# Investigation into the Military Implications of Technology and Skill Shifts to and Dependencies on the People's Republic of China by the U.S. Defense Industrial Base

**Under**
**Contract No. C4892-2-002**
**FOR**

# U.S.-China Security Review Commission

## China's Very Rapid Economic, Industrial and Technological Emergence

**June 5, 2002**

**by**

**Dr. Charles W. McMillion**
**MBG Information Services**

**to**

**The Manufacturing Policy Project**

# China's Very Rapid Technological,
## Industrial and Economic Emergence

*Charles W. McMillion*

## China's Recent Production and Trade Trends

Except for a small, relatively unsophisticated nuclear arsenal, and short range rocketry, China's production of modern technology was extremely limited even 10 years ago.[1] For example, although China's first computer was built in 1958 based on a Soviet model, almost all components were imported with very limited production even during the 1980s. Even in 1990 China's meager computer production was inconsequential.[2]

The collapse of the Soviet Union in 1990 and the success of the US high tech military operations against Iraq, made dramatic impressions on the Chinese leadership. Production of computers and other advanced technology products were a principal goal of China's 8th 5 year development plan (1990-1995,) its 9th five year plan, and is central to its current 10th five year plan that runs through 2005.

Illustrative of the success of its technology development plans in the early 1990s, by 1995 China's slight computer production had soared and accounted for 1.9% of world production; far behind the US -- with 26.5% of world production -- or any G7 country, but equal to that of Thailand. However, by 2000, China's global share of computer production more than tripled to 6.9%, far surpassing that of any European country and trailing only the US, Japan and Singapore.[3] China's computer production almost certainly surpassed that of Singapore in 2001 and appears on a track to surpass Japan's production in 2003 and could even surpass the US in 2005 or 2006.

Computers are only one illustrative example of China's extraordinary technological achievements over the past decade and of its unprecedented potential in the decade ahead. A magnetically levitated railroad connecting Longyang Road and the Pudong Airport is currently under construction in Shanghai. This will be the first high-speed magnetic-suspension railroad in the world when it is put to commercial use by the end of 2003. China's Minister of Railways is also in the final stages of evaluating between Japan's current bullet train (Shinkansen) technology and maglev technology for use in a new high speed trunk line between Beijing and Shanghai.[4]

Construction is also set to begin in August, 2002 by a Chengdu-based consortium for China’s -- and the world's -- first mag*plane* operation line. The consortium includes the Chengdu Feimei Magplane Co, the

---

[1] For a discussion of China's evolution in nuclear weapons technology, see US House of Representatives Report of the Select Committee on U.S. National Security and Military/Commercial Concerns With the People's Republic of China, (Washington, DC: USGPO, January 1999), Volume I, Chapter 2 beginning on page 18.

[2] Much of the information on China's computer industry in this report comes from the excellent work by Kenneth L. Kraemer and Jason Dedrick, Asia's Computer Challenge: Threat or Opportunity for the United States and the World? (New York: Oxford University Press, 1998) and their most recent Enter the Dragon: China's Computer Industry (Irvine, CA: Center for Research on Information Technologies and Organizations, 2002.)

[3] Ibid, Enter the Dragon, p. 33.

[4] "China weighs technologies to be used on high speed railroad," China Online, March 14, 2002 from reports in *Zhongguo Xinwen She* on March 13, 2002.

Sichuan Zhineng Rare Earth Group, Chengdu Airplane Group, and the U.S.-based Commercial Cooperation Bank. Magplanes provide a new means of high-speed land transport, consisting of an advanced technology in which magnetic forces lift and propel vehicles over a track. Unlike maglev trains, the automatic control systems, rudders, cabins and satellite-positioning systems of the magplanes are designed according to airplane standards.[5]

China's extraordinary post-1990 success in technology development occurred within the larger context of equally remarkable and unique patterns of overall growth in its economy, net export surpluses and net inward investment. Whereas the US has received much praise for achieving 3.4% average annual real growth in its Gross Domestic Product over the past decade, China's reported real growth has averaged near 10% per year.[6] Yet despite China's remarkable growth over the past decade -- almost three times stronger than US growth -- China achieved a substantial global surplus in its trade and current account balances every year except in 1993 as well as large net financial inflows.[7]

It is normally expected that a country growing faster than the world economy -- which averaged near 4% annual growth over the past decade -- will experience global trade and Current Account deficits; this has not been the case with China. It is also expected that a country with a consistent surplus in its trade and Current Accounts will have an equally consistent -- and similarly sized -- offsetting deficit in its financial accounts. Japan and Switzerland, for example, have a consistent global surplus in their trade and Current Accounts and similar deficits in their global financial accounts. Conversely, most developing countries such as India and Mexico -- as well as the US -- have consistent global deficits in their trade and Current Accounts and offsetting surpluses in their financial accounts.

Yet, for most of the past decade, China has enjoyed both substantial global trade surpluses AND substantial net financial inflows. This has allowed China to build up foreign exchange reserves which stood at $212.2 billion at the end of 2001, an increase of $46.6 billion for the year. This is in addition to China's 500 tons of gold reserves.[8] China's foreign reserves are now second only to Japan, assuring increasingly significant financial latitude and considerations.

China's overall merchandise trading patterns also demonstrate many sharp disparities. In particular, the US consistently accounts for far more than the total of China's global trade surplus. That is, China's $23 billion global surplus in merchandise trade for 2001 includes a surplus of $83 billion with the US.[9] Excluding the surplus with the US, China experienced a 2001 trade deficit of -$60 billion with the rest of the world. The pattern was almost exactly the same in 2000 as China's global surplus of $24 billion included a surplus of $84 billion with the US; a two year global trading surplus of $47 billion becomes a deficit for China of -$120 billion with the world other than the US.

---

5 "World's first commercial maglev plane line set," *China Online*, May 3, 2002 from reports in *Tianfu Zaobao* on May 2, 2002.

6 "International Financial Statistics," published by the International Monetary Fund, various issues.

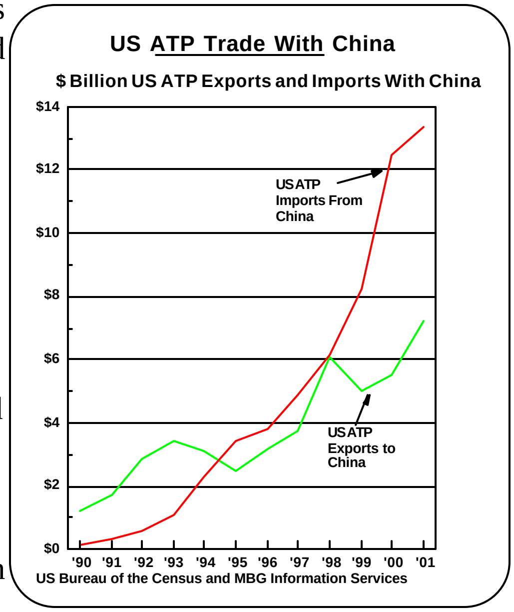
7 As a result of its trade and Current Account deficit in 1993, the Chinese authorities devalued the Yuan by 50% against the US Dollar on January 1, 1994.

8 "China Won't Devalue Yuan," *People's Daily*, January 15, 2002.

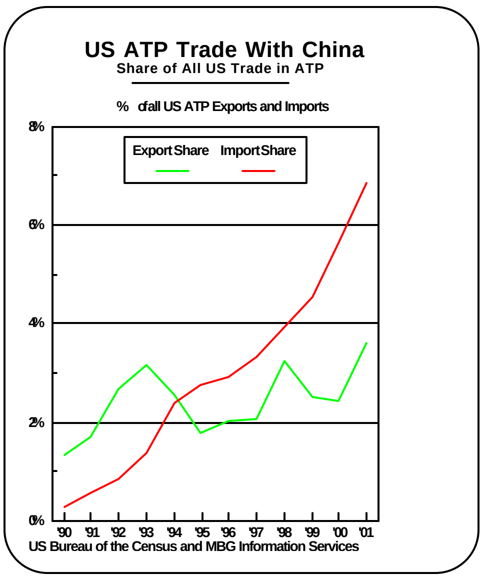
9 Throughout this report, whenever possible, we use trade data reported by the US Department of Commerce, Bureau of the Census. Trade data reported by China's Customs Ministry assigns a large share of its trade to HK where much transshipment occurs. We believe the US Census data, which attempts to assign trade flows on the basis of origin and final destination, presents a much more accurate account.

# The Dramatic Shift in US-China trade in Advanced Technology Products

China's rapid technological and economic success, and its unique overall trading relationship with the US, is strongly reflected in its trade of advanced technology products. The US, of course, has long been a powerhouse of advanced technology products. Since 1989, the US Department of Commerce has maintained a constantly updated list of Advanced Technology Products, ATP. This ATP list is maintained at the most highly detailed, 10-digit Harmonized Code level of specificity.[10] In 2001, two-way ATP trade accounted for $395 billion -- 21% of total US trade with the world.




Global ATP trade has been one of the few areas of US strength even as manufactured goods deficits worsened to record deficits during the past decade. However, the vast export advantage that the US enjoyed in ATP trade with China in 1990 was lost in 1995 and the US has seen a trend to generally broadening and deepening ATP deficits with China every year since.




In 1990, the US had an overall -$10.4 billion trade deficit with China but a surplus of over $1 billion in the meager bilateral ATP trade. US ATP exports to China exceeded imports by a ratio of 7.6 to 1 in 1990 while overall US deficits were concentrated in toys, clothing and footwear. But this traditional trading relationship changed very quickly.

