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.

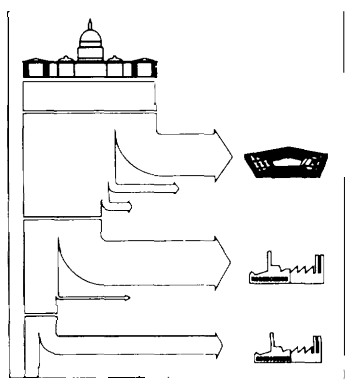


TABLE 3-1: Important Commissions and Studies

- 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.

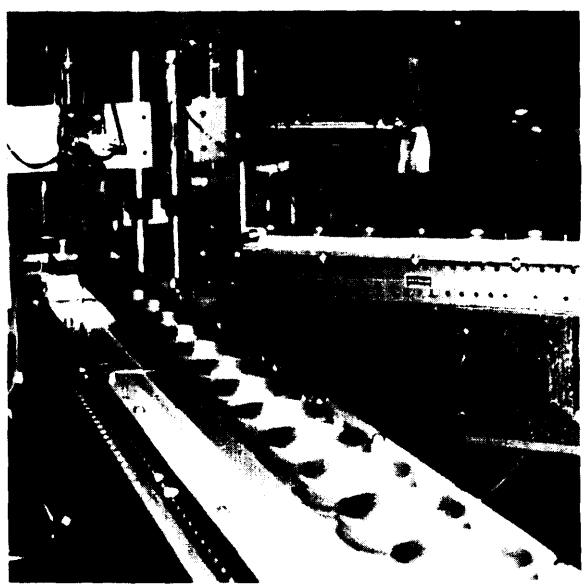
Compliance with acquisition laws and regulations raised defense firms' overhead costs and made their commercial product lines less competitive. Moreover, the laws and regulations provided few incentives to incorporate new processes. Compliance with DOD contracting rules required actions that were totally 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).

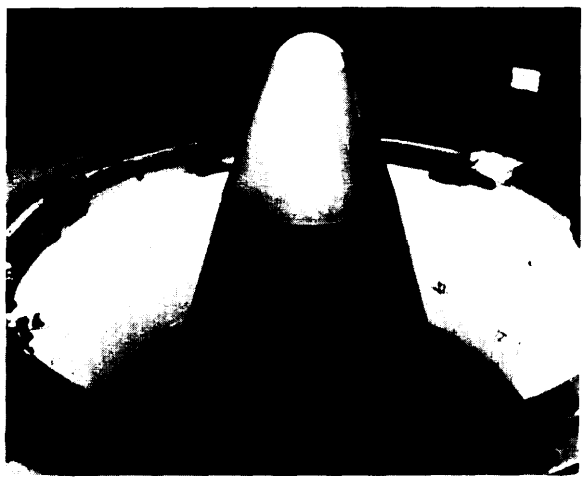
But while final assembly of some of these systems might be militarily unique, many weapon-system components could be commercial. Fur-



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.

