vote more resources to commercial development without endangering Japanese national security. The constrained size of the Japanese Self Defense Forces (SDF), coupled with a decision not to export arms, has also limited sales opportunities for the Japanese DTIB. Therefore, although the Japanese have a DTIB that produces a wide variety of products, it is neither a substantial portion of the Japanese national technological-industrial base (relative to its CTIB) nor the primary focus of Japanese technological development.

The United States followed a third path between these two extremes. Over the course of the Cold War, extensive U.S. security considerations required a large, robust DTIB. Domestic political considerations and security doctrine emphasized technological sophistication over sheer mass and led to the development of advanced, and expensive, weapons. Commercial interests and the American political structure, meanwhile, ensured that the defense sector would not dominate the economy. As a result, although the American DTIB is ahead of the CTIB in some areas of technology, the opposite is true in other areas. A further consequence was that portions of the DTIB became segregated from the CTIB (see box B).

This background paper focuses on integration in the PRC and Japan. It begins by outlining the Chinese and Japanese defense procurement systems. It then assesses the extent to which they are affected by the same obstacles that shaped the American system, particularly those factors that led to segregation of the American DTIB from the CTIB: acquisition laws and requirements, military specifications, militarily unique technologies, and emphasis on military performance. The extent of integration at each level of production—sector, firm, and facility—is then considered. The paper concludes by assessing the relevance of the Chinese and Japanese experiences to the American CMI effort.

THE PEOPLE'S REPUBLIC OF CHINA

A fundamental aspect of the Chinese People's Liberation Army's (PLA) ideology is that "the Army and the People are one." The PLA has, therefore, long been integrated into the general development of the Chinese economy. PLA construction troops, for example, were responsible for developing much of the Chinese transportation infrastructure in the first decades of the People's Republic.[6] Similarly, most Chinese amphibious forces have been integral to Chinese riverine trade on a day-to-day basis. "Typical employment of the [military] ships includes haulage of cement for civilian construction projects, imported foodstuffs from one region to another and bulk cargoes not easily handled by other haulage means."[7]

Such integration, however, did not initially extend to the Chinese DTIB. At the time of the founding of the PRC, the Chinese had only a minimal defense-industrial base. This was due, in part, to the predominantly agrarian nature of the Chinese economy in 1949, coupled with the devastation of both World War II and the subsequent Chinese Civil War. The PLA was primarily equipped with weapons captured from either the Imperial Japanese Army or the Nationalist Army.

With the signing of the Sino-Soviet Treaty in 1950, the Soviet Union became the primary arms supplier of the Chinese military. Soviet aid included not only the provision of complete weapons, but also involved the transfer of Soviet-designed arms factories, among them those for "aircraft, naval vessels, electronic equipment, and

[6]From 997,600 km of highway and 22,512 km of railroads in 1950 to 6,500,000 km and 40,000 km, respectively, in 1970. M.D. Eiland, "Military Modernization and China's Economy," *Asian Survey*17(12): p. 1148, 1977.

[7]G. Jacobs, "China's Amphibious Capabilities," *Asian Defence Journal*, p. 64, January 1990.

BOX B: Sources of Segregation in the American Defense Technology and Industrial Base

As the OTA report *Assessing the Potential for Civil-Military Integration: Technologies, Processes, and Practices* Indicated, the American defense technology and industrial base (DTIB) and commercial technology and industrial base (CTIB) exhibit signs of segregation. That is, there are clearly limits to the extent to which common technologies, processes, labor, equipment, material, and/or facilities can be used to meet both defense and commercial needs.

Several factors have led to the segregation of the American DTIB from the CTIB. The factors that are most relevant to this background paper are discussed below.

Acquisition Laws, Regulations, and Culture. In the four decades of the Cold War, an acquisition culture arose in the American defense procurement system, marked by special accounting rules and regulations. Many of these rules and regulations are the results of past acquisition abuses and scandals. The resulting network of rules and regulations has separated the DTIB from the CTIB by imposing additional reporting burdens on any venture interested in providing defense products or services In some cases, these reporting requirements have included demands for details (e g., technical data rights) that are central to a firm's competitive advantage.

Military Specifications and Standards. In pursuit of standardization after various logistical difficulties experienced in World War 11, and to ensure interoperability and uniform quality of components and systems from diverse sources, the Department of Defense (DOD) created a plethora of military specifications and standards. The resulting system of military specifications and standards allowed the American DTIB to support a globally deployed military, operating in environments ranging from the Arctic to the tropics. However, the system eventually came to dictate methods of production as well as performance standards, however, as it grew more bureaucratized over the subsequent 40 years. Significant divergences between military and commercial specifications and standards developed, particularly as commercial quality control and production processes evolved, which led to segregation of the DTIB from the CTIB.

Militarily Unique Technologies. In some cases, segregation IS due to the militarily unique nature of a given technology. Items are militarily unique where there is no commercial demand for a technology, either because the technology is classified, as with weapons of mass destruction, or because the relevant systems and technologies have no commercial market, as with military explosives, missiles, and armored fighting vehicles. In many cases where the final product may be militarily unique, however, and particularly with advanced weapon systems, although the final product may not have a commercial market, its components and subsystems and production technologies and processes might have commercial applications. Moreover, in the course of product and process evolution, technologies that were once militarily unique may become integrated.

Emphasis on Military Performance. American military equipment has tended to emphasize high performance; in particular, it has sought to gain the greatest possible performance margin. Not only is this additional performance not necessarily sought in commercial products (e.g., commercial engines have little need for an afterburner), it often imposes an additional cost. This additional cost was often considered acceptable during the Cold War because the United States sought to gain military advantage through superior quality rather than through superior quantity. It is unclear the degree to which that will remain true in the post-Cold War environment.

SOURCES: U S Congress, Office of Technology Assessment, *Assessing the Potenial for Civil/Military Integration: Technologies, Processes, and Practices,* OTA-ISS-611 (Washington, D.C.: U. S. Government Printing Office, 1994), Office of Technology Assessment, 1994

Most Chinese military equipment, including tanks, is derived from earlier Soviet designs.

land armaments. . . ."[8] The Soviets also trained large numbers of Chinese engineers, designers, and other members of the intellectual infrastructure (including those involved in the Chinese nuclear program). As a result, the Chinese defense-industrial base was organized and managed along lines similar to those of the Soviet DTIB.

In the wake of the Sine-Soviet split in the early 1960s, the Chinese were forced to rely on their own efforts. Chinese leaders decided to develop a wholly indigenous arms industry to ensure that they would never again be as dependent or as vulnerable as they felt they had been during the heyday of the Sine-Soviet relationship. This decision was strengthened by concerns over Soviet and U.S. military intentions.