As noted above, the overall US deficits in goods trade with China has soared to -$83 billion with imports outpacing exports by six-to-one. The value of US ATP exports to China grew by 483% between 1990 and 2001 ($1.24 billion to $7.24 billion) but the value of US imports of ATP from China skyrocketed by 8126% (from $0.16 billion to $13.36 billion.) That is, two-way trade in technology

---

[10] About 500 of some 22,000 commodity classification codes used in reporting U.S. merchandise trade are identified as "advanced technology" codes and they meet the following criteria:

1. The code contains products whose technology is from a recognized high technology field (e.g., biotechnology).
2. These products represent leading edge technology in that field.
3. Such products constitute a significant part of all items covered in the selected classification code.

The aggregation of the goods results in a measure of advanced technology trade which appears in Exhibit 16 (of each monthly trade data release.) This product and commodity-based measure of advanced technology differs from broader NAICS industry-based measures which include all goods produced by a particular industry group, regardl ess of the level of technology embodied in the goods. From the methodology section "Information on Goods and Services," of US International Trade in Goods and Services, (publication FT 900) published monthly by the US Department of Commerce, Bureau of Economic Analysis and the Bureau of the Census. p. 28.

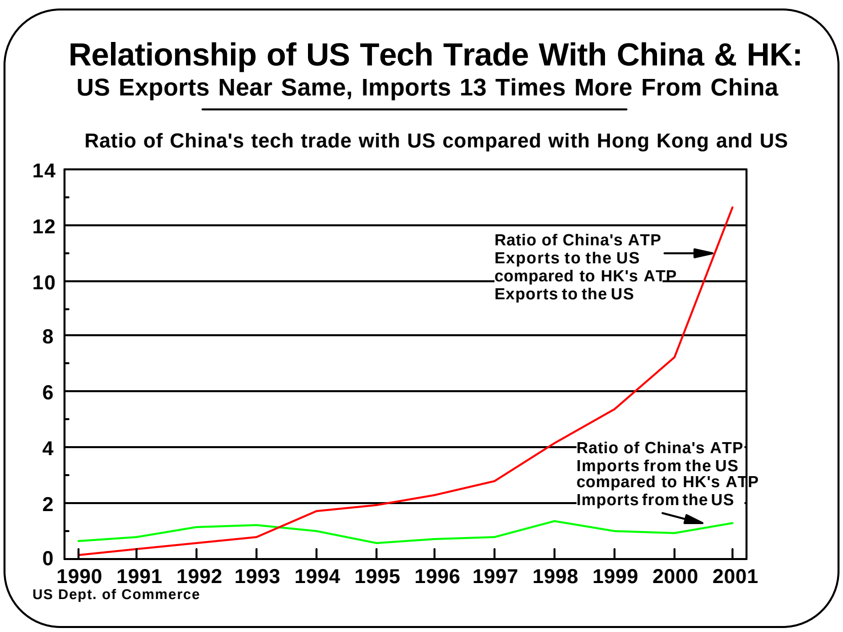
products have grown from $1.4 billion in 1990 to $5.9 billion in 1995 and $20.6 billion in 2001. China's share of all US ATP exports rose from inconsequential in 1990 to 3.1% in 1993 and to a new peak of 3.6% in 2001. (See Appendix A for details.)

Meanwhile, China's share of US ATP imports has soared almost every year from near zero in 1990 to 6.8% last year. The US faced a near -$1 billion ATP deficit with China in 1995, widening to -$6.95 billion in 2000, easing to -$6.12 billion in last year's US recession and technology slump but soaring by 40% so far this year. Alternative future scenarios and projections are included at the end of this chapter.

Advanced Technology Trade between the US and China is distributed between nine major Chapters of the International Harmonized Series Code; Inorganic Chemicals (HS 28,) Organic Chemicals (HS 29,) Pharmaceuticals (HS 30,) Miscellaneous Chemicals (HS 38,) Mechanical Equipment including Computers (HS 84,) Electrical Machinery (HS 85,) Aircraft and Spacecraft (HS 88,) Optical-Photographic and Measuring Equipment (HS 90,) and Arms and Ammunition (HS 93.)[11] Furthermore, in 2001, as in recent years, more than 99% of the two way tech trade between the US and China is accounted for by just four HS Chapters; HS 84 (46%,) HS 85 (35%,) HS 88 (12%) and HS 90 (almost 7%.) In terms of trade balance, between 1997 and 2001 the US deficit with China in technology products under Mechanical Equipment including Computers (HS 84) widened from -$2.6 billion to -$5.6 billion; in Electrical Machinery (HS 85) the US deficit widened from -$0.8 billion to -$3.2 billion; in Aircraft and Spacecraft (HS 88) the US trade surplus widened slightly from $2.1 billion to $2.4 billion; and  the surplus more than doubled to $317 million for Optical-Photographic and Measuring Equipment (HS90.)

Between 1997 and 2001 the US also moved from a slight surplus to an -$11 million deficit with China in the ATP elements of Inorganic Chemicals; saw the deficit in Organic Chemicals deepen slightly to -$20 million; the Pharmaceuticals surplus rose to $6 million; and the US moved from a small surplus to a -$3 million deficit in Arms and Ammunition.

US trade with Hong Kong has been declining since the British returned HK to Chinese authority in 1997 -- with the promise of "one country, two systems."  After rising sharply for many years, US exports to HK peaked in 1997 and were down -6.9% in 2001. Imports from HK had risen modestly for many years before falling sharply in 2001 to -6.3% below 1997 levels. HK's share of all US ATP exports peaked at 3.1% in 1995, fell sharply and regained to 2.8% in 2001. HK's share of all US imports have fallen from 1.8% in 1993 to just 0.5% in 2001.

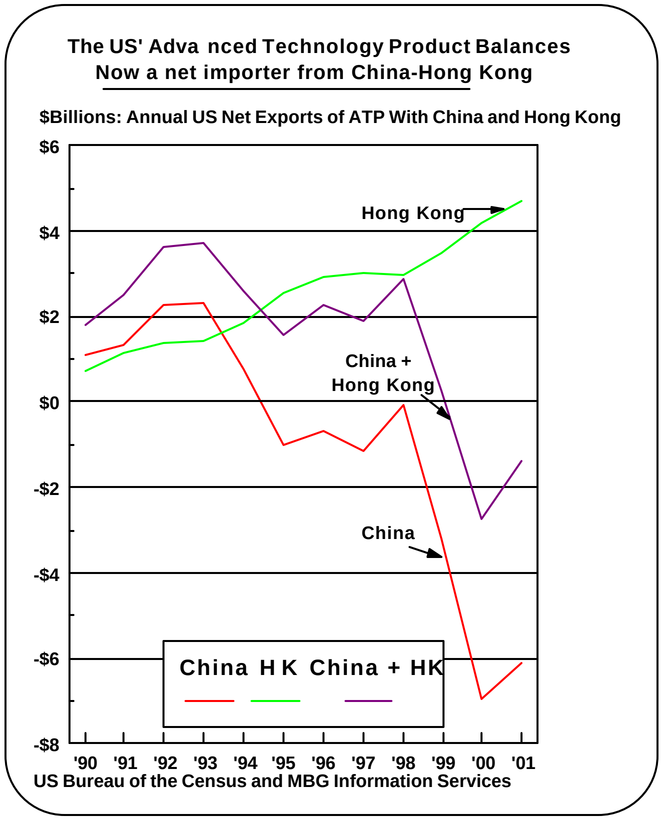



The US had an overall trade surplus with HK in 1997 of $4.8 billion, $3.0 of which was Advanced Technology Products. This overall US surplus subsequently declined with HK's difficult economic conditions but revived to $4.4 billion in 2001 as a steadily increasing ATP surplus of $4.7 billion accounted for more than

11 There were also a few thousand dollars of "Special Classification" (HS 98) items in prior years.

all of the total US trade surplus with HK. The dollar value of US imports of ATP from HK fell by -40% from 1997 to 2001 while US exports rose by 21%.

In 1990, the US exported about one-third more technology goods to HK than to China and imported nearly eight times as much from HK as from China. By 1993 the US was exporting slightly more ATP to China than to HK and importing almost as much from China as from HK. Last year the US again exported slightly (25%) more to China than to HK but imported 12.6 times more from China than from HK.




Combining US trade with China and HK shows US ATP exports rising 52.6% between 1997 and 2001, while imports soared by 117.5%. In 1997 the US had a -$1.1 billion ATP deficit with China, a $3.0 billion surplus with HK and, therefore, a $1.9 billion surplus with China and HK combined. This combined surplus was lost in 2000 as the US faced a deficit of -$2.7 billion. The US deficit was reduced in 2001 to -$1.4 billion with China and HK combined.

As with China alone, more than 99% of the combined US tech trade with China and HK takes place within the four HS Chapters, 84, 85, 88 and 90. As for the trade balance, between 1997 and 2001 the US combined deficit with China and HK in technology products under Mechanical Equipment including Computers (HS 84) widened from -$1.4 billion to -$3.9 billion; in Electrical Machinery (HS 85) the US deficit almost tripled to -$1.4 billion; in Aircraft and Spacecraft (HS 88) the US trade surplus widened slightly from $2.3 billion to $2.7 billion; and the surplus more than doubled to $1.1 billion for Optical-Photographic and Measuring Equipment (HS90.)

Between 1997 and 2001 the US' combined balance also moved from a small surplus to an -$11 million deficit in the ATP elements of Inorganic Chemicals; the deficit in Organic Chemicals fell by half to -$8 million; the Pharmaceuticals surplus shrank by a quarter to $12 million; and the US moved from a $2 million surplus to a -$3 million deficit in Arms and Ammunition.

The meager growth in HK's tech imports from the US since 1997 could be largely the result of its difficult economic conditions for consumers but it could also reflect a shift by producers to the mainland or elsewhere. However, the sharp fall in HK exports supports the theory that tech producers are relocating from HK or that they are losing their competitive edge. These recent trends in HK are sharply at odds with the booming economy in China and skyrocketing increases in technology exports.

