SECTION 3: RESEARCH AND DEVELOPMENT, TECHNOLOGICAL ADVANCES IN SOME KEY INDUSTRIES, AND CHANGING TRADE FLOWS WITH CHINA

"The Commission shall investigate and report exclusively 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. . . ."

Introduction

In January 2006, Beijing published its "Medium to Long-term Plan for the Development of Science and Technology" that detailed the country's 15-year technology development blueprint. It made clear that China intends to become "an innovation-oriented society" by 2020 and, by 2050, a world leader in science and technology. China seeks to "develop indigenous innovation capabilities, leapfrog into leading positions in new science-based industries, increase R&D [research and development] expenditures to 2.5 percent of GDP [gross domestic product] by 2020, increase the contribution to economic growth from technological advances to 60 percent, limit dependence on imported technology to 30 percent, and become one of the top five countries in the world in the number of patents granted."[293]

China's government is openly pursuing the goal of increasing the nation's high-value-added exports while deemphasizing exports of commodity and low-value-added goods, particularly those that require large amounts of energy in their production. The Chinese leadership hopes to accomplish this change, in part, by nurturing a high-technology production sector to produce for export such goods as computers, aerospace components, and telecommunications equipment. Beijing also seeks to increase production within China of high-tech manufacturing inputs such as semiconductors

and printed circuits in order to create a more vertically integrated high-technology sector.[294] Already, China no longer is simply an assembler of parts made elsewhere in Asia but increasingly is a growing technology power on the continent.

China's leaders seek to enhance its advanced technology production through subsidies and other incentives to attract foreign-invested research and technology companies to China. Acquisition of foreign technology is intended to speed China's development of advanced products. The Commission examined the relationships among Chinese and foreign technology companies in a public hearing in Washington, DC, on July 16, 2008. The Commission considered whether the growing presence of foreign-invested research and development centers in China and foreign-invested production facilities for high-tech goods has accelerated China's move into high-technology products, as China's industrial policy openly intends. The Commission also considered whether China's efforts to develop advanced technology products are compatible with the pledge that China undertook in 2001 when it joined the World Trade Organization (WTO): to forgo export subsidies, forced technology transfers, and intellectual property violations.

Further, the Commission examined in particular one source of China's economic growth—international trade patterns. China's GDP growth rate has averaged 10.5 percent per year for the past two decades—twice the rate of the global economy and four times the rate of the U.S. GDP. One key factor in this consistently high growth rate is China's deliberate policy of nurturing export and investment-led economic growth. With a high savings rate, strict capital controls, and low public welfare and social spending, China has accumulated current account surpluses with the United States of over $1.2 trillion since it joined the WTO. China also has accumulated the world's largest foreign currency reserves, which grew from $212 billion when it joined the WTO to nearly $2 trillion in 2008.

In 2007, China edged out Germany to become the world's leading exporter of manufactured goods, and it is now the largest manufacturing exporter to the United States, the European Union (EU)–25, and Japan.[295] This trend is reflected in the growing U.S. current account deficit with China, which increased from $88.7 billion in 2001 to $289.7 billion in 2007.[296] (In the first half of 2008, the U.S. current account deficit with China rose to $136 billion from $134 billion in the first half of 2007). The U.S. deficit with China in advanced technology products grew from $1.4 billion in 2001 to $49.3 billion in 2006, a 3,421 percent increase.[297]

China's Rapid Progress in Advanced Technology

China's government intends to create a more knowledge-based and technologically proficient economy. China has enlisted the help of many western companies in that effort over the past 20 years, with evident success. China already has become an important international center for the development and testing of new pharmaceuticals. China is considered a world leader in nanotechnology, which has many potential applications across a wide range of high-technology products. The number of Chinese nanotechnology-re-

lated publications in scientific journals is now second only to those published in the United States.* [298] China's college and university system has retooled and now is able to supply the country's technology sector with a glut of scientists and engineers. An estimated 40 percent of graduates from Chinese undergraduate and graduate programs now receive degrees in science, technology, engineering, or mathematics, although some of the degrees may not be of comparable quality to U.S. degrees.[299]

Already China has advanced rapidly in the production of automobiles, aerospace, information technology, and telecommunications. China also is striking out on its own in such advanced fields as agriculture biotechnology (genetically modified foods) and nanotechnology by providing financial and tax incentives to those industries, and it has joined the United States, Argentina, Canada, and Brazil as leaders in the important field of genetically modified foods.