Thus, the Chinese began-a major expansion of the DTIB in the mid-1960s. This effort was overseen by a newly expanded group of eight Ministries of Machine Industry (MMI), which were responsible for the development of heavy industry in all sectors. Of the group, only one was responsible for civilian economic development; the rest were devoted to development for national (and primarily military) purposes of such sectors as electronics, aerospace, shipbuilding, nuclear weapons, and energy. During this period, Chinese defense production is believed to have constituted at least 10 percent of overall national industrial production (by volume).[9]

Chinese efforts during the 1960s included the construction of "hundreds—possibly thousands-of small, medium and large-scale [defense] industrial projects in every region of the country, including the remote interior."[10] Such dispersion, however, coupled with the limited Chinese technological, financial, and trained-personnel base, meant that the available resources were not necessarily exploited efficiently. Instead, Chinese weapon systems, particularly relatively sophisticated ones, were often only available in very limited quantities. Indeed, "the total output of the more complicated pieces [of equipment] can be traced to a single industrial complex and in some cases a single factory."[11]

Furthermore, the DTIB was not very sophisticated. For example, although the Chinese developed a substantial machine-tool industry, it was primarily weighted toward the low- and medium-grade end, rather than toward the precision tools needed for production of sophisticated items, whether military or civil. The level of sophistication did not improve significantly during the 1960s and 1970s.

The lack of sophistication in the technological, financial, and trained-personnel base was exacerbated further by the isolation of the Chinese DTIB from its CTIB. This isolation was due, in part, to

[8] D. Shambaugh, "China's Defense Industries: Indigenous and Foreign Procurement," *The Chinese Defense Establishment,* P.H.B. Godwin (cd.) (Boulder, CO: estview Press, 1983), p. 44.

[9] S. James, "Military Industry," *Chinese Defence Policy,* G. Segal and W.T. Tow (eds.) (Chicago,l: Univesity of Illinois Press, 1984), p. 121.

[10] Ibid., p. 118.

[11] J.R. Blaker, "The Proc\duction of Conventional Weapons," *The Military and Political Power in China in the 1970s,* W.W. Whitson (ed.) (New York, NY: Praeger Publishers, 1972), pp. 223-224.

the secrecy associated with the Chinese arms industry, which restricted information flow and technological developments within the DTIB and kept the DTIB separate from the larger commercial economy. During the 1960s and 1970s, the Chinese did not express significant interest in developing a consumer economy. Indeed, the political chaos of the Cultural Revolution during the late 1960s and early 1970s further strengthened the isolation of the military-industrial base (some of which was deliberately insulated by the PLA and the highest echelons of the Chinese Communist Party from rampaging Red Guards). From the Sine-Soviet split to the end of the Cultural Revolution, the PRC's CTIB and DTIB were also isolated from global technological developments, due to Beijing's isolated stance and deliberate pursuit of autarky.

That isolation was not necessarily considered a problem at the time, however. In the first place, given the pervasive Soviet influence, the Chinese DTIB resembled the Soviets'. Practicing "vertical integration, . . . each plant was composed of as many departments as the whole manufacturing process required."[12] The Chinese DTIB was, therefore, in many ways autonomous, depending on neither the CTIB nor the general economy to function.

The demands on the DTIB were limited. The PLA at this time was focused on the Maoist doctrine of "People's War," which was the result of lessons learned from the War of Resistance against Japan (1937-1945). It emphasized the preparation of masses of foot soldiers and militia (which China had in abundance) to engage in prolonged guerrilla warfare in China's interior. The focus was on basic, infantry-oriented equipment, which the Chinese DTIB was well-suited to provide. Indeed, the doctrine essentially made a virtue of the relatively primitive state of the Chinese DTIB. "People's War" as a doctrine, therefore, provided both customers for the DTIB's products and a rationale for their continued production.

Chinese strategy until the 1980s relied on massed forces wielding basic weapons.

"People's War" also emphasized the continuation of war even in the wake of Soviet (or American) nuclear strikes. This view of prolonged warfare, coupled with the need to support and sustain forces even if Chinese industrial centers were occupied or devastated, exploited the vertically integrated nature of Chinese defense production facilities by ensuring that production did not depend on provision of parts, components, or other supplies from facilities that might be destroyed or otherwise isolated. Much of the Chinese DTIB was deliberately located in the (relatively) inaccessible Chinese interior. This deployment, despite the absence of transportation links, was deemed a defensive measure, enabling the militia to always have access to at least basic weapons even in a protracted war. Such a view, again, also made a virtue of a preexisting condition because sophisticated weapons presumably would be difficult to produce, much less maintain, in the absence of an intact logistical and support structure.

After the death of Mao, however, and in the wake of the subsequent power struggle that brought Deng Xiaoping to power, Chinese policymaking hewed to a less ideological line. At the national level, this was marked by Deng's reiteration

[12]D. Shambaugh, op. cit., footnote 8, p. 44.

of the "Four Modernizations": to modernize agriculture, industry, science and technology, and national defense, in that order. The Chinese economy would no longer be autarkic, but would instead establish links with the outside world to gain access to global technological and economic developments. Only through such efforts could the Chinese avoid becoming completely irrelevant in the political, economic, and technological realms.

As part of this national modernization effort, resources were shifted from military to commercial economic development through both conversion and outright diversions away from the military.[13] To make this shift palatable to the PLA, the national authorities essentially proposed a long-term bargain. The strengthening of the national economy and the technological base by the short-term transfer of funds, resources, and personnel from the DTIB to the CTIB would ultimately benefit defense by establishing a more sophisticated national technological, industrial, and scientific base from which to develop future defense capabilities.

The PLA embraced the shift. The poor performance of the PLA in the 1979 "pedagogical war" with Vietnam had demonstrated the primitive nature of the Chinese military's doctrine and equipment. The subsequent organizational restructuring resulted in a reduction of the role of ideology in the PLA's thinking. This triumph of "expert" military thinkers (i.e., military professionals) over the more ideological, or "red," elements, in turn, brought to the fore PLA officers who were interested in gaining access to more sophisticated weapons and in developing a doctrine with more nuance.

To acquire more sophisticated weapons, the PLA recognized that national economic and technological development was necessary. Essentially, the PLA was prepared to tolerate short-term pain, including lower budgets and reductions in numbers of forces and dedicated industrial assets, on the premise that it would eventually recoup those losses through improved equipment in future years.