Although the US continues to treat HK differently from China for purposes of export controls, recent developments such as the un-contested "re-election" of the unpopular Chief Executive for HK, Tung Chee-hwa -- widely regarded as imposed by mainland authorities -- undermines HK's presumed autonomy.[12] The treatment of HK as a part of China or as a separate entity might best be considered on a case by case basis.

[12] Lester J. Gesteland, "Unpopular Hong Kong Leader Clinches Second Term," ChinaOnline, February, 19, 2002.

## China's Extraordinary Gains in Research and Development

The unanimous findings of a bi-partisan Select Committee on National Security of the US House of Representatives has provided a thorough description of China's use of espionage in gaining access to many of the US' most carefully guarded secrets regarding thermonuclear, intercontinental missile and other advanced technologies.[13] But private, international firms have also played a key role in China's remarkably rapid technological achievements. According to China's Ministry of Foreign Trade and Economic Cooperation (Moftec) by the end of 2001, the total number of foreign-invested firms in China stood at 390,484, involving contractual FDI of US$745.9 billion and actual FDI of US$395.5 billion. Almost all of this foreign investment has occurred within the past 10 years and at an accelerating pace. China reports a new record for 2001 of $46.8 billion new foreign investment actually absorbed and expects to attract over $50 billion in new FDI in 2002 with most new FDI focused on high tech sectors.[14]

It is popular practice to refer to China as the *second* leading destination for FDI behind the United States which, according to the latest available figures, attracted $320 billion of FDI in the year 2000. However, 99% of FDI attracted by the US in 2000 was for the purpose of acquiring ownership of *existing* US businesses; in 2000 the US received only $4.4 billion for the purpose of establishing *new* businesses. Over the past decade the US has averaged less than $10 billion per year in FDI for new establishments.[15] This is the opposite of FDI attracted to China where perhaps 90% is destined to establish new operations. It therefore seems likely that China now attracts well over $40 billion per year in FDI intended to establish new businesses -- several times more than FDI attracted to the US for such purposes.

In order to further maximize China's access to the very best Western technology, most direct investments in China have been required to be structured as a joint venture with one or more Chinese firms or universities. These firms and universities, in turn, are usually under the direct control of central or local government authorities.[16]

Certainly the role of FDI must be kept in the context of the entire national economy. The US registered $1.25 trillion in total nonresidential fixed investment in 2001 -- slightly more than the entire GDP of China and many times the total investment rate.[17] Nonetheless, although bureaucratic costs can be

---

13 US House of Representatives Report of the Select Committee on U.S. National Security and Military/Commercial Concerns With the People's Republic of China, op. cit.

14 "China's '02 Direct Foreign Invest Seen Up 7% to $50 billion," Dow Jones Wire, April 2, 2002.

15 Ned G. Howenstein, "Foreign Direct Investment in the United States: New Investment in 2000," Survey of Current Business, (Washington, DC: US Dept. of Commerce, June 2001,) pp. 27-34.

16 For joint venture requirements see the Economist Intelligence Unit, "Going it Alone, *The Economist Magazine*, March 15, 2002. As Kraemer and Dedrick point out "...the ownership structure of the Chinese PC makers is quite unusual from a Western-capitalist perspective, but it reminds us that the market structure still contains elements of socialism. Market leader Legend is closely affiliated with the Chinese Academy of Sciences, the leading government research institution. Likewise, Founder Group is affiliated with Beijing University, and Great Wall is a spin-off of the Ministry of Electronics Industry. Each of these enterprises was restructured into joint-stock companies and went public on either the Hong Kong or local stock exchange. Yet each is controlled by a holding company owned by the affiliated government institution. Kenneth L. Kraemer and Jason Dedrick, Enter the Dragon: China's Computer Industry, op. cit, pp. 31

17 The most recent report for US investments can be found in "Gross Domestic Product: First Quarter 2002 (Advanced)," published by the US Dept. of Commerce, BEA on April 26, 2002. China's GDP figures

## Multinationals shift manufacturing bases to Jiangsu (China Online: February 26, 2002)

Jiangsu province is becoming the new hotspot for multinational firms' high-end manufacturing bases.

Japan's Sony Corp., for instance, will invest in constructing an engineering, manufacturing and customer service (EMCS) base in the Wuxi new area, which will integrate technological development with new production and customer service, Tadakatsa Hasebe, vice chairman of Sony China Ltd., announced on Feb. 1.

Suzhou, Wuxi and Changzhou, which had been known for their township enterprises, are now becoming world-famous manufacturing bases and research-and-development centers, Zhongguo Jingying Bao (China Business) reported on Feb. 21.

Foreign investment is pouring in rapidly. A large number of big-name multinationals, including Sony, General Electric Co., Motorola Inc., Siemens, Philips Electronics, Mitsubishi Motors Corp., Matsushita Electrical Industrial Co., Seagate Technology, Sharp Corp., Maxell Corp., Pfizer Inc. and Bayer AG, have entered Suzhou, Wuxi and Changzhou.

Statistics show that about 25 percent of the world's top-500 firms have invested in the region. In 2001, Suzhou, Wuxi and Changzhou absorbed more than US$20 billion in foreign investment.

"Wuxi has fast economic growth, a fine technological foundation, favorable geographical location and superior investment environment. We will keep putting our latest technologies in Wuxi to produce better products, covering neighboring markets and gradually turn the Wuxi company into a production center in Asia," said Tom Mokillop, global president of AstraZeneca Plc, which is among the top-five firms in the global pharmaceutical sector.

### Regional strength

Historically, Suzhou, Wuxi and Changzhou have been closely connected with Shanghai in economic terms. The region adjoins Shanghai in the east and neighbors Nanjing in the west.

The Beijing-Shanghai Railway, the Shanghai-Nanjing Expressway, No. 312 National Road and No. 101 Provincial Road form a transport network extending in all directions, while the Beijing-Hangzhou Canal traverses it.

Labor costs in the southern Jiangsu region are about 40 percent lower than in Shanghai, and the area is close to exporters, making it convenient to load goods onto ships or airplanes.

The city of Suzhou, which is enclosed by the canal, now has two industrial parks. Each park has export-processing centers, and goods can apply to Suzhou customs, which means that exported goods can be transported out of factories within two days and be put onto airplanes or into containers.

In Wuxi, goods can go through customs procedures at a newly completed, modern logistics center and be directly shipped at the Shanghai port.

With the backing of Shanghai and its own developed economy, convenient transportation, beautiful landscape and high-quality labor force, the Suzhou-Wuxi-Changzhou region boasts an outstanding investment environment and advantageous geographic location, the article said.

In 2001, the gross domestic product of the Wuxi new area exceeded 10 billion yuan (US$1.21 billion). Last year, 104 new foreign-investment projects were approved, each project involving an average of US$11 million in investment, and the US$3 billion contractual foreign capital was equivalent to the total in the previous two years.

Additional contractual foreign capital in Suzhou last year reached US$7.23 billion, with the actual foreign capital used reaching US$3.02 billion. In Changzhou, newly approved contractual foreign capital registered US$1.15 billion, an increase of 95 percent over the previous year.

Data shows that multinational investment in Suzhou, Wuxi and Changzhou is developing from simple manufacturing to high-end manufacturing and R&D. As a result, foreign investment in this region tends to integrate R&D with production. Recently, Sony decided to build a multi-purpose base embracing production and R&D in Wuxi. The General Electric Medical System (China) Co. Ltd. will also reportedly build its largest production base in Asia in Wuxi.

Bayer's leather chemical R&D center involving a huge investment has successfully developed more than 30 new products, and more than 10 new textile auxiliaries have witnessed rising sales after being put onto the market.

So far, more than 10 foreign-invested enterprises have transferred or plan to build their R&D institutions in Wuxi alone.

substantial, most costs in China are a small percentage of US costs, further magnifying the purchasing power of FDI and other investments in China. Furthermore, China's technology modernization program is not universal but targeted to priority areas. This Commission received the testimony of the Deputy Under Secretary of Defense for Technology Security Policy and Counterproliferation that points out:[18]

> *Recognized experts observe that China's modernization program appears to be focusing on "pockets of excellence," where advances in select technologies can be leveraged for disproportionate benefit in a potential conflict. Several such "pockets" include: preemptive long-range precision strike capabilities; information dominance; command and control; and integrated air defense. In support of these efforts, Beijing has identified the development of an indigenous microelectronics industry as one of its highest priorities. A cutting-edge domestic microelectronics sector will support both military and commercial modernization in China. China's increasing emphasis on development of very large-scale integrated circuits will have direct application in future military systems, for example, advanced phased-array radars.*

Over 400 of the 500 largest companies in the world are now invested in China, including Microsoft, General Electric, Sony, Exxon-Mobile, Royal Dutch Shell, General Motors, Toyota, Volkswagen, Boeing, Matsushita, Siemens, Toshiba, Intel, Kodak, Hewlett-Packard, and IBM. Moftec reports that United States based firms have been China's largest investors for three consecutive years, with 33,000 projects at the end of 2001 involving actual investments of $35 billion and total contracted investment of $67.8 billion. With admission to the World Trade Organization, direct investments from the United States to China in 2001 hit a record high of US$4.9 billion. The investments were concentrated in the machinery, automotive, computer, communications, energy, infrastructure, finance, insurance and oil and petrochemical sectors. The average size of each new investment projects is also reported as quite large and growing.[19] Furthermore, a large survey completed by Deloitte & Touche and CFO Asia magazine at the end of 2001 found that 90% of foreign-invested businesses in China plan to expand their operations in the next three years. Most of the firms in the survey that do not currently have operations in China have plans to initiate operations.[20]

China's remarkable drive for technological modernization has been greatly aided by the world's leading technology companies. But it has also been carefully guided by the leadership of the Communist Party. Under President Deng Xiaoping, the so-called 863 Program was adopted in 1986 dedicated to accelerate the acquisition and development of science and technology for both commercial and military use.[21] Senior Chinese scientists developed science and technology goals in the late 1980s and continue to identify the goals and monitor the progress for each Five Year Development Plan. China maintains a carefully integrated

---

are reported in "International Financial Statistics; May, 2002" published by the International Monetary Fund.