China has become a very significant exporter of advanced technology products.† In 2004, China achieved a global trade surplus (of $14 billion) in computers and electrical machinery and in equipment and parts, according to figures from the U.S. Department of Commerce; even with the economic downturn, this surplus is projected to grow 60 percent, from $147 billion in 2007 to $235 billion in 2008.[300] Meanwhile, the United States, historically a net exporter of advanced technology products, experienced a global deficit in this category for the first time in 2002, according to Census Bureau figures using the bureau's definition of advanced technology products. The U.S. advanced technology products deficit with China is now eight times the corresponding U.S. deficit with Japan.[301] The United States is expected to run a $124 billion deficit with China in machinery and computers alone in 2008 and an advanced technology products global deficit of $50 billion in 2008.[302] These figures are projected to increase in future years.

The composition of China's exports, particularly those manufactured in association with foreign-invested firms, already reflects the shift away from labor-intensive, low-value-added products to higher-value, technology-based goods. In 2007, 58 percent of total merchandise exports consisted of machinery and electronics, while the share for clothing declined from 14 percent in 2000 to 9 percent in 2007.[303] The share of total merchandise exports by foreign firms and joint ventures located in China rose from 48 percent in 2000 to 57 percent in 2007. The share of Chinese high-technology exports by foreign firms and joint ventures increased from 65 percent in 1996 to nearly 90 percent in 2005.[304] Both sets of numbers indicate that foreign firms, particularly those involved in producing high-technology products, are using China as an export platform rather than just selling domestically.

China's total research and development effort has been growing about 17 percent annually over the past 12 years.[305] From 2000 to

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* The number of articles published in scientific journals is one of several recognized guidelines for judging scientific advancement among nations. The quality of the articles is not necessarily equal, however.

† No universally accepted definition exists, but the operational definition used by the U.S. Department of Commerce includes computers and parts, office and electrical machinery, telecommunications gear, biotechnology, opto-electronics, advanced materials, aerospace, weapons, and nuclear technology.

2006, R&D spending in China from all sources increased by 19 percent per year compared with 4 percent in the United States, the EU–15, and Japan.[306] In 2007, China's spending on R&D amounted to over 300 billion RMB ($44 billion) or 1.49 percent of GDP, which places China among the world leaders in research. In nominal terms, China ranks fifth in the world in R&D spending, but it moves up to second place when the calculation is made according to purchasing power parity.[307] The government has set an overall goal of increasing R&D spending to 2.5 percent of gross domestic product by 2010, which would be comparable to the U.S. rate and would constitute a doubling of China's rate in four years.[308]

The contribution of foreign-invested enterprises to China's ambitions and capabilities remains controversial, even within China. Through a variety of government initiatives, China has succeeded in attracting technology production to the country. Despite promises in its WTO accession agreement to forgo imposing technology transfer requirements on foreign investors,[309] China has insisted that portions of commercial passenger jets be manufactured and assembled in China as a condition of purchasing them, a practice known as "offsets." A key objective for China appears to be acquiring technology from American and European aerospace companies so that it can independently manufacture its own aerospace products. China also has sought to acquire process technology from U.S. and European automobile manufacturers by requiring foreign companies to form joint ventures with Chinese companies to assemble cars and trucks in China.

China has given numerous subsidies and incentives to foreign firms to locate research and technology and production facilities there. One powerful incentive has been China's practice of manipulating its currency—an action designed in part to make investments in China cheaper than if the RMB were allowed to seek a market level. Consequently, foreign-funded R&D in China has added considerably to domestic R&D efforts. The number of foreign R&D centers in China has nearly tripled since 2002, to 1,160.[310, 311] Locating R&D efforts within China likely leads to eventual establishment of production facilities there as well.