This combination of changes, including the short-term deemphasis on military production and modernization, implied a radical alteration of the Chinese approach toward not only military acquisition and procurement, but the relative importance of the Chinese DTIB and CTIB. Rather than single-mindedly pursuing an improved DTIB to the exclusion of the CTIB, the Chinese would seek to develop their overall technological sophistication, with an emphasis on the CTIB, in order ultimately to improve the DTIB's capabilities.

Such an approach, though, presented two enormous problems, as Chinese defense planners themselves recognized. The first was how to modernize an industry that for two decades had produced few new weapons but that had relied instead on designs provided by the former Soviet Union in the 1950s, designs that themselves dated from World War II. The second was how to cut or cancel existing production lines and retain the work force, and still generate arms-export orders in order to allow some production plants to remain open in the event of hostilities.[14]

As the Chinese defense budget subsequently shrank, it became imperative to both the Chinese government in general and the PLA leadership in particular that the resources available to them be used more efficiently. One of the first signs of this effort involved the replacement in the late 1970s of the leadership of the MMIs, up to then composed of senior military personnel, with civilian administrators.[15] This was followed by the estab-

[13] "Conversion" involves commercial application of defense facilities; it occurs when the fixed costs are paid for by the military.

[14] G. Jacobs, "The PLA—From Doctrine to Organizations," *Jane's Intelligence Review*, p. 373, August 1993.

[15] H.W. Jencks, "The Chinese 'Military-Industrial Complex' and Defense Modernization," *Asian Survey* 20 (10): p. 987, 1980.

lishment of a commission to "tighten central supervision of the machine-building industries and to coordinate their production."[16] In 1983, in an apparent move to "erase special treatment of the military in the allotment of scarce resources," the various Chinese organizations and committees charged with oversight of defense production were merged into a single body, the Commission for Science, Technology and Industry for National Defense (COSTIND).[17] Concomitant with this, the Chinese military was cut by some million people, from 4 million to 3 million.

In the early 1980s, Beijing also began to convert many of the available defense-oriented plants into commercially oriented ones. Industries that were not producing critical hardware or that were unable to attract export markets were targeted for conversion to civilian production. This effort was aided by the release, in the course of economic liberalization, of massive, pent-up demand for various consumer (and later, light-industrial) goods. This massive demand ensured that at least an initial market existed for many of the commercial goods produced by the DTIB during this transition.

The conversion of redundant defense-industrial plants was further facilitated by the Chinese government's promulgation of several guidelines aimed at furthering integration of the civilian and military economies. These included the mandate that "civilian goods manufactured by their defense industry must use production technologies similar to military products, and must be goods which are in short supply and have market potential."[18] This ensured that the manufacture of commercial goods would involve minimal changes to the current plant (requiring, in turn, minimal capital and technological investments). It also meant that those goods that **were** produced would be goods that were desired (i.e., a market existed for them). To further assist the shift toward civilian production by military industry, the China Industrial and Commercial Bank set aside money for loans aimed at transferring military technology to civilian purposes.[19] This shift soon began to bear fruit. Between 1978 and 1983, civilian production on military lines rose 90 percent, until it amounted to nearly 20 percent of the defense industry's total output (by volume).[20] By the early 1990s, civilian production had risen to over 70 percent of Chinese defense-industrial production (by volume).[21]

PLA Procurement

The current Chinese military procurement process is oriented toward two specific goals: improving the PLA's combat capabilities and using the defense base to generate income. Although the Chinese defense budget has risen by over 10 percent annually for the past several years (see figure 1), Chinese resources for military modernization remain badly constrained. Much of the increased spending has gone toward salaries (a substantial outlay in a military still numbering over 3 million), rather than acquisitions. Furthermore, the heated state of the Chinese economy has meant a high inflation rate, further minimizing the real effect of defense-budget increases. Consequently, the primary focus of the Chinese military has generally involved upgrading available equipment, rather than purchasing new or additional items.

Overall PLA equipment holdings have improved only slowly. The slow pace of improvements is exacerbated by the need for hard currency

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[16]E. Joffe, *The Chinese Army After Mao* (Cambridge, MA: Harvard University Press, 1987), p. 101.

[17]S. Jammes, op. cit., footnote 8, p. 125.

[18]E. Joffe, op. cit., footnote 15, p. 102.

[19]*China Today: Defense Science and Technology,* Volume 1 (Beijing: National Defence Industry Press, 1993), p. 160.

[20]E. Joffe, op. cit., footnote 15, p. 102.

[21]Chong-Pin Lin, "The Stealthy Advance of China's People's Liberation Army," *The American Enterprise,* p. 33, January/February, 1994.

because most Chinese equipment upgrades have required foreign assistance. The upgrade of the A-5 aircraft, for example, centers on the addition of French inertial guidance and attack systems, including a heads-up display and laser range-finder.[22] Similarly, the new *Luhu*-class destroyers have extensive foreign equipment, including American gas turbines (for dash power) and French surface-to-air missiles (to remedy the dearth of air defense within the Chinese surface navy).[23]

The Chinese goal of using the defense base to generate income applies not only to the PLA as a whole (through such means as arms exports), but also to individual factories, units, and commands (which usually involve commercial production of some sort). These groups are further motivated to generate income by the bureaucratic competition within the Chinese procurement system. All of the major players of the Chinese procurement process sponsor their own firms, which in some cases now have competing product lines (discussed below).

The PRC's current procurement structure comprises several players (figure 2). The important ones are the PLA, the MMBs (the Ministries of Machine-Building, formerly the MMIs), and the Committee on Science, Technology and Industry for National Defense (COSTIND). Each player is not only involved in procurement for the PLA as a whole, but also heads up commercial organizations aimed at generating income, especially hard currency.

The PLA is the most important player of all, both due to the prominent role of the military in Chinese politics and because the PLA is charged with developing requirements for new equipment, thereby setting the agenda to some extent. The PLA answers to the Central Military Commission (CMC). The most important of the three elements within the PLA is the General Staff Department's Equipment Department (GSD/ED). The GSD/ED draws up operational parameters for PLA equipment acquisitions and coordinates demands from the three services. The PLA's General Logistics Department (GLD) is responsible for logistics and quartermaster duties, primarily food and uniforms. The third element, the General Political Department, has no direct influence on PLA weapons procurement.