18 Prepared statement of the Deputy Under Secretary of Defense for Technology Security Policy and Counterproliferation, "The Challenge of China," before the China Commission, January 17, 2002, p. 2.

19 Xinhua News Agency, February 13, 2002 reported by China Online, February 14, 2002.

20 "Securities Daily," March 27, 2002 reported by China Online, March 28, 2002.

21 See the excellent introduction to the organizational structure of the Chinese Communist Party, the State and the People's Liberation Army, and the stated goals for China's acquisition of US technology in Chapter 1 of US House of Representatives Report of the Select Committee on U.S. National Security and Military/Commercial Concerns With the People's Republic of China," op cit.

set of evolving industrial policies recently revised to either "encourage, permit, restrict or ban" foreign involvement in very specific areas of technology and production. These policy guidelines were designed to encourage foreign investors to move away from labour-intensive projects in manufacturing and real estate and towards joint ventures in advanced technology, modern infrastructure development and high value-added goods.[22]

The 863 Program was initially supported by nearly 30,000 scientific and technical personnel, working to advance the "economy and . . . national defense construction," producing about 1,500 identifiable research achievements by 1996. The 863 Program aimed to narrow the gap between China and the West by the year 2000 in key science and technology sectors, including the military technology areas of: astronautics, information technology, laser technology, automation technology, energy technology and new materials.

The US Government Accounting Office points out in a recent report that to encourage domestic innovation, China has constructed 53 "Silicon Valley"-style, high-technology development zones among many other supporting mechanisms.[23] Late last year China's Ministry of Information Industry (MII) consolidated 46 research institutes and 26 manufacturers into the China Electronic Technology Corporation (CETC) with the aim of developing and producing globally competitive proprietary products within five to ten years. From a work force of 720 million, China is cultivating the human capital to operate and manage state of the art design and manufacturing facilities, in part from students returning to China after earning degrees at U.S. universities in advanced technology-related subjects. It also is acquiring expertise from foreign technology firms who provide their Chinese employees with advanced training, establish research and development facilities in China and integrate their Chinese facilities into worldwide research networks. And as the Department of Commerce has noted, unlike the US, China has no shortage of well-trained scientists, engineers, mathematicians, or other technical experts to absorb and apply advances in technology.[24]

The unprecedented and accelerating pace of China's leapfrogging of generations of development in targeted technological modernization is well demonstrated by their advancements in the production of the key advanced technology products. Advances in Mechanical Equipment Including Computers (HS 84) is noted above. Semiconductors, key elements of Electrical Equipment (HS 85) are, like computers, key military and civilian objectives of the 863 Program and major, subsequent initiatives including Project 909.[25] The GAO has found that in the last 7 years China's advanced manufacturing facilities have already narrowed the gap from 7-to-10 years behind US semiconductor production capabilities to 2 years or less. According to the GAO report:[26]

---

[22] The latest industry targeting and guidelines went into effect on April 1, 2002. See US Department of Commerce, International Trade Administration, International Marketing Insights, "New Rules on Foreign Investment: China," March 22, 2002. The best assessment of China's powerful strategy and early success in technology modernization is US Department of Commerce, Bureau of Export Administration [recently renamed Bureau of Industry and Security,] U.S. Commercial Technology Transfers to the People's Republic of China, (Washington, DC: US Government Printing Office, 1999.) For targeting strategies regarding FDI, see Part I pages 26-31.

[23] US Government Accounting Office, Export Controls: Rapid Advances in China's Semiconductor Industry Underscore Need for Fundamental U.S. Policy Review, (Washington, DC: GAO, 2002) p. 16.

[24] U.S. Commercial Technology Transfers to the People's Republic of China, Part 1, page 18. This report also provides details of China's large and rapidly evolving R&D infrastructure.

[25] See Charles W. McMillion, "China's Rapid Leap Into Advanced Technologies," (Washington, DC: MBG Information Services, 2000) p. 7-10.

*The most sophisticated facilities in China are capable of producing semiconductors with feature sizes that are more advanced than those used in some of the United States' most advanced weapons. For example, the U.S. Air Force's new F-22 advanced tactical fighter is now undergoing preproduction testing after a decade of development. The aircraft's avionics rely on an Intel i960MX microprocessor that has a feature size of 0.8 micron. In terms of feature size, the i960MX processor is at least four technology generations behind the integrated circuits that China is capable of producing today*.

The Chinese concept of defense conversion is based on the so-called "16-Character Policy" set by Deng Xiaoping in the late 1970s to guide science and technology development in the defense realm toward production of more commercially viable products (spin-offs). This policy remains the guiding principle governing defense conversion efforts in China today. It is translated as: "integrate the military with the civilian; integrate war with peace; give priority to weaponry; make goods for civilian use and use the profits thus generated to maintain the military" [junmin jiehe, pingzhan jiehe, junpin youxian, yimin yangjun]. It is important to note that this definition is interpreted by Chinese officials to mean both defense conversion and reversion capabilities, as needed. U.S. Commercial Technology Transfers to the People's Republic of China, Part 1, page 37.

China's semiconductor capacity has just expanded by orders of magnitude with the introduction of larger, 8 inch wafers. Two Shanghai firms, Semiconductor Manufacturing International and Grace Semiconductor, recently ordered equipment from Europe and Japan capable of etching 0.13 microns wide circuitry. Such tiny circuitry is used in the smallest, fastest and most powerful computer chips in world and could be in operation in China as early as next year.[27] Further, several of these new facilities are designed to produce custom-made semiconductors for any customer. Therefore, they provide China's industry and military a new source of custom-made integrated circuits that are not subject to foreign export controls. Five out of China's eight newest major integrated circuit manufacturing facilities were established as joint ventures; the other three are wholly-owned entities funded with foreign capital. The GAO believes this accelerating trend in joint ventures and foreign direct investment will continue since there are already plans to construct another 10 to 20 advanced semiconductor manufacturing facilities in China by 2005 at an estimated cost of over $1 billion per facility.[28] China has also recently announced the establishment of a new national research and development center to focus on so-called system-on-a-chip technology including processing, memory and input-output functions and 0.10 micron integrated circuit technology.[29]

Motorola is the largest foreign investor in China now with $3.4 billion invested. It has just added modern, new semiconductor lines at its Sichuan-based Leshan Phoenix Co. joint venture with ON Semiconductor and Leshan Radio Company. ON Semiconductor has also announced that it will further transfer high performance semiconductor production from Malaysia to the Leshan plant making it the largest small semiconductor manufacturing facility in the world.[30]

---

26 US Government Accounting Office, Export Controls: Rapid Advances in China's Semiconductor Industry Underscore Need for Fundamental U.S. Policy Review, op. cit. p. 16.

27 Craig S. Smith, "China Makes Progress on Chips," *The New York Times*, May 6, 2002.

28 Export Controls: Rapid Advances in China's Semiconductor Industry, p. 15.

29 "China to set up national semiconductor R&D centre," *China Business Times*, January 22, 2002.

At Motorola's annual board meeting, held in Beijing last November, Chairman and CEO Christopher Galvin announced that Motorola will be implementing a "three ten billion" plan for China: US$10 billion in output, $10 billion in investments and $10 billion in localized Chinese sourcing by 2006.[31] Motorola is one of a growing number of large "US" transnationals, including such other firms as Boeing, Lucent and Kodak, that have bet so heavily on Chinese ventures as to raise questions about their ongoing independence. That is, the Commission might want to consider future investigations into the extent to which Chinese joint venture partners and/or Chinese authorities could achieve excessive influence on firms that are vital to US security.

China's Aircraft and Spacecraft industry (HS 88) also demonstrates the remarkable success and the effects of China's own science and engineering along with managed foreign investment focused on technology acquisition. China was only the third country to develop reconnaissance (so-called "spy") satellites a generation ago. Early this year China successfully launched and recovered its third unmanned "Shenzhou" space vehicle in preparation for a manned mission as early as later this year.[32] More recently China launched the Haiyang-1, the first marine surveying satellite independently developed by China. It was the 25th successful launch in a row for China's Long March series of rockets.[33] China has announced plans to construct a permanent space station within five years, to explore the moon and to establish a permanent moon base by 2010.[34]

As the Cold War was coming to an end, the United States and China agreed in January 1989 for China to charge prices for commercial launch services similar to those charged by other competitors and to launch nine U.S.-built satellites through 1994.[35] This and subsequent technology transfer agreements, called "cooperation" agreements, served both the commercial and military interests of Chinese authorities eager to gain access to critical technologies. Through joint ventures with foreign aerospace firms, co-production, licensing agreements and other commercial offsets, including technology transfers, China has made remarkably rapid progress in most aspects of the aerospace industry.[36] China's leaders, including President Jiang Zemin, repeatedly emphasize the importance of developing independent, proprietary high technology capabilities as a means to boost China's economic and military prowess to counter "hegemonic" actions of the United States.[37]

---

30 "ON Semiconductor, Motorola to establish world's largest small-chip manufacturing plant in Sichuan" ChinaOnline, August 7, 2001 from reports in the China News Service of August 4, 2001.

31 "Motorola Chairman Accounces 'Three Ten Billion' Plan for China," ChinaOnline, November 8, 2001 from reports in the China News Service of November, 8, 2001.

32 Phillip S. Clark, "Shen Zhou 3 - mission report 4," Janes Online, April 3, 2002.

33 AP Wire, "China Launches Two Satellites," May 14, 2002.

34 CNN.com, "2010 Moon Mission for China," May 20, 2002.

35 For a history of US transfer of aerospace technology to China see US General Accounting Office, "Export Controls: Issues Related to Commercial Communications Satellites," Delivered as testimony to the Select Committee on Intelligence of the US Senate, June 10, 1998.

