SECTION 3: THE IMPACT OF TRADE WITH CHINA ON THE U.S. DEFENSE INDUSTRIAL BASE

"The Commission shall investigate and report on—

"WORLD TRADE ORGANIZATION COMPLIANCE—The compliance of the People's Republic of China with its accession agreement to the World Trade Organization.

"ECONOMIC TRANSFERS—The qualitative and quantitative nature of the transfer of United States production activities to the People's Republic of China, including the relocation of high technology, manufacturing, and research and development facilities, the impact of such transfers on United States national security, the adequacy of United States export control laws, and the effect of such transfers on United States economic security and employment."

Changes in the U.S. Defense Industrial Base

During the past two decades, the U.S. defense industrial base has undergone three significant changes: A substantial reduction and redirection of defense expenditures in the period immediately following the end of the Cold War; effects from the dramatic expansion of globalization including increased reliance on imported components and end items in defense applications; and halting the reliance by the U.S. Department of Defense (DoD) on a dedicated, exclusive development and production pipeline for its military weapons and materiel.

During the Cold War, co-production with foreign defense companies often was a means of integrating American systems and components with those of U.S. allies, and served as a mechanism for strengthening alliances and ensuring inter-alliance standardization and interoperability. Still, manufacturing of American defense articles was located predominantly in the United States, creating weapon systems with high, if not total, domestic content. Policymakers believed this offered the greatest possible assurance that U.S. defense systems would be reliable and superior to those of other nations, notably the Soviet Union. The higher costs of this approach were considered to be acceptable trade offs for the benefits, one of which was the establishment of a strong and productive indigenous defense industrial base that was able to develop and field the weapons and other equipment that constituted an effective deterrent to the Soviets.

One of the characteristics of this model was that the Pentagon created its own specifications for a wide range of items used by the nation's military forces. This extended well beyond weapon systems, to include such disparate items as field rations with sufficient calories to sustain a combat soldier on the battlefield and communications gear able to withstand the rigors of aerial combat. Policymakers of the time believed such needs could not be fully satisfied with commercial off-the-shelf (COTS) components. The military's specifications ("mil specs") had the additional effect of supporting a strong domestic defense industrial base in the United States.

When the Cold War ended, U.S. defense budgets were trimmed substantially in constant purchasing power. The defense industrial base absorbed much of the effect of this major redirection, and reduced its workforce and its aggregate physical plant. During the same period, major businesses, including defense firms, began to employ some of the same business practices being used by successful commercial firms in an increasingly globalized economy: they began to procure parts and components wherever they could be obtained at the lowest costs. More and more frequently this led to offshore sources. When it did, the subcontractors and other suppliers in the United States whose businesses had depended on contracts from the major defense manufacturers and prime contractors found it difficult or impossible to survive. This, too, resulted in diminution of the once-massive U.S. defense industrial base.

The following table illustrates how U.S. defense spending fell in the years between 1990 and 2000 (and then, accelerating dramatically between 2000 and 2005—a 48 percent increase during that period—transformed the reductions of earlier years into a gain of almost 11 percent for the entire period of 1990 to 2005). It compares the U.S. experience during this fifteen-year period with the changes in the defense budgets for eight other key nations including China, and provides world totals.

Table 1.3 Comparative Defense Budgets 1990–2005 [127]
In millions of U.S.$
(all figures adjusted to constant 2003 prices)

	1990	1995	Percent Change from 1990	2000	Percent Change from 1990	2005	Percent Change from 1990
United States	431,282	336,635	−21.9	322,309	−25.3	478,177	10.9
France	50,040	46,089	−7.9	43,797	−12.5	46,150	−7.8
Germany	51,160	37,852	−26.0	36,021	−29.6	33,287	−35.2
United Kingdom	51,479	43,101	−16.3	40,533	−21.3	48,305	−6.2
China	12,300 (est.)	14,000 (est.)	13.8	22,200 (est.)	80.5	37,700 (2004 est.)	206.5
India	10,533	10,983	4.3	15,487	47.0	20,443	94.0
Israel	7,677	7,809	1.7	9,330	21.5	9,579	24.8
Japan	37,668	40,483	7.5	41,755	10.9	42,081	11.7

Table 1.3 Comparative Defense Budgets 1990–2005 [127]
In millions of U.S.$
(all figures adjusted to constant 2003 prices)—Continued

	1990	1995	Percent Change from 1990	2000	Percent Change from 1990	2005	Percent Change from 1990
Russia	126,400	16,000	−87.3	14,100	−88.8	21,000	−83.4
World	1,003,000	768,000	−23.4	784,000	−21.8	1,001,000	−0.2

Exchange rates utilized are specific for each calendar year.