Both the GSD/ED and the GLD control their own private corporations, which use the defense factories under their jurisdiction to produce not only weapons for the PLA, but also goods for export, including weapons and commercial items. The GSD/ED controls Poly Technologies Inc., a major corporation at least loosely affiliated with the China International Trade and Investment Corp. (CITIC), one of the first corporations established under Deng Xiaoping's reforms and still one of the largest and most well-connected. The GLD controls China Xinxing Corp., which numbers among its products food, clothing, and construction materials.[24]

Although it is the PLA that sets requirements, it is the MMBs that fulfill them. The six "defense-industrial ministries" answer to the State Council: the Ministry of Nuclear Industry, the Ministry of Aviation Industry, the Ministry of Electronics Industry, the China State Shipbuilding Corporation, the Ministry of Space (Astronautics) Industry, and the Ministry of Ordnance Industry. Each of these, in turn, controls at least one corporation. Thus, for example, China North Industries Corp. (NORINCO) is affiliated with the Ministry of Ordnance Industry, while the Great Wall Corp. and China Precision Machinery Import/Export Corp. (CPMIEC) are associated with the Ministryof Space Industry. The ministries and their subordinate corporations

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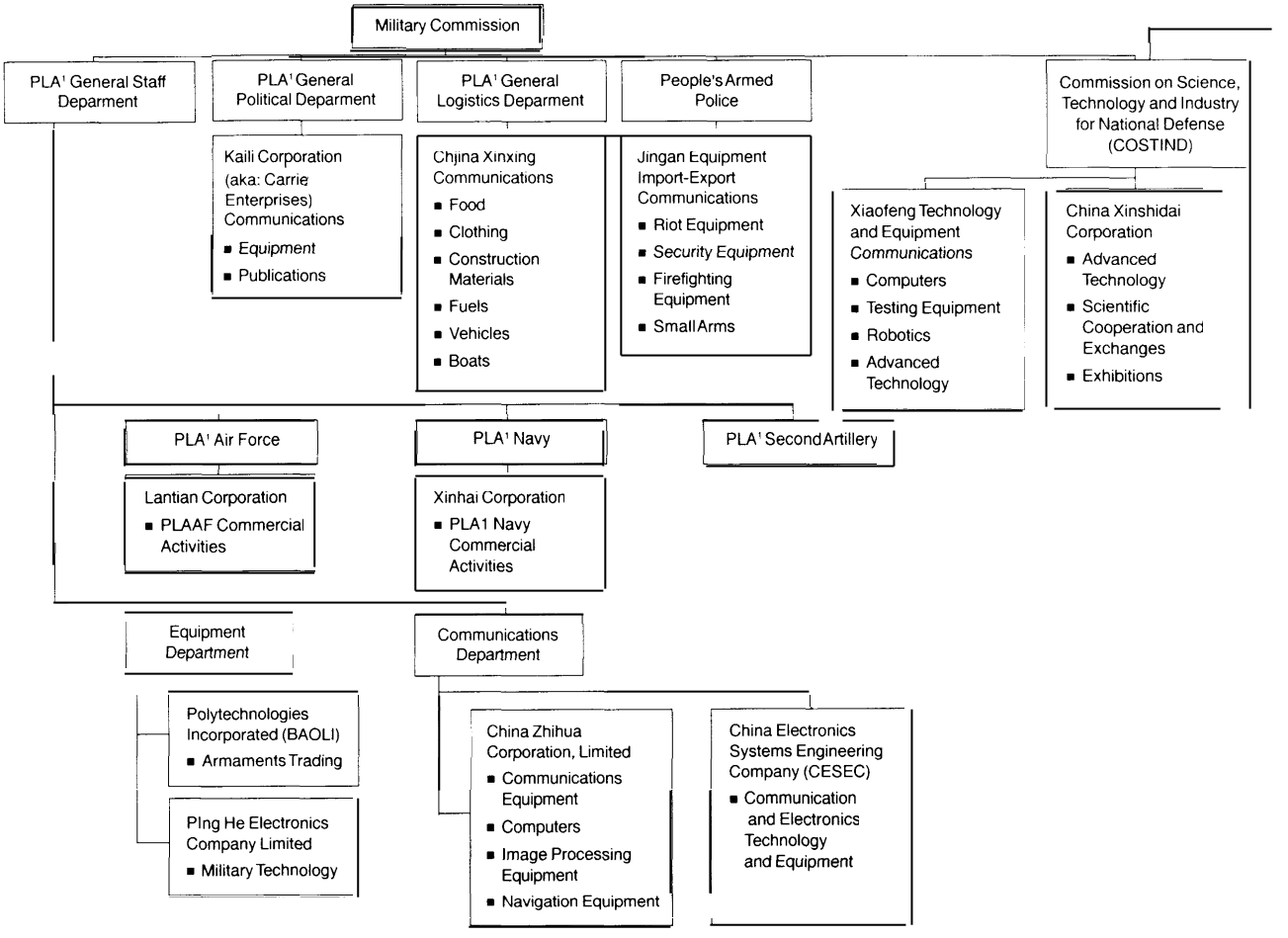
[22]Mao Jingli, "Replacing the Old with the New—on Upgrading China's Qiang (A)-5 II Aircraft," *Xiandai Bingqi* [Beijing] 7, pp. 4-5, July 8, 1993, in Joint Publication Research Service report (hereafter JPRS) 93-075 (Oct. 12, 1993) p. 36.

[23]"New Ships for the PLAN," *Jane's Defence Weekly,* p. 88, Jan. 18, 1992.

[24]Tai Ming Cheung, "On Civvy Street," *Far Eastern Economic Review,* 155:41, Feb. 6, 1992.