36 See the excellent case study of China's Aerospace development in, U.S. Commercial Technology Transfers to the People's Republic of China, Part 2, beginning on page 54. See also McMillion, China's Rapid Leap Into Advanced Technologies, op. cit. pp. 13-18. An important description of China's use of partial access to its market as leverage for offsets, see Status Report of the Presidential Commission on Offsets in International Trade (Washington, DC: GPO, 2001) p. 64.

37 ChinaOnline, "Jiang: Space Station in China's Future," March 28, 2002 reporting from the China News Service of March 26, 2002.

The same pattern of stunning progress is evident across a range of strategic chemicals and advanced pharmaceuticals, HS 28, HS 29 and HS 30. China has emerged as one of the world's leading countries with a complete range of nuclear technologies including uranium exploring, prospecting and abstracting, uranium isotope separation, nuclear fuel component manufacturing, nuclear fuel reprocessing, security and environmental protection, and waste-disposal technology.[38] China is now one of a very few countries with a modern, domestic zirconium tube production line, designed to provide zirconium material to nuclear power stations. Operated by Northwest Zirconium Co., a zirconium material manufacturer that also operates a science-and-research base, the production ended China's reliance on imports and allows it to gain important international leverage as a Zirconium exporter.

Much more development is immediately on the horizon. The Shanghai Chemical Industry Park Development began only two years ago but has already attracted near $10 billion in foreign investment for modern chemical production. Joint ventures involving British Petroleum, BASF, Huntsman, Bayer AG and other transnationals together with major Chinese firms such as China Petrochemical, Shanghai Petrochemical and Shanghai Tianyuan will soon produce very large quantities of ethylene, isocyanate, polycarbonate and a widening variety of other industrial products in modern, state-of-the-art facilities.[39] This is in addition to a $4.4 billion special petrochemical zone recently approved in Ningbo, Zhejiang province for Formosa Plastics Group (FPG,) Taiwan's largest conglomerate.[40]

At least 20 of the world's largest 25 pharmaceutical companies have operations in China and the nature of those operations is changing rapidly. For example, China has recently become a leading site for cost-effective clinical trials. There are now over 30 multinational companies carrying on experiments on more than 40 first-class medicines in China. This was not the case in the past as global pharmaceutical companies including Pfizer Corp. Ltd, Merck & Co., Inc., Bristol-Myers Squibb (BMS) and Aventis Pasteur Inc., have changed their traditional practice of only selling in China new medicines already available in other regions. Now, they invest heavily in later-stage clinical trials in China to speed up and lower the cost of commercialization of their products.[41]

Indeed, as unprecedented as China's recent success has been in modernizing production in targeted pockets of excellence, China now seems poised for an even more dramatic "take off" in advances over the next few years. Those advances could very greatly widen its current pockets of excellence, slash its technological lag time, and even push China to the lead in some key technologies.

Announcing the establishment of Bell Labs Basic Science Research Institute in Beijing in April 2000, Dr. Xu Jun, president of Bell Labs (China) explained a fundamental shift in the strategies of global companies.[42] Multinational companies have previously confined their R&D work to their own countries. However,

---

38 ChinaOnline, "China's nuclear industry develops steadily," January 9, 2001. And "Zirconium materials needed by China's nuclear stations to be domestically made " ChinaOnline, November 10, 2000. Shanghai First Machine Tools Plant is also one of the few companies in the world that can manufacture reactor cores for nuclear power plants. It has also provided material to Pakistan and perhaps others. General Electric, Westinghouse and ABB Combustion Engineering have been among the leaders in providing advanced nuclear power generating equipment and expertise to China.

39 ChinaOnline, "Chemical industry park to become China's largest," June 8, 2001.

40 ChinaOnline, "Formosa Plastics gets nod to invest inNingbo," May 28, 2002.

41 ChinaOnline, "China popular site for clinical trial of new drugs," May 13, 2002.

42 Bell Labs is now the R&D arm of Lucent Technologies. Dr. Jun's remarks are reported by ChinaOnline, "Foreign IT Cos. localize R&D in China," April 3, 2000.

this mode of operations is outdated, according to Dr. Jun, who added that localization is the only effective strategy in terms of both time and money. Localized R&D responds more quickly to change, reduces costs, trains its own personnel and is well positioned to grab local market share. Bell Labs entered China in 1997, setting up development laboratories in Beijing and Shanghai. But the basic research center in China is Bell Labs first -- and only -- outside the US, greatly broadening and deepening research in China, and integrating research with that done in the US.

The pace of change in China has accelerated very rapidly since the Commerce Department's excellent study of US technology transfer to China in the late 1990s found that the transfer of advanced US technology is the price of market access for high technology companies.[43] When the report was published in 1999, China's rapidly improving infrastructure and the localization of top quality suppliers -- along with the long anticipated potential market of 1.3 billion consumers -- had already led to sharp increases in the nature of effective technology transfer and other offset demands. The Department of Commerce study indicated that China's preferred offset demand in 1999 had already become the establishment of joint R&D centers in China. Since then, membership in the World Trade Organization now prohibits Chinese authorities from explicitly requiring technology transfers. But the promise of unfettered access to world markets, and accelerating competitive pressures, has greatly increased the pressures on firms to increase investment in China, to transfer their leading product and process technologies and to include Chinese interests in joint research on next generation technologies and technologies.[44]

Jiang Xiaojuan, vice director of the Finance and Trade Department of the Chinese Academy of Social Sciences recently detailed the results of research on global firms operating in China.[45] Dr. Jiang and his Academy team found that in 1997 only 13% of foreign firms in China applied the parent company's most advanced technologies in China. By 2001 that proportion had already risen to 41% and he expects it will exceed 50% in 2002. Their research found, for example, that no cars made by foreign firms in China in 1997 could be classified as having the most advanced technologies. But in 2001, 70% of car-making joint ventures in China provided high-end products. Among the 13 new types of cars rolling off Chinese production lines this year, the production of at least 10 types is occurring at the same time as in the foreign companies' home country. Dr. Xiaojuan explains that competition has developed so quickly, foreign firms must now provide their very best products and technologies in order to maintain their operations and make further progress.

Dr. Jiang notes that until very recently foreign companies' operations were mainly focused on the low-end, labor-intensive manufacturing sector. But intense competition in low end sectors made such operations unprofitable. Foreign firms have found -- at least for the moment -- that high-tech operations in China have a greater chance of profitability. High tech growth is now double the rate of manufacturing growth with export growth four times the rate of overall export growth. In 2001, high-tech products contributed a fourth to China's total exports.

---

43 "Executive Summary," U.S. Commercial Technology Transfers to the People's Republic of China, p. 2.

44 Technology brokers have greatly animated the technology market by acting as go-betweens in the selling and buying of technology contracts. Such contracts grew at a 10% average annual rate during the 1990s but began to soar at a 58% rate in 2001. ChinaOnline, "Technology brokering, Beijing's hot new profession," February 13, 2002. See also, The Economist Intelligence Unit, "The Coming Boom," The Economist Magazine, October 9, 2001.

45 This research was presented to the 2002 China Business Founders Summit, sponsored by Time Magazine and the Business School of Renmin University of China. Reported in ChinaOnline, "Multinationals change China strategies to boost competitiveness," May 7, 2002.

China's Ministry of Foreign Trade and Economic Cooperation (Moftec) reported in September, 2000 that global firms had already set up nearly 100 high-tech R&D centers in China and the Chinese Academy of Social Sciences identified 124 in 2001.[46] Since that time both the number and the quality of R&D centers established in China by global firms seems to have accelerated rapidly. There is no authoritative current count of R&D centers involving global firms now in China, or any comprehensive assessment of their activities. But from Microsoft and Intel to General Electric and General Motors, there are few global technology firms that do not have at least one R&D center in China working jointly with Chinese state controlled firms and universities. Even leading Taiwanese technology firms such as Acer, Delta Electronics and Hon Hai Precision Industrial Company have recently overcome Taiwan government prohibitions and set up joint R&D centers on the mainland.[47]

It is widely acknowledged that both the scope and the nature of research done in China is advancing very rapidly. As Alcatel's executive vice-president, Ron Spithill recently told the *Financial Times*, "Very soon (China) will be a source of innovative technology."[48] Although the dollar value invested in R&D centers in China is rarely more than a few tens of millions of dollars, the effects can be quite dramatic. With today's tightly networked business environment, R&D centers in China have quickly become part of the "global team" of their international partners. For example, the website of GE Corporate Research & Development recently featured its new R&D center in Shanghai -- GE's third such center joining centers in Niskayuna, New York and Bangalore, India. The Director of GE's Shanghai R&D center, Dr. Xiangli Chen explains:

> *There are several factors that make us unique: we are multi-disciplined and we are integrated with the global R&D team. What does that mean? You might be a physicist in China who works closely with a structural engineer in Balgalore, India or Niskayuna, USA. Our curiosity and fascination with technology draws us together, and we are driven to push its boundaries.*

Indeed, being an integral member of a large, global team is one of many key advantages that foreign firms have in recruiting and retaining top R&D talent in China. But it must be appreciated that most of these centers are joint operations with Chinese government controlled facilities or they are at least dedicated to working with joint ventures with Chinese government controlled firms. For example, no joint venture partner was announced for GE's major new R&D center, but the announcement of its establishment coincided with GE Aircraft Engines' efforts to convince the China Aviation Industry Corp. I (AVIC I) to integrate GE's CF34 engines with AVIC I's ARJ21 feeder-line planes that are now in research and development by AVIC I. On February 20, 2002 GE announcement in China that "We hope to team up with Chinese aviation firms to develop new products." GE announced the creation of its new R&D center one week later.[49] GE already has 30 joint ventures and solely funded companies in China which, presumably, will be directly linked with the new center and thereby to the global network.

---

[46] Moftec press release, September 10, 2000.