A majority of manufactured exports from China are made by foreign-invested firms. In reaction to the proliferation of foreign-invested firms, an internal debate has broken out in China on whether too much of the profits from exports of manufactured goods is going to foreign-invested enterprises rather than indigenous enterprises. Presumably in response to this debate, within the past two years the Chinese leadership has begun to favor domestic companies over foreign-invested enterprises in its tax and investment policies.

China has designated 17 engineering and scientific megaprojects meant to boost indigenous efforts, including advanced, numeric-controlled machinery; extra-large-scale integrated circuits; new-generation broadband wireless; and manned spaceflight. But China remains anxious to shorten the R&D and product development processes in order to reduce their time and resource requirements and will continue to seek technology transfers in these and other areas from foreign-invested enterprises and joint ventures.[312]

In contrast, the United States has not established any effective policies or mechanisms at the federal level to retain R&D facilities or establish new ones within its borders. In fact, between 1998 and 2003, investment in R&D by U.S. majority-owned affiliates increased twice as fast overseas as did all corporate R&D investments in the United States (52 percent and 26 percent, respectively). During that time period, the share of U.S. corporate R&D sites within the United States declined from 59 percent to 52 percent, while the share of U.S. corporations' R&D sites located in China and India increased from 8 percent to 18 percent.[313] The only encouraging exceptions to this trend have resulted from the efforts of several state governments—such as North Carolina's that in the past several years has significantly expanded and strengthened the Research Triangle Park in the Raleigh-Durham-Chapel Hill area. The research park is the largest such effort in the United States, and its success was addressed in section 4 of chapter 1 of this Commission's 2007 Report to Congress.

Exactly how many steps up the technology quality ladder foreign-invested enterprises have boosted China is still disputed among experts. But China is making considerable progress in moving up that ladder. It became the world's third-largest car maker in 2006, behind the United States and Japan. In 2008, China is expected to produce 10 million vehicles, and if the current rate of growth continues, it will produce 12 million in 2010.[314] The majority of this auto production is by joint ventures that were established between state-owned enterprises with major multinational firms such as General Motors and Volkswagen.

China also is moving forward to develop its own commercial aerospace industry. China's aviation industry already consists of more than 200 enterprises that produce and manufacture products for aerospace, and they employ 491,000 workers. However, China, like most nations, still is a net importer of commercial passenger aircraft. (There are four major exporters of finished aircraft: the United States, France [because it is home to the final assembly plant for the European consortium that owns Airbus], Canada, and Brazil.)[315] But China has ambitious plans to manufacture a large passenger jet by 2020 to compete with the two world leaders, Airbus S.A.S. and The Boeing Company. Toward this end, China in 2008 created the Commercial Aircraft Corporation of China with the specific goal of building a passenger jet with more than 150 seats.

Whether Chinese workers merely assemble into intermediate or final products parts manufactured in and supplied by other Asian nations has been a persistent question. That is still not clear. Too little research has been done on this question to supply a definitive answer, according to witnesses at the Commission hearing. But the trend seems apparent: China increasingly is the source of the parts that go into the final products assembled in China. For example, the ratio of China's computer and parts exports to imports climbed from 2.6 to 1 in 2000, to 4.7 to 1 in 2007, "indicating a sea change in value added," according to one Commission witness.[316] (The higher the ratio, the more domestic content is in the product.)

In fact, China's ratio of imports to exports in the technology sector is moving in the direction of South Korea's and Taiwan's ra-

tios—two of Asia's technology tigers. China's share of world technology exports was 14 percent in 2005, and its share of imports was 12 percent, or a ratio of 7 to 6. For South Korea, the ratio was 5.3 to 3.1; and for Taiwan, it was 4.4 to 2.8. Japan was a standout among nations, with 8.5 percent of world technology exports and just 4.7 of tech imports. The United States, by contrast, ran a huge $120 billion deficit, with 10 percent of the world's tech exports but 15 percent of its imports.[317]

The U.S. technology trade balance continues to deteriorate. The U.S. global balance in advanced technology products suffered its worst-ever one-month loss in July 2008, with a deficit of $7.1 billion, bringing the seven-month 2008 deficit in U.S. high-tech trade to a record $29.9 billion. The U.S. advanced technology products deficit with China alone reached a new monthly record of $7.2 billion in July and a new seven-month record of $40.5 billion.