During this same period, three realities drove the Pentagon to move away from its long-standing, predominant reliance on "mil specs" and toward greater use of COTS procurement: [128]

1. The costs of a totally separate research and development (R&D) process dedicated to weapons and military equipment, plus the costs of a totally separate supply chain for those weapons and equipment that was necessary to manufacture mil-spec parts and components that were neither needed nor used for commercial purposes, were so high they could not be supported in the post-Cold War era of smaller defense budgets.
2. Military planners knew that, increasingly, U.S. forces would derive critical advantage from their ability to integrate and effectively utilize high technology in their war fighting, and that it would be this "edge" that would be crucial to realize military victories with acceptable casualty and other costs. High technology increasingly was employed in all weapon systems and in myriad support functions. Further, the United States sought and found military advantage in greatly expanded and enhanced command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) activities, all of which were fundamentally dependent on extensive and integrated high technology. The dedicated defense R&D processes were incapable of satisfying this rapidly expanding universe of defense high-technology product needs, and the only way the U.S. military could satisfy them was to tap the cutting-edge products of the prolific commercial marketplace—either as complete systems or as components of specialized military systems.
3. Military systems dependent on high technology are subject to the same patterns and pace of obsolescence as commercial products. But the mil-spec process of system development and production proved incapable of keeping pace as anticipated product life spans grew ever shorter. In a growing number of cases planners projected that the mil-spec product development and production process would not place weapons or equipment in the operational inventory until after the items were obsolete. Even in circumstances where cost was no object, this reality forced DoD to begin using COTS components and subsystems in the weapons and equipment it procures and, in some cases, to procure and utilize complete COTS systems.

Because using COTS components in defense systems is faster, more efficient, and less expensive in most cases, it now is the rare exception when there is a separate supply chain for a defense-related product. Generally, defense-related products now emerge from the same supply chains from which civilian commercial products emanate.

Deputy Under Secretary of Defense for Industrial Policy William C. Greenwalt testified to the Commission:

> *[T]he Commissioners may ask . . . why are we buying commercial items at all? Can't we insulate ourselves from commercial supply chain globalization trends? I believe that we cannot affordably do so. Globalization of supply chains is the reality of the 21st century and the Department has to develop a strategy to reap the benefits of this globalization and mitigate the risks.*[129]

Deputy Under Secretary Greenwalt further noted that, as production trends continue to move supply chains across the globe, DoD will continue to develop policies that aim to reap the benefits of globalization, including cost reduction, while seeking to mitigate attendant risks to national security.[130] Deputy Under Secretary Greenwalt said that while it would be better for the U.S. defense industrial base if DoD could influence the companies to retain their supply chains in the United States, DoD is, in fact, too small a customer of many of these companies to wield sufficient influence to accomplish this.[131]

In his testimony to the Commission, Mr. William Hawkins, Senior Fellow at the U.S. Business and Industry Council, confirmed that although reliance on COTS items is not new for DoD, it is a growing trend:

> *Since the 1980s, defense policymakers have encouraged the use of more and more commercial off-the-shelf or "dual use" components and products in military systems, largely because of their growing ubiquity in these systems and because innovation appeared to be proceeding faster in civilian industries than in defense-specific industries. This is not as new a situation as is often supposed.*[132]

The Impact of U.S.-China Trade on Sourcing of Defense Components, on the U.S. Defense Industrial Base, and on U.S. Security

During the past two decades, China's economy has grown (as documented in the other sections of this chapter). Beginning with cost advantages attributable to a host of factors (its low wage base, the absence of many social programs and supports available to U.S. workers, refusal to recognize workers' rights, failure to establish and adhere to environmental standards, etc.), manufacturers in China have been able to wrest sales from firms in the United States. This has resulted in the creation of a cycle in which many U.S. companies wanting to remain profitable have concluded they either must move their own manufacturing operations to China or halt their manufacturing operations and purchase parts and com-

ponents, and sometimes assembled products, made in China by other firms.