[47] EE Times, "Taiwan component makers set up R&D in China," April 8, 2002.

[48] James, Kynge, "Rich vein of raw talent makes China potential R&D hothouse," *Financial Times*, April 19, 2002.

[49] ChinaOnline, "GE eyes China's feeder-line market," Febuary 21, 2002. See also, CCTV.com "GE to build international R&D Center in Shanghai, February 28, 2002.

It appears that most R&D centers in China are set up along the model of the United Innovative Research Institute, a joint venture between IBM, Peking University and Tsinghua University. IBM provides the software, hardware, research technicians and most of the operating costs for the institute's research, while the universities provide the office space, network connection, instructors and professional staff. IBM and the universities equally share the intellectual property rights of all research.[50] Both universities are government controlled and both control an array of technology-related companies. Peking University, for example, controls Founder Computer, which has raced past IBM and other foreign brands to become China's second leading computer producer. Tsinghua University controls Tsinghua Tongfang Computers, another major computer producer and has extensive cooperative agreements with the Langchao Group, China's leading server producer.

European firms have also rushed to form joint R&D centers in China since the late 1990s. Nokia, Ericcson and Siemens have each worked aggressively along with several Chinese partners to develop internet products, a third generation of mobile communications technology and for other purposes.[51] Many other European firms from Airbus and Fiat to Unilever and Volkswagen have joined with Chinese partners for R&D.[52] Most Japanese firms resisted moving R&D to China. However, just in the past nine months many of Japan's major technology firms have suddenly begun setting up R&D centers in China; many with Chinese partners. Japanese firms announcing the location of R&D to China in the last few months include, Matsushita Electric, Sony, Hitachi, NEC, Honda and Yamaha. The New York Times quotes the chairman of Fuji-Xerox, Yotaro Kobayashi saying, "China is quickly becoming a country of low age and high tech. They are going to prove to be extremely competitive with Japanese companies."[53] A Matsushita board member, Toshio Sugiura put it more plainly saying that "Nothing will be resolved by simply being afraid of a hollowing out (of Japan.) It would be easier to envision a future scenario by accepting there will be a hollowing out and rethinking (the roles of) Japan and China," and of course, the United States.[54] The Commission may want to carefully consider the many probable dimensions of this "inevitable" hollowing out on US military and economic security and to what extent these new relationships would be acceptable.

The addition of Japan's best technology firms locating R&D to China will add to the already intense competitive pressures for all firms to move more and better technology to China and to upgrade and better integrate those operations already there.

Finally, other important facets of China's strategy for technology innovation include substantial technology licensing agreements, various forms of corporate or government technical assistance and collaborative academic research. The Commerce Department's Technology Administration maintained a valuable catalogue of many of these large scale activities until it was discontinued in 1999. The Commission might consider having the collection of this important information reinstated and intensified.

---

50 ChinaOnline, "IBM, two universities establish e-commerce research center," July 25, 2000.

51 ChinaOnline, "Nokia To Develop Next-Generation Internet Technology in China," April 18, 2000. ChinaOnline, "Ericsson to fund China's 3G standards research," March 16, 2001. ChinaOnline, "Siemens, Datang to cooperate on 3-G development," November 2, 2001.

52 ChinaOnline, "Airbus builds cooperation with China Aviation Industry Corporation," June 28, 1999. ChinaOnline, "Fiat high-tech engine component plant opens in Shanghai," June 14, 2001. ChinaOnline, "Unilever Opens R&D Center in Shanghai," March 1, 2000. ChinaOnline, "No price cut but more R&D for Volkswagen," February 21, 2002.

53 James Brooke, "Japan Braces for a 'Designed in China' World," *New York Times*, April 21, 2002.

54 Edmund Klamann, "Matsushita China to Be Crucible for Manufacturing, Reuters, May 28, 2002.

## Two Forecasts of future US-China technology relations:

China's post-Cold War technological emergence has occurred with such unprecedented speed that there is no clear basis upon which to build confident forecasts. Knowledgeable analysts present quite different views of the grave challenges and enormous opportunities that are both surely ahead for China.[55] Certainly it is true that China's rapid development over the past decade has been from a small base. For example, real GDP growth in China seems unlikely to grow by 10% per year as it did in the past decade but rather seems to be slowing to the 6%-to-8% annual range.

It is vital to keep in mind that even China's Labor Ministry officials acknowledge that their labor force now grows by 12 to 13 million people each year. A 7% annual GDP growth rate with current productivity growth is officially calculated to create only about 8 million net new jobs per year.[56] This implies that a minimum of 4 to 5 million new unemployed -- or never employed -- workers are likely to be added to China's increasingly desperate, perhaps 150 million rural jobless and over 100 million "floating population" of often jobless in and around urban centers.[57] This unending sea of unemployed labor is, of course, the major source of China's potential instability. It is also a key reason that extremely low wages and regulatory costs have generally not risen even during the past decade and are unlikely to rise during the forecast period of the next five years. Indeed, China has faced wage and price *de*-flation in recent years, adding to their competitive advantages.[58]

Another vital consideration in forecasting China's near-term development is the unprecedented progress that has been made in recent years in upgrading and modernizing China's basic economic infrastructure. While outside the scope of the current report, it must be emphasized that infrastructure modernization has been as high a priority of China's successive five year plans -- and just as spectacularly successful -- as development of advanced technology. The last ten years has seen road, rail, port, aviation, water and sewer projects throughout China, particularly in previously remote Western provinces, on a scale that is unimaginable outside China.[59] Enormous rural electrification and communication initiatives, a priority in the 9th Five Year Plan, were completed in 2000. Beijing alone plans to spend $100.7 billion on new construction in just the next five years.[60] China's utter lack of modern infrastructure 20 or even 10 years ago -- together with an authoritarian government -- allows them to easily leapfrog to 21st Century development without the marginal cost/benefit analysis of replacement upgrades required in the US.

This is clearly seen in China with the very rapid use of fiber optic cable that are overwhelming not a replacement for copper wires but initial lines. From an extremely primitive communications system in most of

---

[55] See, for example, David Sheff, China Dawn: The Story of a Technology and Business Revolution (NY: HarperBusiness, 2002) and Joe Studwell, The China Dream: The Quest for the Last Great Untapped Market on Earth (NY: Atlantic Monthly Press, 2002)

[56] AP Wire, "China, wracked by labor protests, warns of worsening unemployment," April 29, 2002.

[57] see Charles W. McMillion, China's Agricultural Glut, MBG Information Services, May, 2000 p. 11.

[58] Despite strong growth, China's deflation worsened again to -1.1% year-over-year to April, 2002. "China's Financial Outlook," The Economist Intelligence Unit, May 21, 2002.

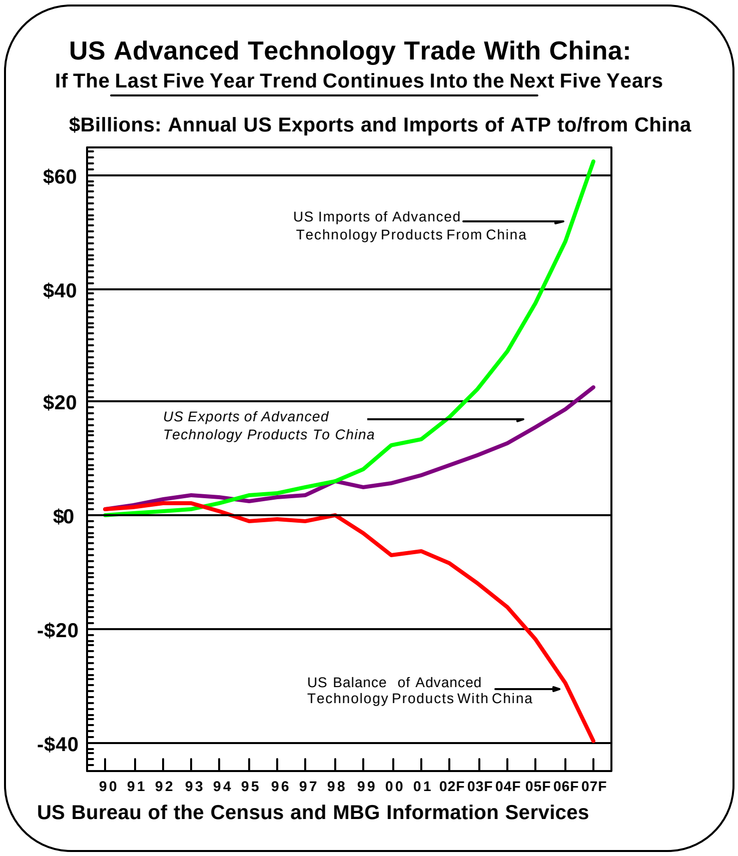
[59] China has moved quickly to integrate modern "intermodal" transportation systems. Not all infrastructure projects are successful; most noteably, the $25 billion "Three Gorges Dam" has been marked by corruption, shoddy work and massive cost over-runs. China is also moving forward with $85 billion in highway construction, $17 billion for a South-to-North water canal and thousands of smaller projects.

[60] ChinaOnline, "Beijing to spend US$100B on construction over next 5 years," May 29, 2002.

the country in 1990 and almost no fiber optic lines in 1995, China had 1.2 million kilometers of optical trunk cable in operation at the end of the year 2000. This provided fiber optic service to 75% of Chinese cities and counties and brought phone access to 85% of China's rural administrative villages -- often for the first time. China plans a 100% increase, doubling its fiber optics network to 2.4 million kilometers during the 10th Five Year Plan that ends in 2005.[61] China already has over 170 million cellular phone users -- the most in the world -- and is adding about 5 million new users per month. There were 182 million fixed-line phones at the beginning of 2002 and they are increasing at almost 3 million per month.[62]

These rapid infrastructure modernizations together with seemingly endless supplies of capital and very cheap labor that is disciplined and skilled, the localization of top quality supplier and R&D clusters, an expanding domestic market and unlimited export opportunities under the strong guiding hand of the Communist Party and central government, suggests China's development trajectory may be ready for accelerating take-off over the next five years. Certainly China faces severe challenges from internal instability as well as external competitive challenges from others -- including the US -- who find increasingly substantial investment, production, exports and jobs displaced from their country to China. In many ways these internal and external challenges are in conflict for China; managing internal instability may require acceleration of investment, production and exports but managing external tensions might require a slowing.