The United States continues to maintain an overall lead in some of the indices of success in advanced technology. A 2008 RAND Corporation report notes that

> *The United States accounts for 40 percent of total world R&D spending and 38 percent of patented new technology inventions by the industrialized nations of the OECD [Organization for Economic Cooperation and Development], employs 37 percent of OECD researchers, produces 35 percent, 49 percent, and 63 percent, respectively, of total world publications, citations, and highly cited publications, employs 70 percent of the world's Nobel Prize winners and 66 percent of its most-cited individuals, and is the home to 75 percent of both the world's top 20 and top 40 universities and 58 percent of the top 100.*[318]

However, RAND Corporation noted some disquieting trends as well. China added the same number of researchers as did the United States in the period 1995–2002, and both the EU–15 and China have been graduating more scientists and engineers than the United States. Students in America's high schools "demonstrate lower achievement than most of their peers in other industrialized nations." Also, the "diminishing share of degrees awarded to U.S. citizens, particularly for the higher degrees such as doctorates and masters, suggests that science and engineering careers are becoming less attractive to U.S. citizens or, alternatively, that U.S. citizens encounter more competition (from foreigners) in applying for a limited number of desirable spots at colleges and universities."[319]

Perhaps most ominously:

> *The United States is less capable (than it once was when it was more dominant) of denying other nations access to advanced technology to maintain a wide military capability gap between itself and potential adversaries. Technological capability is more widely diffused to potential competitors and may provide adversaries with capability to pursue non–traditional strategies and tactics on the battlefield or through insurgency and terrorism.*[320]

In its critique of the RAND study, The Information Technology & Innovation Foundation[321] notes that most of the study's statis-

tics are no more recent than 2003, which the foundation says is "not adequately reflective of the competitive challenge that has emerged since 2000 and do[es] not satisfactorily depict the competitive landscape as it exists in mid-2008." The critique notes that the most intensive period of R&D offshoring occurred more recently than the period covered by RAND as "innovations in information technology . . . have made offshoring of R&D and other services economically feasible." [322]

Does the Growing Trade Deficit in Advanced Technology Matter?

While few experts dismiss trade deficits as meaningless, there is considerable debate about the nature and severity of harm that bilateral trade deficits in goods and services can cause a nation. That diversity of opinion was reflected in the Commission's July 2008 hearing. One Commission witness, economist Charles W. McMillion, calculated that America's cumulative $1 trillion trade deficit in goods with China from 2000 through 2007 led to the loss of slightly over one million U.S. jobs, which would certainly constitute a drag on the overall U.S. economy.[323]

But others stressed the overall benefits of free trade with China. Mary Amiti, a senior economist at the Federal Reserve Bank of New York, agreed that China "has moved from labor intensive goods such as apparel, textiles, footwear and toys to sophisticated manufactured machinery goods, which now comprise more than 50 percent of its world exports." [324] But she argued that China's rise as an advanced technology products exporting power, particularly its production of computers, telecommunications gear, and office machinery, is due to China's having become an assembly point for electronics parts originating elsewhere in Asia, such as Taiwan, Korea, and Japan. "The value added in China continues to be in the more labor intensive parts of the production process," she said. Therefore, many of the job losses due to the trade deficit in advanced technology products should be allocated to other countries throughout Asia that are supplying manufacturing inputs to China [rather than to the United States], she said. Dr. Amiti, however, was also among those witnesses who said a lack of data collected by the U.S. government has made it difficult to reach timely conclusions on the nature and effects of the U.S. trade imbalance. Some of the most recent trade statistics on advanced technology products goods are three or more years old, she noted.