FIGURE 2: China's Defense Industrial Trading Companies



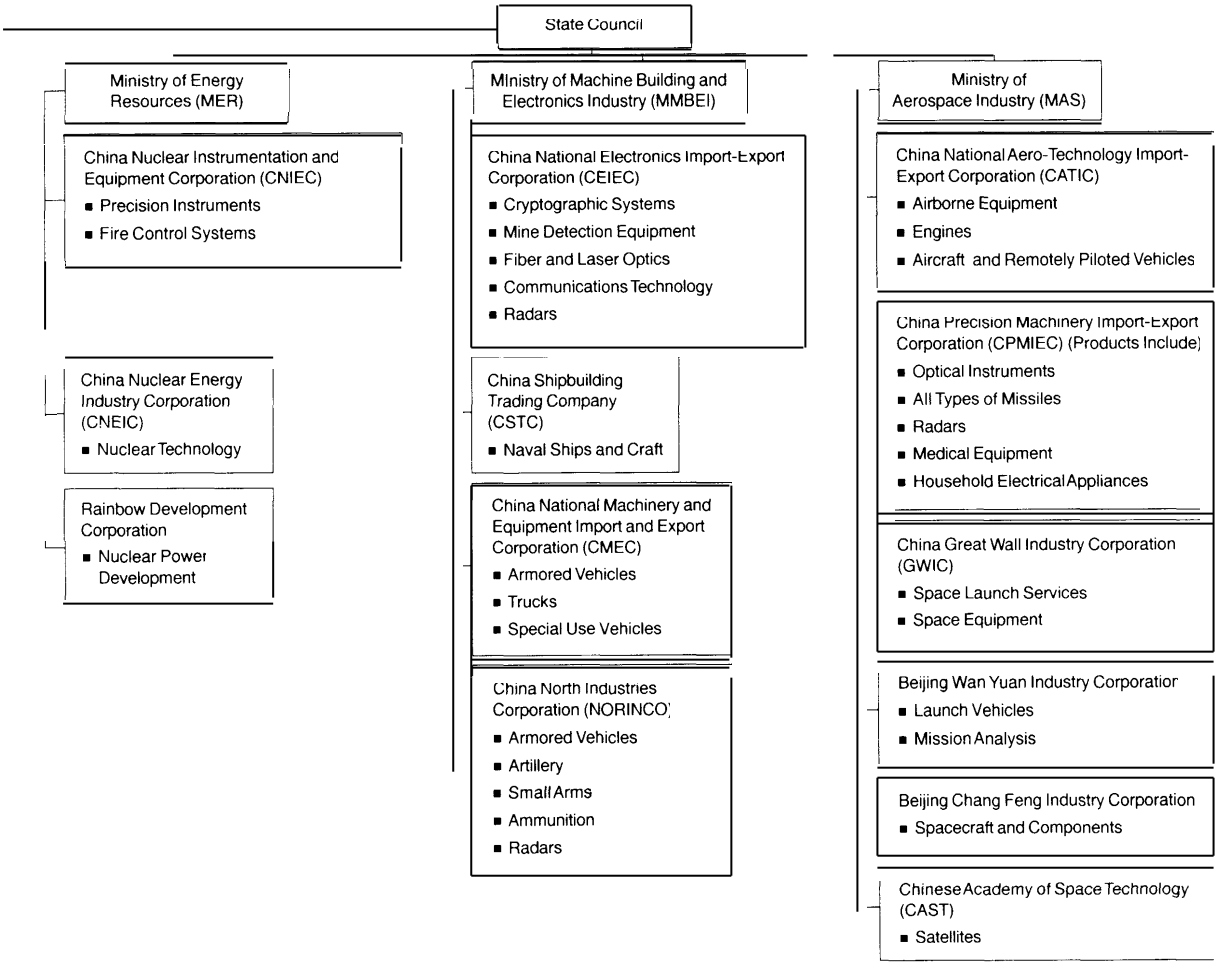
"own" China's DTIB, except for the portion that is under the control of the PLA and COSTIND.

In the past, the GSD/ED and the MMBs have often failed to see eye to eye. In particular, the GSD/ED's officers were not necessarily concerned with budgets because production costs were frequently the responsibility of the state, rather than the military per se. Nominally, this allowed military users to set requirements without having to worry about budgetary stresses.[25]

GSD/ED officers were also often unfamiliar with the production process. At the same time, the MMBs often did not necessarily understand operational requirements. As a result, the MMBs paid little attention to either potential combat needs or maintenance requirements. Instead, equipment was produced according to MMB capabilities, rather than to a plan for greater sophistication (with its ideological implications). This was most evident with aircraft production. The Ministry of

25 A.J. Alexander, "National Experiences: A Comparative Analysis," *Disarmament, Topical Papers #5, Conversion: Economic Adjustments in an Era of Arms Reduction,* Vol. *2 (New* York, NY: United Nations, 1991), p. 19.

FIGURE 2 (Cont'd.): China's Defense Industrial Trading Companies



SOURCE Defense Intelligence Agency, 1990

Aviation produced thousands of combat aircraft, most of which were obsolescent, if not obsolete, rather than attempt to develop better designs.

With the commercialization of the Chinese economy over the past 15 years, however, the Chinese procurement process has changed somewhat. The PLA now has greater responsibility for the budgetary aspects of acquisition, and the PLA's requests for more sophisticated arms must now be reconciled with other demands. At the same time, the MMBs now have a far greater incentive to procure and develop more sophisticated technologies. This does not mean that the MMBs are necessarily more responsive to the demands of the military, however. Instead, the "ministries tend to seek out technology that will directly affect industrial modernization."[26] They have, therefore, often subordinated military production to com-

26 J. P. Gallagher, "China's Military Industrial Complex," *Asian Survey* 28(9):998, 1987.

mercial requirements. COSTIND's role is to mediate between the PLA and the MMBs.

COSTIND combines research and development (R&D) functions. In some ways, it resembles the Director of Defense Research and Engineering (DDR&E) office within the Office of the Secretary of Defense in the United States. It is, however, granted a much wider purview. COSTIND is responsible for the specification, assessment, and application of all advanced technologies within the Chinese military and DTIB. The political power of COSTIND, moreover, is far greater than that of DDR&E. Several of COSTIND's members sit on both the State Council and the CMC.

Like both of the other players, COSTIND also controls its own corporations. These include China Xinshidai Corp. and Xiaofeng Technology and Equipment Corp.. The former is primarily oriented toward advanced technologies generally, whereas the latter is more narrowly focused, with special interests in computers, testing equipment, and robotics.

Comparison of the PRC with the United States

The Chinese DTIB differs in several important respects from its American counterpart. Initially, starting in 1949, the Chinese DTIB—indeed, the entire Chinese economy—was state-run. The Chinese economy was also heavily militarized. For decades, the DTIB had priority for receiving the highest-quality raw materials, trained personnel, and advanced technology. Although the Chinese economy has changed drastically since the advent of Deng Xiaoping and the introduction of economic reform and liberalization measures, significant portions, particularly the heavy-industrial sectors, remain centrally planned. Such differences clearly limit the relevance of the Chinese experience for the United States.

In the past decade, however, the Chinese have striven to liberalize their economy and to increase its sophistication. This has involved the acquisition of more sophisticated technology from abroad. At the same time, the Chinese have sought to make greater use of their current work force and available industrial plant. As a poor country, the PRC seeks to maximize its use of available labor and resources. Thus, there is a great emphasis on transferring DTIB resources to the CTIB (hence the Chinese emphasis on conversion). Those efforts, particularly in the areas of conversion and increasing the use of the same production lines for both civilian and military items, may offer some useful comparisons with the American case.

Acquisition Laws and Procedures

One of the most important obstacles to integrating civil and military procurement in the United States involves acquisition law.[27] The myriad requirements for reporting various costs have discouraged integration by imposing additional expenses on firms that seek to produce goods for the military. Even highly successful commercial firms are, therefore, frequently reluctant to undertake military production for fear of incurring these costs.