In some industries, reliance on China as the source of products or of parts and components is high—indeed, in some cases that reliance is complete. However, because U.S. policymakers see China as a possible strategic rival, DoD has established policies, as Deputy Under Secretary Greenwalt told Commissioners, that prohibit purchase from China of items with a significant military purpose. He also noted that broader statutory prohibitions, such as the Buy America Act, prevent DoD from directly acquiring many Chinese commercial items.[133]

Mr. Hawkins noted in his comments to the Commission, however, that as China's share of global manufacturing continues to increase, the American defense industrial base could become more reliant on Chinese components, and this might occur largely without the knowledge of policymakers. In fact, the Pentagon does not know how extensive this problem currently is because it does not keep track of the origin of many components of the weapon systems and other materiel it procures. Mr. Hawkins told the Commission that even the few government reports that have been released in recent years tracking the trend have failed to examine sub-tier suppliers and those reports that do look beyond the end-user level only examine a very small number of weapon systems.[134]

Deputy Under Secretary Greenwalt acknowledged that the potential exists for DoD unknowingly to acquire COTS items that have Chinese components:

> *[W]e are prohibited by law from incorporating Chinese munitions items at any tier in the contracting process. There is, however, the potential of buying commercial products that incorporate Chinese parts at the sub-tier level from either U.S. or foreign sources [that] are statutorily exempt from the Buy America Act. . . . [T]here may be some Chinese content in commercial off-the-shelf auto parts we buy. As commercial companies set up manufacturing operations in China, it is possible that some of these products will turn up in the DoD supply chain. If they do, DoD needs to do the risk/benefit analysis necessary to ensure that these products do not pose any national security risk through, for example, tampering, and then to mitigate those risks if necessary. My biggest concern for the future is in the microelectronics area.*[135]

The difficulty of maintaining an accurate awareness of the scope of this problem appears likely to grow in the future. According to Mr. Hawkins, the major U.S. defense contractors are moving away from manufacturing and toward the role of systems integration, which compounds the task of tracking the origin of the components they assemble:

> *[T]he trends don't look good here because our prime defense contractors are finally becoming systems integrators. They outsource most everything to somebody else and they're looking more and more to putting more emphasis on overseas partners. . . . [W]e know that the real trend in supply chains is to Asia, and China is getting a larger share of*

that everyday. An April IMF report in microelectronics . . . says that China is taking a larger and larger market share globally of that industry. So if we're going to go down that route of off-the-shelf technology and foreign purchasing, then China is going to be in the mix if we don't keep a sharp eye out for it.[136]

The Risks of Reliance on Foreign-Made Parts and Components in Sensitive Applications

Security risks resulting from tampering with or specially engineering foreign-manufactured parts and components are, of course, only one of the risks of using such parts and components in defense applications. Arguably a more likely problem is the reliability of such products, which may not be subject to the same rigorous production or testing standards that apply in the United States, or where manufacturers may not have the same set of incentives to produce quality products (such as the degree of probability they will be held liable, and forced to pay a substantial penalty, for product failure).

Further, outsourcing or moving portions of U.S. defense supply chains to China or other countries may risk the security of those supply chains and therefore the availability of the weapons and other equipment that depend on them, particularly when supply surges are necessary or while the U.S. is engaged in conflict with a supplying nation or one of its allies. The supply of foreign-manufactured parts and components is far more easily interrupted by acts of nature or national governments than the supply of domestically-manufactured parts and components. Reliance on foreign-produced parts, and inability to meet needs for them from alternative sources on a timely basis, threaten failure in whatever activities depend on the items that, in turn, depend on those parts for their operation.

The Costs to the Defense Industrial Base of Outsourcing Defense Manufacturing to China and Elsewhere: Loss of the Manufacturing Facilities and of Uniquely Skilled Labor

As American companies have either shut down operations in the United States or moved manufacturing overseas, or both, companies have reduced their domestic capacity and lost some of their American workforce. Both have had immediate economic impacts stretching well beyond effects on defense capability and readiness, and even the ability to surge production when necessary.

The workforce loss is of particular concern with respect to workers with unique skills in such fields as tooling, shipbuilding, and aircraft and submarine production.[137] These skills are highly specialized, requiring unique training and industry know-how. Some of the skills involved are so specialized and precise that it takes workers not months but a number of years to acquire them through both concentrated training programs and on-the-job apprenticeship. Manufacturing downsizing attributable to offshoring has resulted in fewer Americans being trained in these fields, leaving a skills gap as the aging defense manufacturing workforce moves toward retirement.[138] Testifying before the Commission, Mr. Owen

Herrnstadt, Director of Trade and Globalization for the International Association of Machinists and Aerospace Workers, noted this trend:

> *[W]hat was once a drip maybe 50 years ago has turned into a tidal wave, as literally three million manufacturing jobs have disappeared from our shores in the last few years. . . . And as these jobs disappear, more and more industry, particularly manufacturing industry, is gaining steam in countries like China. . . . We need to develop and implement comprehensive solutions and do it in a timely fashion. . . . We need [also] to look at building skills—[establishing] skills schools to replace the skills that are being lost . . . on a daily basis by our own U.S. defense workers as the aging workforce grows and new workers are unable to enter the market because those new jobs aren't there.*[139]

Possible Relaxation of Prohibitions of Defense-related Acquisition from China

Despite these concerns, DoD is considering relaxing the prohibitions on obtaining defense components from China other than those found in COTS items. Deputy Assistant Secretary of the Army for Policy and Procurement Tina Ballard testified before the Commission that the Army is considering purchasing the rocket and missile propellant butanetriol trinitrate from China that is used in weapons such as the Hellfire missile.[140] With less than an 18-month supply remaining and with no American sources, the Army may need to acquire this chemical from China, according to Deputy Assistant Secretary Ballard[141]—although DoD is continuing to examine the possibility of developing an American or allied source.[142]

The U.S. Defense Industrial Base Remains Strong But Vulnerable

Despite the wrenching changes it has experienced in the past 20 years, U.S. defense firms remain the most profitable in the world. Currently, seven of the top ten defense firms in the world are located in the United States.[143] The strength and size of the top American companies are in part due to the growth they enjoyed prior to the cutbacks in the mid 1990s. However, a number of them grew even during the leaner years, because they merged with and acquired other firms that were buffeted by the defense spending cuts.[144]

The following table shows the ten U.S. defense firms with highest revenue and their ranking compared to other defense companies around the globe.

Table 1.4 World Rankings of the Top 10 U.S. Defense Firms According to Revenue[145]

U.S. Rank	World Rank	Company	2005 Defense Revenue*	2005 Total Revenue*	Percent of Revenue from Defense
1	1	Lockheed Martin	36,465	37,213	98
2	2	Boeing	30,791	54,845	56

Table 1.4 World Rankings of the Top 10 U.S. Defense Firms According to Revenue[145]—Continued

U.S. Rank	World Rank	Company	2005 Defense Revenue*	2005 Total Revenue*	Percent of Revenue from Defense
3	3	Northrop Grumman	23,332	30,700	76
4	5	Raytheon	18,200	21,900	83
5	6	General Dynamics	16,570	21,244	78
6	8	L–3 Communications	8,549	9,445	91
7	10	Halliburton**	7,552	20,994	36
8	12	United Technologies	6,832	42,700	16
9	13	Science Applications International Corp***	5,400	7,792	69
10	14	General Electric****	3,500	149,700	2

*Figures are in U.S. $ million.
**Defense revenue from KBR Federal and Government Division.
***For fiscal year ending 1/31.
****Defense revenue from GE Aerospace Engines.

It is important to note while considering the revenue statistics presented in this table, however, that they provide no information whatsoever about the extent to which the products the listed American firms sell to DoD are manufactured in the United States or abroad, nor about the status or trends of their domestic manufacturing facilities or workforces. As previously noted, the major U.S. defense contractors increasingly are systems integrators that operate globally, and their revenues have no certain linkage to the health and survivability of the U.S. defense industrial base.

At the upper tiers, the leading U.S. defense companies dominate the international defense market, and can supply current U.S. requirements. There are key uncertainties regarding the future health of the defense industrial base at lower tiers, however. For two years, the Commission has tried unsuccessfully to ascertain the extent to which the industrial base relies upon Chinese components to supply critical weapon systems. Given trends in the Sino-U.S. trade relationship and the loss of manufacturing capacity in the United States, the ability of the U.S. defense industrial base to meet future U.S. military requirements is uncertain.

Research Commissioned by this Commission

In the summer of 2007, the Commission, after issuing a public request for proposals, approved a contract for a private firm to research and document the parts supply chains of three significant U.S. weapon systems: the Air Force's F/A–22 Raptor fighter/attack aircraft, the Army's UH–60 Blackhawk utility helicopter, and the Navy's new DDG–1000 Destroyer. The Commission had hoped the results of this research would be available in time to comment on them in this Report. However, the contractor has experienced considerable difficulty in obtaining access to parts and component data bases, and its initial work suggests that information beyond the secondary or tertiary levels is sparse or nonexistent.