Few if any international trade experts believe that the United States should maintain a balance of exports and imports with each of its trading partners. Certainly the balance of trade is affected by changes in macroeconomic conditions, the business cycle, and a country's investment requirements—all of which are subject to market fluctuations. Developing nations often run deficits as they invest in capital goods; this can be healthy for their future growth. Developed economies often run trade surpluses in manufactured goods, as did the United States through much of the 20th century. But many economists are alarmed by a current account deficit that registers 5 percent of GDP, which is the U.S. current account deficit level as of August 2008.[325]

The last time the United States decided to deal with such large imbalances, in 1985, the United States convened an international meeting in New York at the Plaza Hotel to agree on a realignment of currencies. The Plaza Accord led to a 50 percent decline in the trade-weighted value of the dollar and a large reduction in the U.S. trade deficit. One witness in the July 16 hearing advocated a second such effort aimed at China, much as the 1985 effort was aimed at Japan.[326]

Reaching a conclusion on whether the United States is being harmed by U.S.-based producers of advanced technology products locating production and research and development facilities in China was another difficult challenge placed before the witnesses at the Commission's July 2008 hearing. Several witnesses said that the U.S. government spends too little effort in compiling statistics on research and development and related foreign investment issues, thus making it difficult to analyze accurately what is occurring and what is likely to occur, and how fast circumstances are changing. Dr. Amiti noted that her research on China and the United States depended on three-year-old information from China, the International Monetary Fund (IMF), and the World Bank rather than any updated U.S. sources. Witnesses also said that the U.S. government knows little about the experience of U.S. technology corporations locating in China. "Right now, I believe the U.S.-based companies are attempting to control what they would view as the key technologies or the core technology and keeping them in areas with very strong intellectual property protection, which is not yet the case in China," said Kent Hughes, director of the program on Science, Technology, America and the Global Economy at the Woodrow Wilson International Center for Scholars. Their rate of success, however, is less certain, he said.

Reinstating the Office of Technology Assessment (OTA), a respected 23-year-old Congressional advisory body that was closed in 1995, has been suggested by authorities on science and technology, including Dr. Hughes. Although the National Academy of Sciences also follows developments in the technology field, the *Bulletin of the Atomic Scientists* notes that

> *In contrast, OTA looked at science and technology from a broader societal context. It investigated the potential unforeseen social, economic, and environmental consequences of a technology's widespread implementation and communicated its findings in language carefully tuned to congressional audiences. OTA used a process in which committees of science and technology experts served as advisers rather than as the report's authors. (NAS [the National Academy of Sciences] does not separate the two responsibilities.) OTA reports did not make specific consensus policy recommendations, but rather, sought the views of all the important stakeholders and then explained the possible consequences of alternative courses of action to help inform congressional debate. This type of information is critical for Congress to responsibly implement and oversee policies dealing with alternative energy sources, biodefense research, and other complex issues. OTA would provide Congress the broad perspective needed to write the best possible legislation. Given*

our current domestic and global mess, we need all the help we can get.[327]

The applicability of many research projects to eventual military use adds another dimension to the issue of technology transfers to China. "It is an objective of PRC [People's Republic of China] policy to exploit such commercial and dual-use opportunities to enhance its defense industrial sector as part of ongoing military modernization efforts, not unlike the defense sector in the United States and other countries, which rely in part on commercial market investments and innovations," according to Kathleen Walsh, an assistant professor at the Naval War College. The United States should make greater efforts to "exploit the hell out of" technological developments in China. "I think if we continue what seems to be a more laissez-faire approach to this, that it will become a threat, that we will fall behind, that we won't maintain our competitive edge in innovation," Ms. Walsh said. Both Ms. Walsh and Dr. Hughes said that the United States lacks a technology strategy but definitely needs one.

Walsh concluded that technology advances, if shared among nations, could benefit all. She cited advances on energy efficiency and pollution controls. "What may matter most is not where the ideas come from but what is done with them," she told the Commission.

China's Automotive Sector Is Growing Quickly

After concentrating largely on supplying its rapidly growing domestic market for vehicles, China now is becoming a major exporter. China shipped 600,000 vehicles abroad in 2007, up from 78,000 in 2004. So far, this growth in exports has been directed primarily toward developing countries or emerging markets such as Russia, South Africa, and Iran. But that may be about to change as China develops the capability to meet the more stringent antipollution and safety requirements of the European and American markets.

China's auto production is on a fast roll. China's auto output has nearly quintupled since 2001, and China is expected to become the world's largest producer in 2009.[328] Half the world's auto industry expansion has recently occurred In China.[329] China achieved a surplus in auto parts in 2005. That surplus grew 83 percent in 2007 and has been increasing at an even faster rate in 2008.