One aspect of the acquisition-law problem is technical data rights. The Department of Defense (DOD) frequently demands extensive rights to technical data to ensure that a given system can continue to be produced even if the original contracting corporation goes out of business. Thus, DOD may request not only data about the system itself, but also information on the manufacturing processes, which the company may well have developed on its own, often at significant expense.

The Chinese suffer from fewer such problems. In the past, this may have been due to state ownership of the bulk of the means of production. Indeed, within the Chinese DTIB, the State con-

[27]U.S. Congress, Office of Technology Assessment, *Assessing the Potential for Civil-Military Integration: Technologies, Processes, and Practices* (Washington, DC: U.S. Government Printing Office, 1994).

trolled and supplied all of the relevant industrial elements. As long as the DTIB was ahead of the CTIB, therefore, technical data rights were hardly a problem because the government possessed most technical data rights from the outset and was under no pressure to share them with the CTIB.

Furthermore, the Chinese DTIB was shrouded in secrecy. Thus, there was only a limited flow, if any, of technical data rights to the CTIB. Because the Chinese emphasized the military sectors over their commercial sectors, technical data, especially for relatively advanced processes, rested in the DTIB.

Military Specifications and Standards

In the PRC, although operational parameters are set by the PLA, the standards involved in actual production have been, and still are, set by the MMBs. This is due, in part, to the different backgrounds of PLA officers and MMB officials. The latter are far more versed in engineering, whereas the former have generally been capable only of setting out operational requirements without necessarily understanding the industrial demands involved. Thus, production standards have been the responsibility of the producers, rather than the users.

Chinese manufacturers set fairly high standards for the manufacture of their weapon systems within the capabilities of the Chinese DTIB. As was true for their Soviet counterparts, quality has generally been higher on military than on commercial production lines. The difference has been due, in part, to the Chinese DTIB receiving the best raw materials and facilities and the best-trained labor force. In addition, the priority accorded the DTIB by political authorities for material and political support may have obviated somewhat the need for extensive military specification. The government expected that only the highest-quality items would be provided for military production lines and that only the highest-quality products would be made.

Questions have been raised about the quality of Chinese military items, however. There have been reports, for example, that Chinese aircraft manufacturers' quality control has tended to be uneven. Entire Chinese aircraft types were recalled to their factories in 1975. In the 1980s, Chinese combat aircraft were reported to have serious problems that involved contamination of their hydraulic systems.[28] In the wake of joint ventures with the United States and Europe in the area of civilian aircraft (particularly the MD-80 and MD-90 at Shanghai Aircraft Industries Corp. (SAIC)), though, the general level of Chinese aircraft workmanship has apparently risen. Indeed, the certification by the U.S. Federal Aviation Administration of Chinese-manufactured components for McDonnell-Douglas aircraft, including fuselages and nose cones, for sale in the United States would seem to suggest that the Chinese work force at SAIC is now capable of meeting Western commercial standards. Because Western commercial standards are more stringent than previous Chinese specifications, the overall level of Chinese quality control, at least at this facility, would appear to have improved.

At the same time, Chinese combat aircraft are now reported to have a much smoother surface, or skin, than before.[29] This suggests that there is a flow of personnel and expertise from civilian to military production lines, at least in situations where the former had become more advanced than the latter. Such a flow would amount to "spin-on" of (relatively) more advanced techniques and capabilities from the commercial to the military side.

The Chinese modernization program currently focuses on the acquisition of more-advanced foreign weapons technology, such as the Su-27 fighter. Right now, these efforts do not involve any

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[28]R. J. Latham and K.W. Allen, "Defense Reform in China: The PLA Air Force," *Problems of Communism,* p. 46, May-June 1991.

[29]Professor P. Godwin, National Defense University, Washington, DC, personal communication, March 1994.

Chinese manufacturing, nor have the most recent acquisitions yet led to either production of reverse-engineered equipment or purchase of production facilities. Mastering the production of such equipment, by either method, will undoubtedly take several years. Because current Chinese efforts are aimed at producing much more sophisticated equipment, with higher tolerances, than the country had previously manufactured, it is likely that better quality control will be necessary. If requirements exceed current Chinese standards, new specifications, essentially military specifications and military standards, may be necessary.

Militarily Unique Technologies

Another obstacle to U.S. civil-military integration involves militarily unique technologies, which necessarily limit the degree of commonality between commercial and military goods and services. Although militarily unique technologies usually have no direct civilian applications in the United States (e.g., ballistic missiles and electronic warfare programming), in the PRC military technologies have tended to be rendered "unique" because certain resources have been in limited supply. That is, the PLA had priority for receiving many of the more advanced and expensive technologies and facilities (e.g., computers and wind tunnels) until Deng Xiaoping's economic liberalization raised the Chinese CTIB's status. It is likely, for example, that the Chinese air-defense network has a more advanced set of air-traffic-control capabilities than does the Chinese civilian air-traffic net.[30] Similarly, until the liberalization program commenced, one-half to two-thirds, if not more, of all Chinese-produced electronics were dedicated to military use.[31]

The decision to promote defense-industrial participation in the commercial market, however, would suggest that those items and qualities once reserved for the PLA, such as high-quality steel and better-trained workers, may now be seeping into the CTIB. Even now, however, the MMBs have sole control over many areas of Chinese technology that were once primarily military. Thus, the means of producing communications equipment remain concentrated in the hands of the DTIB, although the products are being dispersed into the CTIB at large. The arrival of Western telecommunications corporations in China may alter that situation further in the coming decade, although Chinese demands for co-production suggest that the MMBs may retain a large degree of control over any technologies and processes transferred from the West.

Emphasis on Military Performance

Since the beginning of the Cold War, the United States has placed a greater emphasis on military-product performance than on cost, whereas in the commercial sector, quality and performance were balanced against the likely costs incurred. The emphasis on high performance not only raised costs, but in some cases, minimized the commonality between functionally similar military and commercial goods.

In the PRC, significant effort does not seem to have been made to acquire or develop state-of-the-art weapons technologies. This is due, in part, to the relatively primitive state of the Chinese DTIB and, in part, to political and bureaucratic pressures, particularly within the MMBs. As a result, despite the Chinese DTIB's favored status compared with the Chinese CTIB's, for high-quality raw materials and tools, Chinese defense products have generally not been significantly more advanced than products of the Chinese CTIB as a whole, particularly in such areas as electronics and communications. According to one Chinese assessment, "In the realm of firepower and control

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[30]Chinese aviation officials noted in conversations that only one Chinese civilian airport has the more advanced Type 2 instrument landing rules (ILR) equipment. All others are equipped with only Type 1 ILR equipment. December 1993.