As soon as this research is completed, the Commission will provide it and the Commission's analysis of it to interested members of Congress, and will post it on the Commission's website. This also will serve as one point of departure for further Commission investigation of this topic, which is a matter of considerable concern to its members.

The Impact of U.S.-China Trade on U.S. Research and Development

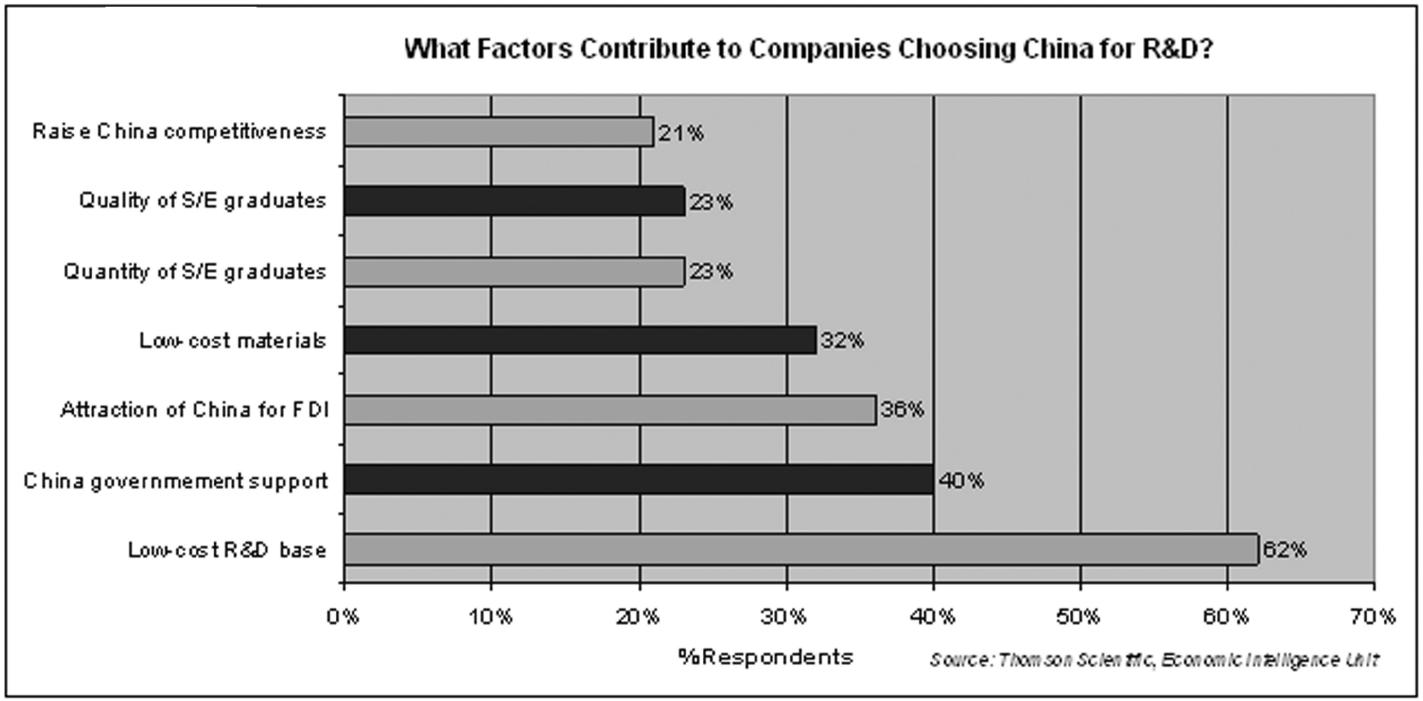
For the last 25 years, the United States has been the world leader in research and development, including R&D focused on defense applications.[146] While for years Japan has been second to the United States, China's R&D achievements in more recent years have been rapidly approaching those of the two leaders.[147] The technology China is acquiring, in part because of China's R&D achievements, is being applied to Chinese weapon systems, helping to bolster PLA capabilities. (Advances in the capabilities of the PLA are discussed further in Chapter 2, Section 1, "China's Military Modernization," and China's advances in science and technology are discussed further in Chapter 2, Section 3, "China's Science and Technology Activities and Accomplishments.")