China's potential domestic auto market is so enormous that just supplying it might seem a sufficient challenge for a domestic industry that still is largely dependent on joint ventures with western companies. In 2006, there were just 10 vehicles per 1,000 residents, as compared to 940 in the United States and 584 in Western Europe. But China's government seeks to wean its auto industry from dependence on the joint ventures. Notes Qingjiu Tao, an expert on the Chinese automotive industry who teaches management at Lehigh University:

The original thinking behind the Open Door policy in China's auto market by forming JVs [joint ventures] with multinationals was to access capital and technology and to develop Chinese domestic partners into self-sustaining inde-

pendent players. However, this market-for-technology strategy failed to achieve its original goal. Cooperation with foreign car companies did bring in capital and relevant technology, but also led to over-dependence on foreign technology and inadequate capacity (or even incentive) for independent innovations. By forming JVs with all the major domestic manufacturers and controlling brands, designs, and key technologies, multinational companies effectively eliminated the domestic competition for the most part of the last two decades. Only in the last few years did Chinese manufacturers start to design, produce, and market independent brands. In 2006, domestic companies controlled some 27 percent of the domestic market (mostly in entry-to-mid-level segments). They have become masters at controlling costs and holding prices down, with a typical Chinese auto worker earning $1.95 an hour against a German counterpart making $49.50 an hour.[330]

Beijing's goal, says Dr. Tao, citing the State Development and Reform Commission, is to "make China the fourth pole of the global automotive industry" behind the United States, Germany, and Japan. To do so, Beijing envisions "emancipating" Chinese auto companies from their western JV partners, following international safety and emissions standards, and establishing "preferential income tax rates for high-tech companies."[331]

The likelihood of China being able to export many cars to the North American market in the near future "is quite low," says Dr. Tao. All the various plans announced during the past three years by Chinese companies to begin exporting cars to the United States have been rescinded. China may yet be 10 to 20 years behind the leading multinational firms in the development of internal combustion engines, but several Chinese firms have made significant progress in the past three years in the development of alternative engine technology. Dr. Tao concluded, however, by noting that if China can develop a new, energy-efficient car engine, China could "leapfrog" the old gasoline engine technology and become competitive in North America.

One Chinese company, Build Your Dreams, a rechargeable battery maker, plans to build an all-electric car by June of 2009 and to market it abroad by 2011. A company founded by American financier Warren Buffett, Berkshire Hathaway, purchased a 10 percent stake in the 13-year-old Chinese company in September, explaining that Build Your Dreams "is on the cutting edge of battery technology."[332]

China Plans an Aerospace Sector to Equal America's and Europe's

China is determined to advance at all levels of aerospace technology, from jet fighters to satellites, and from space travel to commercial aircraft. China plans a global positioning system of 30 satellites called "Compass" that will cover China and the western Pacific Ocean. China put its first astronaut in space in 2003, launched a lunar satellite in 2007, accomplished its first space walk in September 2008, and even plans a manned moon landing at a time not

yet specified. (See chap. 2, sec. 3, for additional detail about China's space activities, especially their military/security implications.) Meanwhile, China has been developing small- and medium-sized commercial passenger jets and in 2008 created a state-owned corporation to produce a wide-body passenger jet to compete directly with the largest passenger aircraft from The Boeing Company and Airbus S.A.S.[333] Much of China's objectives for its aerospace sector are spelled out in the government's Eleventh Five-Year Plan.

China's aviation industry consists of more than 200 separate enterprises, many of them state owned, which produce aircraft, turboprop engines, aircraft components and subsystems, and helicopters, according to a 2005 U.S. Department of Commerce study. The 200 are grouped into two very large, government-controlled conglomerates, China Aviation Corporations I and II, or AVIC I and AVIC II, as they are generally known. Their production has allowed China to maintain a positive trade balance in aircraft parts since 2006, although not in finished commercial aircraft.