[31]D. Shambaugh, op. cit., footnote 8, p. 58.

systems, the Chinese fighters are lagging some 15 years behind advanced foreign levels."[32] The electronics in the most sophisticated domestically produced fighter aircraft, the J-8II, are comparable to American 1970s-level technology. Although the DTIB has tended to have priority for receiving higher-quality items (e.g., higher-quality machine tools), the quantities available have been so limited that they have had little effect on the overall quality of the DTIB, much less the CTIB.

The situation has been exacerbated by the PLA's own lack of interest in technologically advanced weapon systems. Only relatively recently has the PLA leadership demanded access to high-tech weaponry and advanced capabilities for its nonnuclear forces. These demands were then rapidly preempted by the Four Modernizations. As a result, it is only in the past four years that the PLA has had both the interest in and the wherewithal to obtain more sophisticated weapon systems. These have, in turn, primarily involved acquiring foreign technology. Thus, the Chinese DTIB's state-of-the-art weapon systems still lag behind Russia's, and even further behind the West's.

Integration of Levels of Production

In light of the circumstances enumerated above, what is the degree of integration between the Chinese DTIB and CTIB? As noted earlier, the PLA has played an important role in the economic development of the PRC. Conversely, the PLA also relies on the civilian infrastructure. The Chinese military, for example, evidently continues to use the national communications network, including the telephone system, microwave radio, telex, and multiplex wireless.[33] The PLA's Tibetan garrison is supported by China Southwest Airlines, which has ferried rotating formations of troops in and out of the region.[34] Thus, at a minimum, it appears that the Chinese military and popular economies are closely linked.

With economic liberalization, however, the additional impetus of making money has arisen, pushing all the ministries, corporations, and subsidiaries into seeking and exploiting commercial opportunities. Consequently, the output of civilian goods made on military production lines has risen sharply since economic liberalization began in the late 1970s and early 1980s. Indeed, according to some estimates, "profits generated in 1992 by more than 20,000 military-run companies [alone] totaled around 30 billion yuan [renminbi]—. . . with just six billion yuan given to the central military authorities."[35] The result has been a form of integration at all three levels (sector, firm, and facility; see box A). The Chinese version of integration, however, does not necessarily correspond with that in the United States.

Sector Level

At the sector level, most industrial sectors are integrated, insofar as they are involved in both military and commercial R&D, production, and operations and maintenance (O&M). The Chinese have emphasized the exploitation of their defense R&D facilities and resources in pursuit of overall national economic growth. One government effort aimed at facilitating this shift is the Torch Program, which promotes the shift of scientists and engineers from traditional research institutes and projects to those with greater commercial potential.[36]

The PLA itself is pressuring such centrally directed programs to promote R&D in a more commercial direction. In particular, given the semiau-

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[32]Zhang Yongqian, "Brief Look at China's Fighter Aircraft Development Level," *Xiandai Bingqi* [Beijing], Oct. 10, 1993, in JPRS 94-008, Jan. 31, 1994, p. 21.

[33]D. Shambaugh, op. cit., footnote 8, p. 60.

[34]"Making a Modern Industry," *Jane's Defence Weekly,* Feb. 19, 1994, p.27.

[35]"Balancing the Books," *Jane's Defence Weekly,* Feb. 19, 1994, p.35.

[36]R.D. Humble, "Science, Technology and China's Defence Industrial Base," *Jane's Intelligence Review,* January 1992, p. 8.

tonomous nature of many PLA units, there is an almost grass-roots quality to some of the PLA's R&D projects, which tend to emphasize commercially profitable ventures. Thus, the *Liberation Army Daily* reported on an "All-Army Enterprise Scientific and Technological Research Achievements Fair" in Beijing. At the fair, over 2,000 projects and experiments, few of which were for military customers, were displayed.[37]

In the heavy-industry sectors, it is reported that 68.8 percent of the output from Ministry of Ordnance Industry facilities and 80 percent of shipbuilding and repair activities are now for nonmilitary use.[38] In Chinese shipbuilding, integration of the military and commercial sides is quite explicit: the China State Shipbuilding Corp. owns all Chinese shipyards and shipbuilding and marine-equipment firms.[39] Thus, shipyards that once built warships are now turning their expertise and facilities to the construction of freighters and other vessels for commercial purposes.[40] Similarly, in the automotive sector, NORINCO, the largest Chinese arms corporation, which produces much of the PLA's heavy equipment including tanks and self-propelled guns, is also responsible for some 50 percent of Chinese motorcycle production and 30 percent of all minivans.[41] In fact, three-quarters of all minivans now apparently come from military sources.[42]

In the area of O&M the Chinese also appear to have achieved some degree of integration. Once equipment is procured, its upkeep becomes the responsibility of the PLA's GLD. Although the GLD controls a few depot-level maintenance facilities, primarily for heavy vehicles, there is no analogue in the PRC to the extensive depot structure that provides O&M support in the U.S. Instead, maintenance is primarily the province of the "owning" formation, or PLA unit. Extensive repair operations, particularly for aircraft and naval vessels, apparently involve the manufacturers (in the case of shipbuilding, the manufacturers control the primary shipbuilding and repair facilities).

Although the Chinese appear to have succeeded in integrating many of their sectors, it also appears that few of the lessons they have learned are transferable to the United States. Chinese efforts at the sector level exploit what are, at best, limited technologies and capabilities within the Chinese science-and-technology infrastructure. The Chinese themselves recognize this. In a recent article in *Xiandai Bingqi* (*Modern Weaponry*) assessing the newest domestically produced fighter plane, the author notes that "China's manufacturing technology was exceedingly backward; their stock of relevant technology was obviously inadequate, and this had a direct impact on model development."[43] The Chinese consider the attainment of international standards of sophistication in such areas as aerospace as a triumph in and of itself.[44] The levels of military and commercial tech-

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[37]Nie Zhonglin and Ma Chunlin, "First All-Army Enterprise Scientific and Technological Research Achievements Fair Opens in Beijing," *Jiefangjun Bao* (Oct. 19, 1993), p. 1, in Foreign Broadcast Information Service China daily report (hereafter FBIS-CHI) 93-211, Nov. 3, 1993, p. 40.

[38]D.J. Blasko, "Beijing's Big Bang," *Far Eastern Economic Review*, 157(8):37, 1994.

[39]R.D. Humble, op. cit., footnote 36, p. 6.

[40]Cao Huanrong and Jia Yong, Xinhua (Dec. 6, 1993), in FBIS-CHI 93-239 (Dec. 15, 1993), p. 27.

[41]Tai Ming Cheung, op. cit., footnote 24, p. 40.

[42]Cao Huangrong and Jia Yong, op. cit., footnote 40, p. 27.

[43]Zhang Yongqian, op. cit., footnote 32, p. 20.