The United States, Japan, and the European Union have averaged annual increases of 4 percent to 5 percent in R&D spending over the last 12 years, while China has increased its R&D spending an average of 17 percent annually during the same period. During the past five years, China registered annual increases of more than 20 percent.[148]

In 2006, China's R&D expenditures surpassed those of Japan.[149] Expectations are that China's R&D investments will continue to surpass Japan's in coming years by large margins.[150] China's R&D infrastructure is showing signs of strong growth as well. From 1991 to 2002, China's industrial research workforce grew from 16 percent to 42 percent of that of the United States.[151]

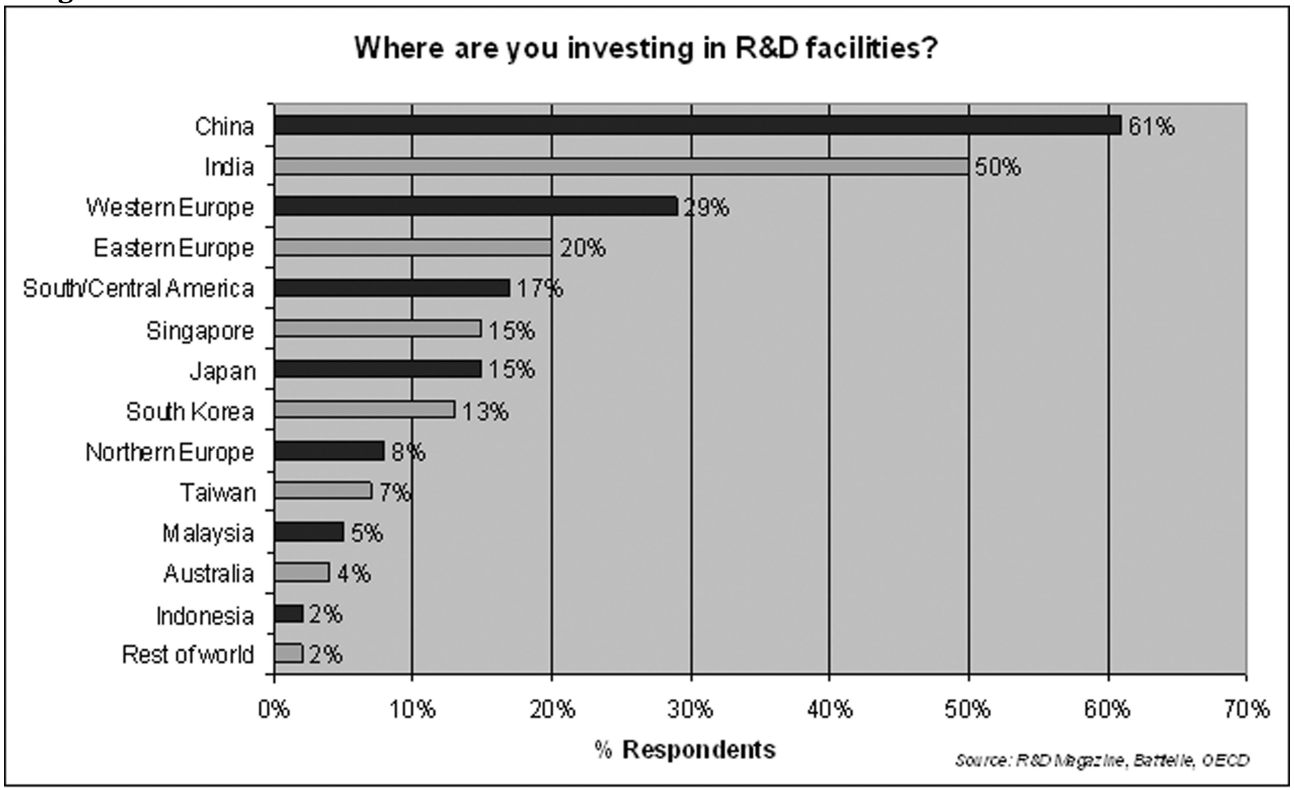
China's emergence as an increasingly capable R&D power, coupled with its low business costs, special incentives in the form of government subsidies, and lax enforcement of environmental and workplace standards, is making it an ever more attractive destination for outsourcing R&D. Recent surveys have indicated that U.S. industry is seriously considering outsourcing select segments of its R&D activities.[152] India remains the premier destination for the outsourcing of computer and software R&D, but in all other sectors China is the leading choice of multinationals for R&D outsourcing.[153]

Figure 1.1



Source: R&D Magazine, Global R&D Report 2007, (Northbrook, IL: September 2006), p. G4. Question originally posed to respondents: "What is China's attraction for R&D?"

Figure 1.2



Source: R&D Magazine, Global R&D Report 2007, (Northbrook, IL: September 2006), p. G4.