These developments in China are occurring at a time when the U.S. aerospace industry is continuing to lose jobs. The U.S. industry has lost 500,000 jobs in the past 20 years, according to the Aerospace Industry Association. Certainly the loss of all these U.S. jobs is not due to competition from China. Europe's Airbus is the principal competitor to Boeing in the international commercial aircraft sector, and Brazil and Canada are competitors in small- and medium-sized aircraft as well. Other factors, such as sharply increased productivity enabled by automation and new manufacturing techniques, are partly responsible.[334] But some number of jobs have been lost specifically to competition from Japan and China as well as other nations due, in part, to demands from those nations for offsets (as addressed previously in this section). In the case of passenger jets, this translates into a requirement by the purchasing country that, in exchange for its purchase of the finished products, some portion of passenger jets be manufactured within its boundaries.[335] For example, Boeing notes on its Web site that there are over 4,500 Boeing airplanes with parts and assemblies built in China that are flying in the world today. According to company summaries, Boeing has purchased more than $1 billion in aviation hardware and services from China, and Boeing and its supplier partners have contracts to purchase from China's industry over $2.5 billion in additional parts and services.[336] On its Web site, Airbus says that over half its fleet worldwide has parts produced by Chinese companies.

Boeing forecasts that its orders from China over the next 20 years will account for 3,400 new aircraft, or 12 percent of the total of 28,600 that Boeing expects to sell worldwide. At the end of 2007, 57 percent of the 1,180 commercial jetliners operating in China were Boeing aircraft, including those once produced by Boeing's merger partner, McDonnell Douglas Corporation, and 33 percent were from Airbus.

According to Boeing's Web site,

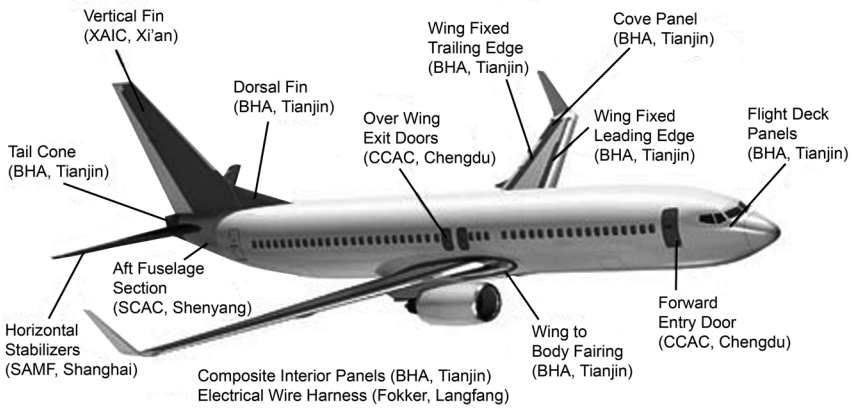
> *Boeing is pleased to have been invited to help Chinese companies develop skills, achieve certification, and join world aviation and supplier networks. China has an increasingly sophisticated and expanding part to play in the commercial*

aviation industry and has a role on all of Boeing commercial airplane models—737, 747, 767, 777 and the newest and most innovative airplane, the 787 Dreamliner. China builds horizontal stabilizers, vertical fins, the aft tail section, doors, wing panels and other parts on the 737; 747 trailing edge wing ribs; and 747–8 ailerons, spoilers and inboard flaps. China also has an important role on the new 787 Dreamliner airplane, building the rudder, wing-to-body fairing panels, leading edge and panels for the vertical fin, and other composite parts. . . . In cooperation with Chinese airlines, CAAC [Civil Aviation Administration of China] and industry, Boeing has provided enhanced professional training to more than 37,000 Chinese aviation professionals since 1993, including pilot techniques, flight operations, maintenance engineering, regulatory, air traffic management, executive management, airline management and airline marketing, manufacturing, quality assurance, finance and industrial engineering, at no charge to China.[337]

Relatively little is known about offset requirements, because they generally are between purchaser and supplier and frequently are not disclosed. Notes Owen E. Herrnstadt, director of trade and globalization at the International Association of Machinists and Aerospace workers:

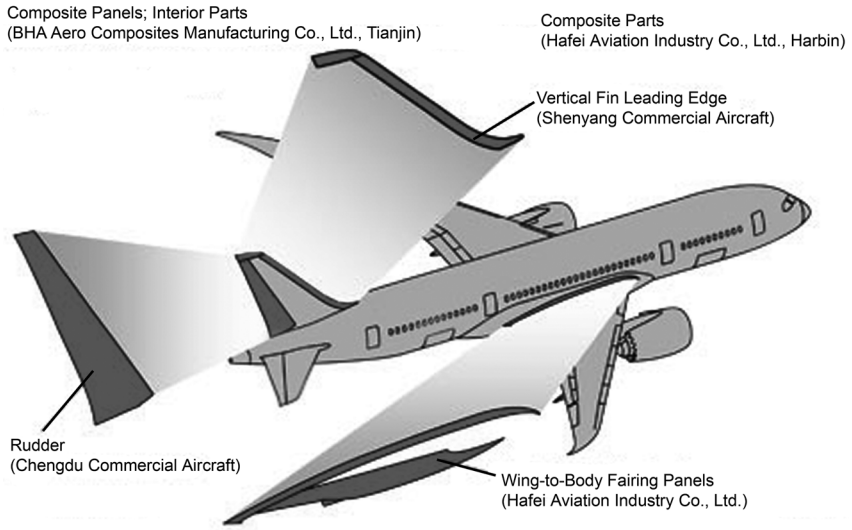
The inherent weakness in leaving the use of offsets virtually unregulated is obvious—private U.S. companies must compete with foreign companies that have the full support of their governments. If a sale means transferring production and/or technology, private companies are in a difficult position given that their interests do not always align with the national interest. They can be expected to maximize corporate returns, even through the use of offsets, which can deeply affect an industry as essential to the nation's economy and security as aerospace, can be detrimental to U.S. national interests.

China's Role in the Production of the Boeing 737NG



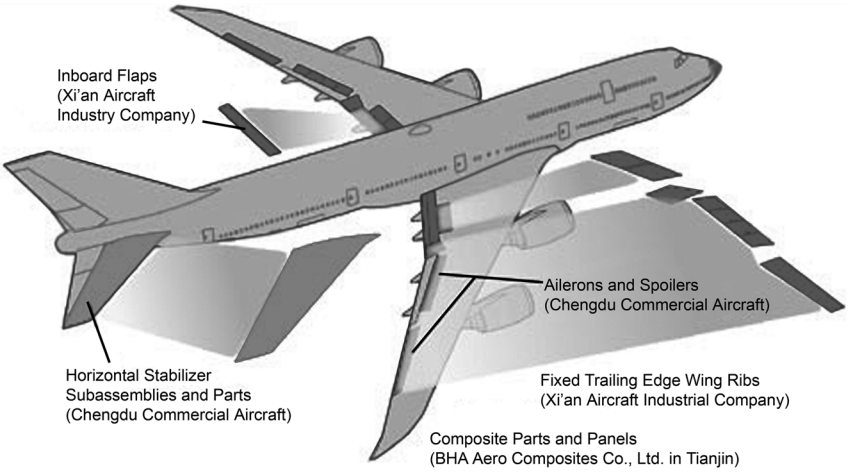
Source: The Boeing Company.

China's Role in the Production of the Boeing 787



Source: The Boeing Company.

China's Role in the Production of the Boeing 747-8



Source: The Boeing Company.

Conclusions

- China has been pursuing a government policy designed to make China a technology superpower and to enhance its exports. Some of its tactics violate free market principles—specifically its use of subsidies and an artificially low RMB value to attract foreign investment.
- Foreign technology companies, such as U.S. and European computer, aerospace, and automotive firms, have invested heavily in research and development and production facilities in China, sharing or losing technology and other know-how. Chinese manufacturers have benefitted from this investment.
- The U.S. government has not established any effective policies or mechanisms at the federal level to retain research and development facilities within its borders.
- China's trade surplus in advanced technology products is growing rapidly, while the United States is running an ever-larger deficit in technology trade. China also is pursuing a strategy of creating an integrated technology sector to reduce its dependence on manufacturing inputs.
- China seeks to become a global power in aerospace and join the United States and Europe in producing large passenger aircraft. China also seeks to join the United States, Germany, and Japan as major global automobile producers. So far as China competes fairly with other nations, this need not be a concern. But China's penchant for using currency manipulation, industrial subsidies, and intellectual property theft to gain an advantage violates international norms.