A very rough, primary forecast for US-China technology trade might be that US export and import growth could remain the same over the next five years as they have been over the last five years. Although the annual growth of US ATP exports and imports have been quite volatile (see Appendix,) the use of a five year lagging average to project the next five years seems not unreasonable since it covers the years since the 1997 Asian financial crisis as well as the US recession in 2001.




Over the past five years US ATP exports to China have grown by an average of 20.9% per year while US imports from China have averaged annual growth of 29.2%. Extending these growth rates out until 2007 produces US exports worth $22.6 billion, imports worth $62.2 billion and a resultant US ATP deficit with China of -$39.7 billion -- six and one-half times last year's -$6.1 billion deficit.

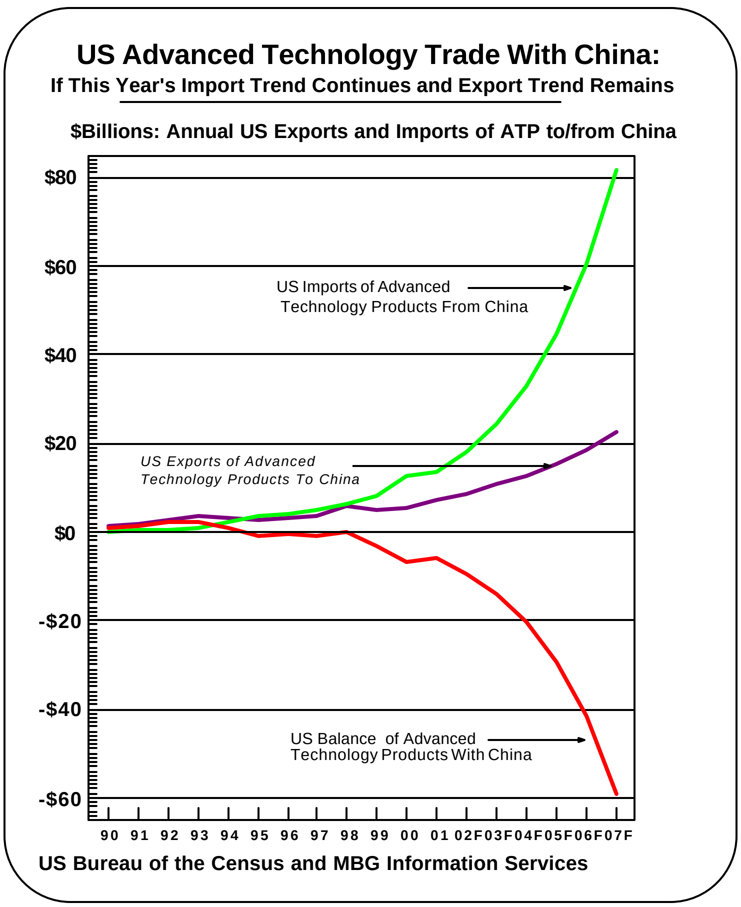
Obviously it would take much further study to make even plausible five year forecasts for individual technology products or even categories. However, given China's targeting and extensive new modern investment, R&D and production that will be coming on line over the coming months and years, it seems likely that China will greatly broaden as well as deepen its range of technological strength. That is, in 1990 China had

61 ChinaOnline, "China lays out high-fiber-optic diet for next five years," October 26, 2000.
62 ChinaOnline, "Mobile phone users reach 150 million in January," February 26, 2002.

surpluses with the US in only 97 detailed advanced technology products while the US had surpluses in 260 products. By 1995, as innovation expanded the number of products, the US surplus had extended to 288 products while China's surplus soared to 205 products. Last year, 2001, the US surplus fell to only 254 products while China's surplus rose to 315.

China's targeting of technology production has been an effective form of import substitution that seems well positioned to accelerate. From chemicals, pharmaceuticals and computers to semiconductors, spacecraft and aviation, there are no technology product categories in which China should NOT be expected to strengthen impressively over the next five years. Indeed, the Commission might begin to consider whether or not there are _any_ individual technology products -- goods OR services -- which China is incapable of producing to substitute for imports and, indeed, to compete with or substitute for US-based producers.

This leads to a second, only slightly more aggressive forecast. This alternative forecast assumes that China's ATP exports to the US continue the general acceleration trend they have experienced since 1996, maintaining the 35.2% growth rate recorded between 2001-QI and 2002-QI. It is further assumed that US exports to China maintain the 20.9% annual average growth rate of the past five years. This forecast, too, seems conservative but quite reasonable since China's average annual ATP export growth to the US was 37.3% for the three years before the 2001 recession while US exports grew by only 8.0%.




This only slightly more aggressive forecast continues to yield $22.6 billion of US exports in 2007 but raises US imports -- China's exports to the US -- to $81.6 billion. That is, under this scenario, the US would import from China 3.6 times as much as it exports and its advanced technology deficit with China would soar to -$59.1 billion, almost 10 times the deficit in 2001.

It should be noted that as US technology imports from China are significantly larger than US exports and imports are growing much faster than exports, the deficit grows much larger with every passing year. Under the alternative scenario the US advanced technology product deficit with China reaches -$83 billion in 2008 and -$162 billion in 2010.

Surely there is no possibility that the US ATP deficit with China will reach these astronomical heights. Policies sustain or change trends and unsustainable trends stop. The value of these forecasts is not to predict what will occur in 2010 or even in 2005 but to demonstrate just how immediate and severe are the consequences implied by present trends. The Commission may want to quickly develop a precise, forward-looking action agenda to assure that these technology trends end promptly and in the most productive and peaceful ways possible for both the US and China.

## Appendix A

# List of the National Engineering Research Centers

## Agriculture

NERC for Comprehensive Agriculture at Changping/ The Chinese Academy of Agriculture Science
NERC for Vegetables/ The Vegetable Research Center of the Beijing Academy of Agriculture Science
NERC for Integrated Agriculture Experiment at Yangling/ The Coordination Committee of Wugong Agriculture Science Research Center of Shanxi Province
NERC for Chemical Industry of Forest Products/ The Research Institute of Chemical Processing and Utilization of Forest Products
NERC for Hybrid Rice/ The Hunan Academy of Agricultural Sciences

## Energy

NERC for Renewable Energy/ The Beijing Solar Energy Research Institute
NERC for Coal Water Mixture/ HuaMei CWM Technology Center
NERC for Isotopes/ The China Institute of Atomic Energy

## Information & Communication

NERC for Application Specific Integrated Circuit System/ Southeast University
NERC for Application Specific Integrated Circuit Design/ The Institute of Automation/ CAS
NERC for Data Communications/ The Research Institute of Data Communications of the Ministry of Posts and Telecommunications
NERC for Flat Panel Displays/ The Nanjing Electronic Devices Institute
NERC for Parallel Computer/ The Institute of Computing Technology of the CAS and the Jingnan Institute of Computing Technology
NERC for Mobile Satellite Communication/ The Panda Electronics Group Company
NERC for Digital Switching System/ The Information Technology Institute of the People s Liberation Army

## Manufacture

NERC for Computer Integrated Manufacturing Systems/ Qinghua University
NERC for Solid State Laser/ The North China Research Institute of Electro-Optics
NERC for Metallurgical Industry Automation/ The Automation Research Institute of the Ministry of Metallurgical Industry
NERC for Power Automation/ The Nanjing Research Institute of the Ministry of Electric Power
NERC for Specific Pump & Valve/ The 11th Research Institute of the China Aerospace Corporation
NERC for Industrial Control Devices and System/ The No. 502 Institute of China Aero-Space Corporation
NERC of Optical Instrumentation/ Zhejian University

## Materials

NERC for Liquid Separation Membrane/ The Development Center of Water Treatment Technology-SOA
NERC for Polymer Matrix Composites/ The Harbin Fiber Reinforced Plastics Research Institute
NERC for Fiber Reinforced Moulding Compounds/ The Fiber Reinforced Plastics Research & Design Institute, the State Administration of Building Material Industry
NERC for Silicone/ The Chengdu Silicone Research Center of the Ministry of Chemical Industry
NERC for Structure Plastics/ The Chenguang Chemical Industrial Research Institute - Chengdu Branch - the Ministry of Chemical Industry
NERC for Engineering Plastics/ The Beijing Municipal Chemical Industry Research Institute
NERC for Reaction Injection Moulding/ The Liming Research Institute of Chemical Industry
NERC for Magnetic Materials/ The Beijing General Research Institute of Mining & Metallurgy

NERC for Non-Ferrous Composites/ The Beijing General Research Institute for Non-Ferrous Metals

NERC for Carbon Fibers/ The Beijing University of Chemical Technology and the Jilin Chemical Industry Corporation
NERC for Catalysis/ The Dailian Institute of Chemical Physics of Chinese Academy of Sciences
NERC for Cl Chemistry/ The South-West Research Institute of Chemical Industry
NERC for Special Glass Fiber & Its Processed Products/ The Nanjing Fiber Glass Research and Design Institute
NERC for Metallic Thin Film of Functional Materials/ The Shanghai Institute of Metallurgy/ CAS
NERC for Superhard Materials & Related Products/ The Zhenghou Research Institute for Abrasives & Grinding under the Ministry of Machinery Industry
NERC for Powder Metallurgy of Titanium & Rare Metals/ The Guangzhou Research Institute of Non-Ferrous Metals
NERC for Precious Metal Materials/ The Institute of Precious Metals in Kunming under the China National Non-Ferrous Metals Industries Corporation.