The question in the title of the preceding graph titled "Where are you investing in R&D facilities?" was posed to readers of *R&D Magazine*, who the magazine identifies as being primarily representatives of U.S. companies. The survey does not reflect whether the companies investing in the indicated foreign locations are or are not also investing in the United States. The table's value is its indication of the propensity of U.S. companies to choose China over other foreign locations as a destination for their R&D investments.

Worldwide R&D spending in 2008 is expected to increase by 7.6 percent from 2007, primarily due to the rapid R&D expansion in China where such spending is expected to grow nearly 24 percent in 2008.[154] A recent report by *R&D Magazine* noted the R&D explosion in China:

> *R&D growth continues in all geographical regions as well, although at less inflated rates than [in] China. Much of the present attention is given to the very significant growth of the offshore R&D out-sourcing practices involving activities throughout Asia—in China, India, South Korea, and Singapore. . . . There is a long history of R&D interactions among the U.S., Western Europe, and Japan. It is only in relatively recent times that the linkages have spread—and then multiplied almost exponentially—to include the rest of Asia and Eastern Europe. Current literature is replete with reports on the expanding R&D activities in China and India.*[155]

Some factors driving this increase in R&D outsourcing include (1) the outsourcing of manufacturing that depends on on-site technical support of R&D personnel; (2) products sold in target countries that need to be modified to meet local or regional cultural, legal, and environmental standards in those countries; and (3) overseas manufacturing conditions that contain "local content" clauses that extend to the research and support of the product, and the possibility of significant labor-related cost savings for companies that utilize resident talent when R&D is outsourced.[155]

The following charts illustrate the rapid increase of China's share of global R&D, and the United States' declining share—even while U.S. R&D spending continues to increase.

Table 1.5 Global R&D Spending[156]

	GDP (PPP[157]) 2006 Billions U.S. $	R&D % GDP 2006 Percent	R&D PPP 2006 Billions U.S. $	R&D PPP 2007 Billions U.S. $	R&D PPP 2008 Billions U.S. $
U.S.	12,416	2.76	343.0	353.0	365.0
China	8,815	1.61	141.7	175.0	216.8
Japan	3,995	3.40	136.7	143.5	150.4
Europe	14,072	1.88	264.3	276.3	288.8

Table 1.6 Share of Total Global R&D Spending[158]			
	2006	2007	2008
U.S.	32.7%	31.4%	30.1%
China	13.5%	15.6%	17.9%
Japan	13.0%	12.8%	12.4%
Europe	25.2%	24.6%	23.9%

Defense Applications of R&D in the United States

In June 2007, the Commission received briefings on U.S. defense R&D activities from each of the U.S. armed services' science and technology (S&T) units as well as from DoD's Defense Advanced Research Projects Agency (DARPA). Each gave a brief overview of its approach to R&D and some of the projects on which it has been working. Presenters from the services' units indicated that China, at present, is considered to possess significant, but not world-class S&T capabilities,[159] and they expressed considerable interest in building partnerships for joint research with China because those might enable U.S. defense researchers to better understand the progress Chinese researchers are making. Such partnerships, however, raise a number of serious security and intelligence concerns.

U.S. Army

The Army is striving to transform itself into a smaller and more capable fighting force. As the anticipated battlefield changes from one focused on large-scale tank assaults through the Fulda Gap to one focused on small-scale urban warfare against non-state combatants, the Army is trying to transform itself into a smaller, lighter, and more agile force.[160]

In response to this shift, the Army is focusing its R&D efforts on such technologies as functional brain imaging, robotics, nanotechnology, quantum computing, and biotechnology. The Army utilizes a range of R&D partnerships and sources other than in-house research to perform R&D, including collaboration with universities, private industry, and foreign partners. In addition, maintaining awareness of global R&D trends and developments in S&T allows the Army to benefit from the latest technology already developed by international sources, and to identify potential partners for the co-development of next-generation technologies.[161]

The Army's Director for Research and Laboratory Management noted China's growing presence in the world's S&T landscape and told the Commission that although China is behind the United States in most fields, China is intently focused on achieving progress and has made considerable progress in both nanotechnology and biotechnology. (China's advancements in these fields are addressed in greater depth in Chapter 2, Section 3—"China's Science and Technology Activities and Accomplishments.")

U.S. Navy/U.S. Marine Corps

The U.S. Navy's Office of Naval Research (ONR) is responsible for managing the Navy's basic, applied, and advanced R&D efforts.

