessment, 1994.

Appendix C: Selecting a Representative Industrial Sample

Cases, if selected randomly, can be expected to be representative of the larger population of companies, contractors, or programs from which they were drawn. As a result, statistical relationships found among characteristics of the individuals (e.g., the probability that an establishment is segregated, as a function of annual sales volume) maybe generalized to the population from which the individuals were selected.

Selecting cases randomly requires randomly identifying the establishments, contracts programs, dollars, or other entities about which information is desired, and then obtaining the information desired e.g., by survey. A high response rate is required to assure representativeness of the sample.

The choice of population from which cases are to be selected (e.g., establishments or contracts) will depend in part on the type of information desired but will be limited by the availability of databases or the ability to obtain a high response rate in a survey. For example, congressional researchers may use the Award Contracts (AWCO) database of the House Information System (HIS), which contains data (provided by the Federal Procurement Data Center of the General Services Administration) on all federal contracts of $25,000 or more in the last full year for which data are available. Once a population and database have been found, individuals may be selected from the population by using the pseudorandom-number generation capabilities of common software products. Pseudorandomly generated numbers may be tested for acceptable independence, randomness, and uniformity.[1]

For each DOD contract or prime contractor in the sample, a random sample of subcontracts or subcontractors may be selected. The sampling may be uniform or weighted by contract value. The former would be more efficient if one wished to make inferences about the number of contractors that are integrated or would be affected by some proposed change; the latter would be more efficient if one wished to make inferences about the fraction of the defense budget that would be affected (e.g., potential cost aversion). Sampling could be restricted to particular sectors of interest.

[1] D.A. Darling, "The Kolmogorov-Simimov, Cramer-von Mises Tests," *Annals of Mathematical Statistics, vol. 28,* pp. 823-838, 1957.

After the cases to be studied have been identified and the desired data obtained, statistical analysis can identify the combination of characteristics that best distinguishes the integrated cases from the segregated cases.[2] It can estimate the probability that a company, for example, in the sample is integrated, based on other characteristics (e.g., annual sales) that are known about the companies in the sample.[3]

A model obtained in such a manner describes relationships e.g., between integration of a company and other variables within the sample to which it was fitted. It may be used to predict integration in a larger population, provided 1) the incidence (i.e., unconditional probability) of integration in the new population is known, and 2) there is no reason to believe that the new population differs significantly from the sample in any aspect that may influence integration. Drawing the sample randomly from the population ensures this and, moreover, allows the incidence of integration in the population to be estimated from that in the sample.

2 J.A Anderson, "Logistic Discrimination," pp. 169-191 in *Handbook of Statistics*, P.R. Krishnaiah and L.N. Kanal, eds., vol. 2, No. 1, 1982.

[3]Gary G. Koch and Suzanne Edward\, "Logistic Regression," pp. 128-133 in *Encyclopedia of Statistical Sciences*, Samuel Kotz and Norman L. Johnson, eds., vol. 5 (New York, NY: John Wiley & Sons, 1985).

D Appendix D: Data Collection

There are a number of possible alternatives for collecting CMI data. One possibility is for the Census Bureau to gather and report statistics on the number of firms that sell to *both* military and nonmilitary markets in selected sectors and the values of such sales. For example, Current Industry Report (CIR) MA37D----Aero*space Orders* reports annually the number of companies in aerospace sectors, the number that sell to military purchasers, and the number that sell to nonmilitary purchasers, but not the number that sell to *both* military and nonmilitary purchasers. [1] The number and percentage of integrated firms may be deduced from the statistics that *are* published, but only within limits. The Census Bureau could report the exact number-not only for aerospace sectors, but also for other sectors surveyed in the M-3 Monthly Survey of Manufacturers' Shipments, Inventories, and Orders.[2]

Unfortunately, these data would only reveal those companies that produce both defense and commercial goods and services. It would provide no information on the degree of integration of research, development, production, and administration processes within these companies. These data would not differentiate between a firm with separate defense and commercial divisions and one that builds its commercial and defense products on the same production line.