**Light Industry & Textile**
NERC for Garment Designing & Processing/ The National Garment R&D Center
NERC for Synthetic Fiber/ The China Textile Academy

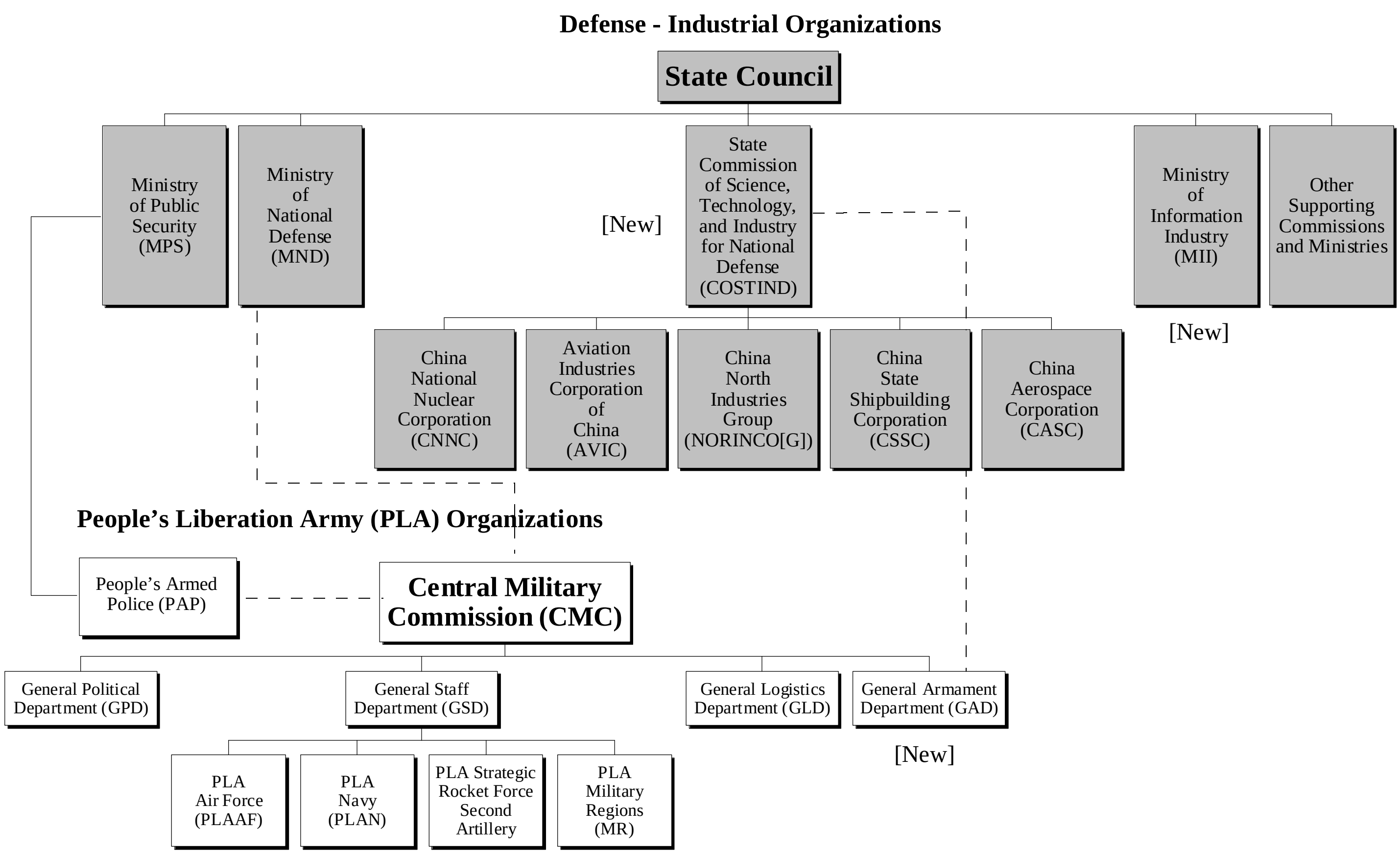
**Resources Exploitation**
NERC for Multipurpose Utilization of Non-Metallic Mineral Resources/ The Zhengzhou Institute of Multipurpose Utilization of Mineral Resources under the Ministry of Geology and Mineral Resources
NERC for Further Processing of Non-Metallic Minerals/ The State Administration of Building Materials Industry Suzhou Design & Research Institute of Non-Metallic Minerals Industry
NERC for Comprehensive Utilization of Metallic Mineral Resources/ The Changsha Research Institute of Mining and Metallurgy, and the Beijing General Research Institute of Mining and Metallurgy
NERC for Geological Exploration/ The Institute of Geophysical and Geochemical Exploration, the Ministry of Geology and Mineral Resources

**Construction & Environment**
NERC for Urban Water & Wastewater/ The North China Municipal Engineering Design & Research Institute
NERC for Road Traffic Management/ The Traffic Management Research Institute under the Ministry of Public Security
NERC for Building/ The China Academy of Building Research
NERC for Industrial Building Diagnosis & Rehabilitation/ The Central Research Institute of Building & Construction under the Ministry of Metallurgical Industry
NERC for Human Settlements/ The China Building Technology Development Center
NERC for Urban Environmental Pollution Control/ The Beijing Municipal Research Academy of Environmental Protection
NERC for Industrial Water Treatment/ The Tianjin Research Institute of Chemical Industry under the Ministry of Chemical Industry

**Medicine & Health**
NERC for Health Care & Medical Devices/ The Guangdong Medical Instrument Research Institute
NERC for Medical Accelerator/ The Beijing Medical Equipment Institute
NERC for Traditional Chinese Medicine/ The Shanghai Chinese Medicine Corporation

# China's International Defense-Industrial Organizations

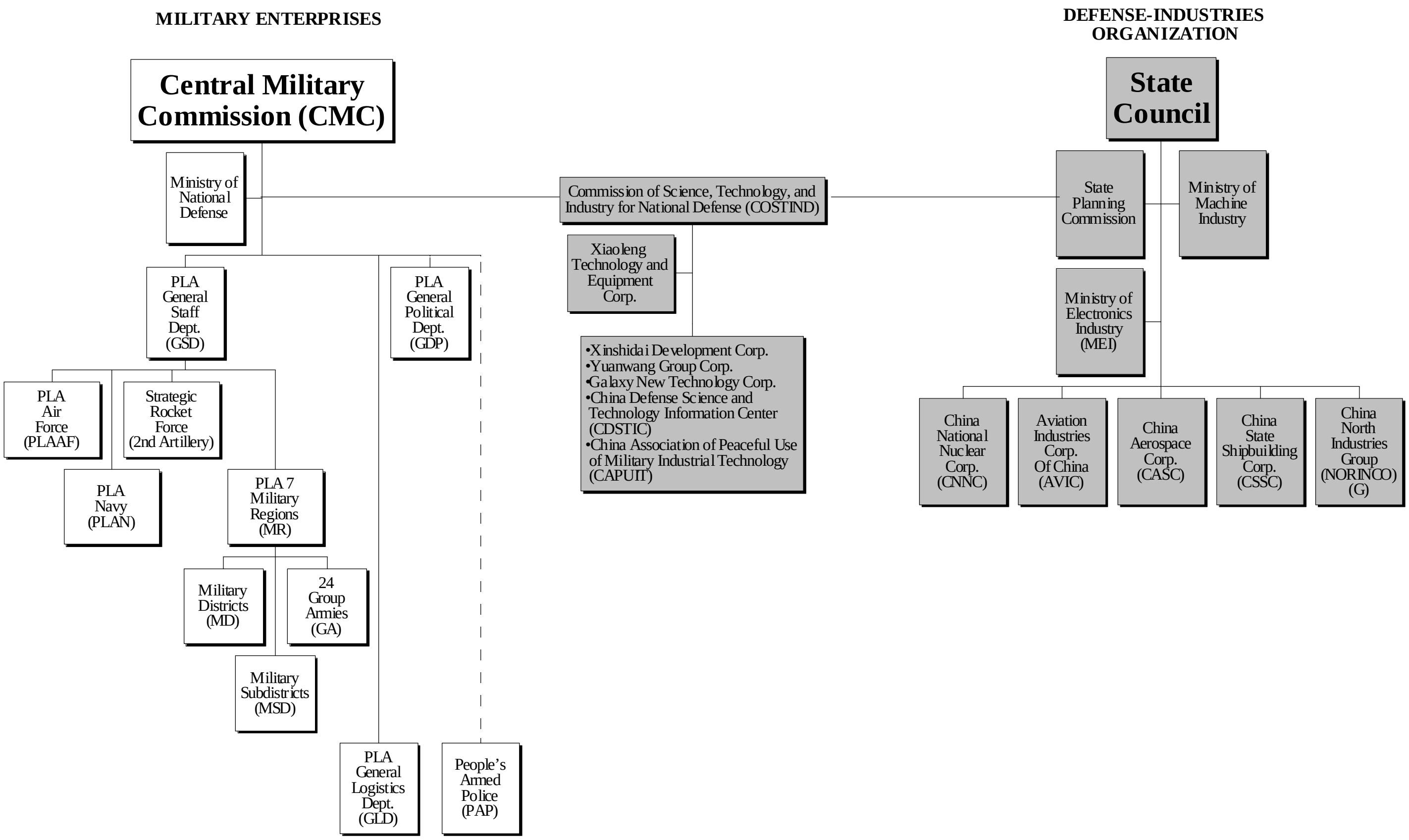
(As of March 1998)




Source: Adapted from Defense Intelligence Agency Reference Document DI-1921-60-98

# China’s International Defense-Industrial Organizations

(Prior to March 1998)




Source: Adapted from Defense Intelligence Agency Reference Document PC-1921-57-95