While recognizing that globalization threatens U.S. technical superiority and competitiveness for reasons described at the beginning of this section, the Navy sees opportunities to leverage current U.S. technological insights for future benefit.[162] Currently, ONR recognizes that its knowledge of China's S&T activities is very limited, and that it is important to increase that knowledge and develop a closer relationship with China's S&T institutions.[163]

The Navy maintains global technology awareness and varying levels of engagement with many countries around the globe. Yet China continues to represent a gap in the Navy's international S&T access and technological understanding. If policy concerns related to U.S.-China cooperation in some of these areas can be resolved, ONR anticipates opening an office in the U.S. Embassy in Beijing in the next two to three years.[164]

U.S. Air Force

The Air Force Research Laboratory (AFRL) is responsible for ensuring that the Air Force is capable of maintaining global leadership in the "discovery, development, and integration" of technologies used in air, space, and cyberspace combat scenarios.[165] Much as the other services are adjusting their anticipated combat scenarios, the Air Force is shifting from a traditional warfare focus to preparing for non-traditional scenarios such as cyber attacks and insurgencies.[167]

The AFRL, however, is concerned about the small percentage of American college students pursuing education in critical fields such as the sciences and engineering.[168] Only 17 percent of the undergraduates in the United States receive degrees in science and engineering, while over half of all undergraduates in China obtain such degrees. This trend is troubling for American researchers, as the R&D activities of U.S. companies increasingly are being moved overseas. In 1996 Chinese R&D accounted for four percent of global R&D while American R&D accounted for 38 percent. In 2006 Chinese R&D accounted for 13 percent of the world's R&D and American R&D dropped to 32 percent.[169]

The Air Force's Asian Office of Aerospace Research and Development (AOARD) establishes and maintains R&D relationships with countries across Asia, hoping to make new S&T discoveries through collaborative efforts. Currently, AOARD has partnerships with several nations in this region including South Korea, Japan, Australia, and India, but does not have any significant joint programs with China.[170]

Defense Advanced Research Projects Agency (DARPA)

Most defense R&D carried out by the Army, Navy, and Air Force focuses on the near- to mid-term. DARPA is responsible for the Department of Defense's mid- to long-term defense R&D.[171] Like the R&D agencies of the services, DARPA maintains government labs and partners with universities and private industry in its research. Currently, DARPA is conducting R&D in quantum information science, new materials, power and energy, microsystems, and neuroscience, among other fields.[172]

Conclusions

- As the globalization of supply chains continues, elements of the U.S. defense industrial base are being moved overseas, thus lengthening the supply chains of U.S. weapons and defense equipment. U.S. defense contractors have merged and moved some manufacturing outside the United States. Sources of defense components are becoming scarcer in the United States, and the supply of American workers skilled in manufacturing these components is diminishing.
- The U.S. Department of Defense (DoD) is not a sufficiently large customer to many of its suppliers to be able to influence their supply chain decisions.
- Some of the items DoD purchases contain foreign-made components, the origin of which, in most cases, is unknown. There potentially are substantial security risks to the United States from using foreign-made parts and components in weapon systems or other equipment important to U.S. defense. These can result from—
  - tampering with or specially engineering foreign-manufactured parts and components.
  - inadequate quality that leads to failure or substandard performance.
  - interruption of the supply chains, thus depriving U.S. forces of the weapons and equipment on which they depend to defend U.S. interests.
- At the present time, U.S. officials are neither carefully tracking the persistent attrition of the U.S. defense industrial base as more and more manufacturing is outsourced offshore, nor identifying and justifying on national security grounds an irreducible minimum defense industrial base that the United States should retain regardless of the cost or effort required to do so.
- Specifically with respect to the impact of trade with China on the U.S. defense industrial base, U.S. officials are neither—
  - methodically tracking what parts and components are obtained from China that are used in significant and/or unique systems important to the nation's defense; nor
  - identifying based on specific national security considerations (1) particular parts and components that, if obtained from China, contractors and subcontractors should be prohibited from using in any such systems, and (2) a subset of key defense systems in which contractors and subcontractors are or should be prohibited from using any parts or components from China; nor
  - developing effective means to implement, monitor adherence to, and enforce such policies and restrictions.
- The United States currently is a world leader in R&D, which greatly benefits its defense industrial base. As the quality of R&D in China continues to improve, and China's research capabilities continue to expand, it is becoming an increasingly attractive destination for American companies to outsource their R&D.