Measuring integration of processes and understanding reasons for segregation of processes would require collection of more specific information, such as that collected in the private

[1] U.S. Department of Commerce, Bureau of Economic Analysis, Current Industrial Reports, MA37D—*Aerospace Orders, 1992.*

[2] The Census Bureau conducts a monthly noncompulsory survey of the shipments, inventories, and orders of "nearly all manufacturing companies with 1,000 or more manufacturing employees and a sample of smaller firms." It solicits separate reports on defense and nondefense activities for the following industry categories: ordnance and accessories; communication equipment; complete aircraft, missiles, and space vehicles; ships, tanks, and tank components; and search and navigation equipment. [U.S. Bureau of the Census, " 1993 Instruction Manual for Reporting in Monthly Survey M-3." M-3(I) (Washington, DC: U.S. Government Printing Office, 1993).] Summary statistics for most 2-digit SIC codes and 75 combinations of 4-digit SIC codes from January 1958 through March 1993 are available on tape reel, tape cartridge, and diskette. The Census Bureau also collects data from establishments on the value of shipments to federal government agencies as part of the Census of Manufacturers. [Form MC-9675, 1 -22-93.] Data from the 1992 Census of Manufacturers are being tabulated as this report goes to press.

1992 CSIS survey.[3] Integration (and reasons for segregation) of firms or establishments in all sectors producing for national defense could be estimated within calculable confidence limits by surveying only a fraction of the firms, if they were selected randomly. and if a high response rate were obtained. Surveying more firms would reduce the range of uncertainty.

Achieving a high response rate will probably require making response mandatory under the law. The necessary legislation already exists to allow the Census Bureau (Title 13, U.S. Code), the Department of Commerce (section 705 of the Defense Product ion Act of 1950 and Executive Order 12656, section 401) or the Department of Defense (section 705 of the Defense Production Act) to collect the pertinent data. Any such mandatory collection still must be approved by the Director of the Office of Management and Budget (44 USC 3507) to ensure that it is not overly burdensome on private industry.

A model for a collection of CM I data is the Census Bureau's 1991 Survey of Manufacturing Technology, a joint effort by the Bureau of the Census and the Defense Logistics Agency's Manufacturing Engineering/Research Office.[4] It surveyed 10,088 establishments with 20 or more employees selected to represent a population of manufacturing establishments classified in Standard Industrial Classification (SIC) Major Groups 34-38. After adjustments to account for establishments that had gone out of business, this population was estimated as 42,250.

The 8-page, multiple-choice questionnaire was designed to collect information for measuring the degree to which manufacturing establishments use technologically advanced equipment and software and the degree to which plant characteristics influence usage. The survey achieved a 92.8-percent response rate, with a 5.5-percent refusal rate. A similar effort, using a questionnaire such as that developed by CSIS, could obtain reliable measures of prevalence of integration of research, development, production, and administration, plans to integrate, reasons for segregation, and plant characteristics. Any such collection effort, however, will require an allocation of government resources and may impose an even greater collective burden on the respondents. The 1991 Survey of Manufacturing Technology was estimated to cost the government "in the low $400,000."[5] OTA estimates that the public reporting burden was about **$700,000.6**

[3] Debra van Opstal, *Integrating Civilian and Military Technologies:* An *Industry Survey* (Washington, DC: The Center for Strategic and International Studies, April 1993).

[4] U.S. Bureau Of the Census, *The Survey of Manufacturing Technology: Factors Affecting Adoption*, SMT/91-2 (Washington, DC: U.S. Government Printing Office, May 1 993).

[5] Mr. John Govoni, Chief. U.S. Bureau of the Census, Industry Division, personal communications, Dec. 13, 1993.

[6] The questionnaire used in th,] 99 1 Survey of Manufacturing Technology estimated the public reporting burden at 30 minutes per response. About 9,()(M) establishments completed reports, so the total burden was about 4,500 hours. If the forms were completed by corporate officials earning an average of $ 100,000" per year, with 2(K) percent overhead, working 48- W-hour week\ per y ear, the collective burden borne by the responding firms would have been about $700,000 (1991).

E Appendix E: Workshops and Reviewers

Workshop on Shipbuilding
June 23,1993

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Workshop on Shipbuilding
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The Pentagon

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U.S. Coast Guard Headquarters

Gerry Lamb
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Bath h-on Works

Paul Martineau
Executive Director
Ingalls Shipbuilding—Washington Office

Robert J. Scott
Vice President
Gibbs & Cox, Inc.

Gunter Woehling
Vice President & General Manager
Henschel, Inc.

Workshop on
Civil-Military Integration of Manufacturing Processes
September 8,1993

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☆ US. GOVERNMENT PRINTING OFFICE: 1994 - 301-804 - 814/27411