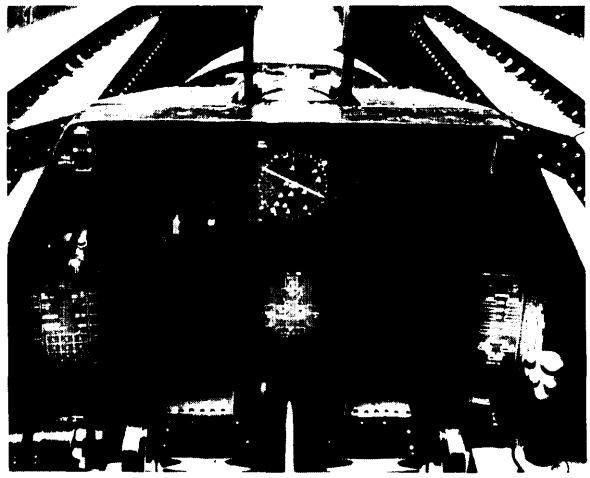
Increased Foreign Dependence

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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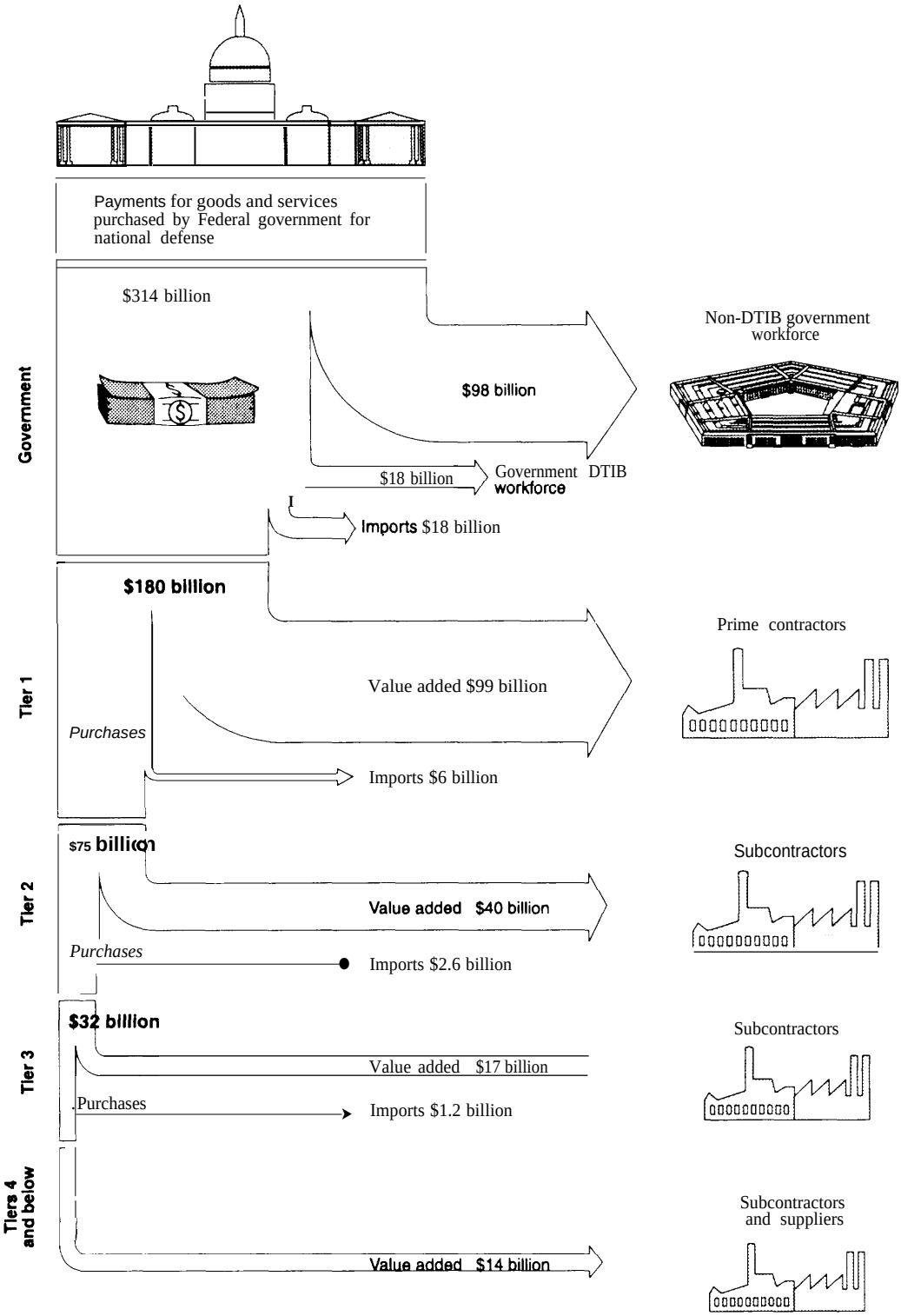
26 The total calendar year 1992 spending of $313.8 billion (current dollars, here rounded to $314 billion) was estimated by the Department of Commerce's Bureau of Economic Analysis (BEA). The fractions spent in various tiers were estimated by OTA on the basis of round-by-round analysis of BEA's unpublished 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.

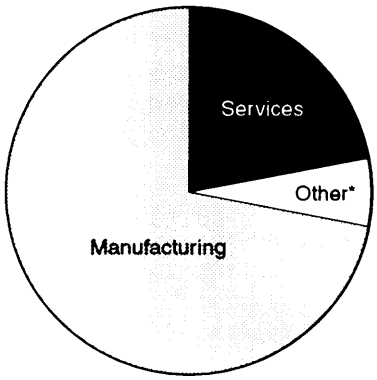
CMI at Different Industrial Levels

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.