[44]See, for example, Sun Mao-qing, "Air Force Test Base Advances to World Rank," *Renmin Ribao* (June 10, 1993), p. 3, in JPRS 93-014 (Aug. 17, 1993), p. 12, and Chang Ko, "China's Largest Drone Base," *Kuang Chiao Ching* (Hong Kong) 254 (16) Nov. 1993, in FBIS-CHI 93-221 (Nov. 18, 1993), p. 46.

nological sophistication in the PRC, for the most part, are below the global average. In only a few areas are the Chinese even maintaining parity.

The limited applicability of the Chinese situation to the American case is made more so by the very different nature of Chinese economic organization. Even after a decade of economic reform and liberalization, the state continues to own and manage the "commanding heights" of the Chinese economy, particularly heavy industry. The MMBs even now effectively exercise control over their respective sectors (e.g., shipbuilding, steel making, and electronics), a situation exploited by their subsidiaries. Each sector is, therefore, integrated, but only because the government controls virtually all production, both commercial and military, in that sector. Integration under such circumstances is more akin to consolidation of the means of production and diversification of products than to the sharing of product and process technologies that is typical of Western efforts. The Chinese approach to integration, involving the participation of the relevant ministries and their attendant corporations, is, therefore, probably unique to command economies and of limited relevance to capitalist ones.

Finally, the Chinese did not necessarily set out to integrate their CTIB and DTIB. Instead, in many cases, they are seeking to develop capitalist economic relations. A report from Shaanxi Province, for example, argues that the infrastructure for "science, technology and industry for national defense" within Shaanxi should be devoted to helping fulfill the "Shaanxi people's wishes to get rich." Indeed, the article goes so far as to suggest that the military industry should be eliminated in favor of national production of "high-technology products and export-oriented management."[45] The profits thus derived, presumably, would be allocated first to Shaanxi and only then to the rest of the nation. Similarly, factories in Guizhou Province appear geared toward provincial rather than national markets.[46]

Firm Level

At the firm level, the Chinese also appear to have become "integrated," or at least diversified. The Shanghai Aircraft Industry Corp., for example, sells everything from automobile jacks to pressurized tanks to refrigerators.[47] Discussions with COSTIND officials about their subordinate industries revealed a product line that included ships and cigarette-manufacturing machines at many corporations. Similarly, much of the Chinese chemical industry's pumps and seals are made by the Chinese Space Industry Corp. because it is accustomed to dealing with highly corrosive chemicals. By 1989, only 10 percent of defense firms remained committed solely to defense production; 16 percent produced only commercial products, and the remaining 74 percent produced both commercial and military products.[48]

As with sector-level integration, however, Chinese examples of firm-level integration may not be comparable to those in the West. In particular, if only firms that are actually profitable are considered successful examples of firm-level integration, there appear to have been more failures than successes. The efficient allocation of the available technological and human resources, however, appears to be only one of the PRC's criteria for successful integration.

Another important criterion for the PRC appears to be the preservation of jobs and, to a lesser degree, of industrial infrastructure, wherever possible. This is very different from Western integration efforts, which almost inevitably involve plant closings and increased unemployment. A high

[45]Zhang Ke, "Roundup," Zhongguo Xinwen She (Sept. 12, 1993), in FBIS-CHI 93-183 (Sept. 23, 1993), p. 39.

[46]Liang Fang, *Beijing Review* (41) Oct. 11-17, 1993, in FBIS-CHI 93-202 (Oct. 21, 1993), p. 36.

[47]Officials of the Shanghai Aircraft Industry Corporation, Shanghai, personal communication, December 1993.

[48]A.J. Alexander, op cit., footnote 24, p. 21.

priority for Chinese authorities appears to be to retain workers and keep equipment employed. As a result, for example, certain enterprises that have been unable to find a suitable product to manufacture have contracted their work force to highway construction and other projects.[49] Similarly, the Chinese DTIB has diverted several tens of thousands of technical facilities to light industry, including the petrol chemistry, chemical fertilizer, and chemical fiber industries.[50]

Although such reallocation has kept plants and personnel occupied, it has come at a price. In particular, there are few good measures of the extent to which the plants and personnel that are converted to commercial production are efficiently used. It is reported, for example, that perhaps no more than one-third of the military industry's capacity is being used efficiently, despite strenuous efforts.[51] More disappointing to the central authorities, only about half of Chinese defense firms have succeeded in manufacturing civilian goods at acceptable prices.[52] Thus, according to one report, "two-thirds of all aerospace enterprises are unable either to produce any marketable civilian products or compete in the civilian market without state subsidies."[53] These firms, however, apparently remain in business regardless of whether they are suceeding in actually producing marketable products.

The low efficiency of some Chinese plants and personnel is due to their location. As noted earlier, many of China's largest defense-industrial facilities (and many smaller ones) are located in the relatively remote interior, constituting the so-called "third line" of production from the days of the "People's War" doctrine. As a result, getting goods to market is, at best, difficult, and getting access to raw materials, in a commercialized economy, is problematic. Corporations that rely on such facilities, therefore, are faced with a daunting task from the outset. Although they may be able to keep their doors open (thanks to subsidies from various governmental sources), that does not necessarily mean that their products are commercially viable. Indeed, it may well be that subsidies are as important as products in ensuring the continued utilization of Chinese DTIB resources and labor. There are indications that at least some production is being shifted away from inland locations closer to transportation links. In some cases, entire plants are being moved.[54]

Facility Level

The prospect of finding relevant lessons for the West in the PRC's conversion and integration experiences may be the most promising at the facility level. Chinese military factories reputedly produce commercial and military goods side by side on the same lines. The production of equipment that varies primarily in the coat of paint applied is the epitome of integration. Chinese military-vehicle factories have in some cases, for example, simply changed the colors available for the commercial market. Thus, Chinese command cars, resembling jeeps, may now be found in both civilian and military livery on the streets of Beijing. Chinese-produced motorcycles, once intended for military dispatch riders, are now provided primarily to the civilian motorcycle market.[55]

At a somewhat higher technological level, some Chinese aerospace products are also reportedly produced in an integrated manner. The Y-7,

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[49]Liang Fang, op cit., footnote 46, p. 35.

[50]*China Today*, op. cit., footnote 19, p. 163.

[51]"Making a Modern Industry," p. 29.

[52]Tai Ming Cheung, op. cit., footnote 24, pp. 40-41.

[53]Ibid., p. 42.

[54]Liang Fang, op. cit., footnote 46, pp. 35-36.

[55]C. Hollingworth, "China's Arms Industry," *NATO's Sixteen Nations* 32 (2): 52, 1987.