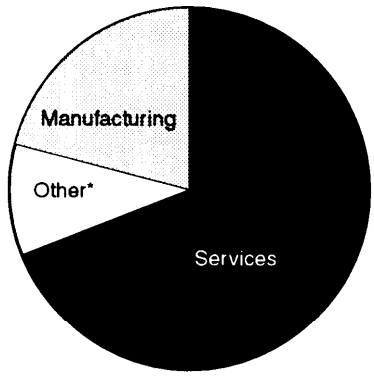
Integration at the technology or industrial sector level is characterized by the DTIB and CTIB sharing common technologies, processes. and specialized assets (e. g., unique test stands, wind tunnels, and industrial research centers). An industrial sector can be said to be integrated if its defense goods 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.

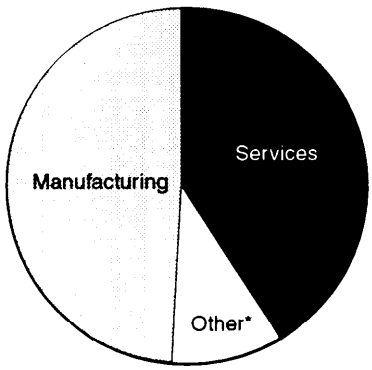
FIGURE 3-2: Composition of Defense and Nondefense Purchases



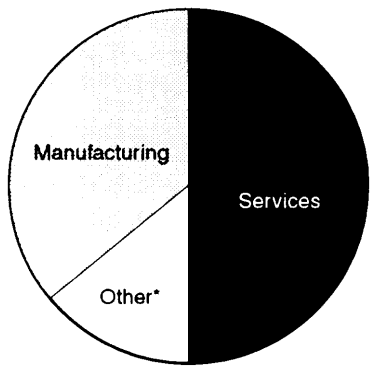
Defense final purchase



Nondefense final purchase

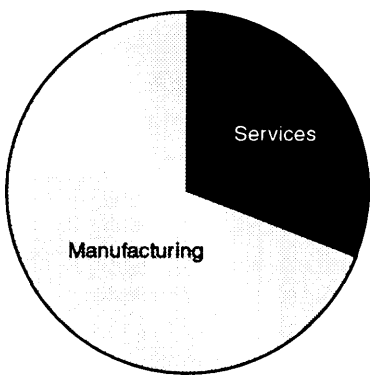


Indirect or lower tier defense purchases



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

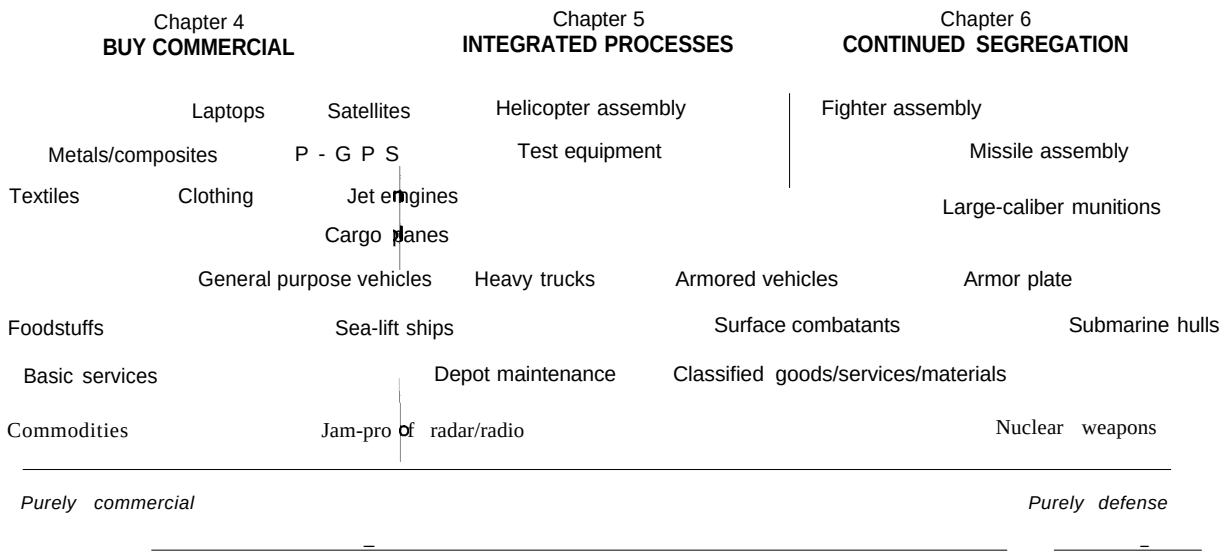
SOURCE Off Ice of Technology Assessment, 1994

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.