The Power Behind 'Spin-Ons'
The Military Implications of Japan's Commercial Technology

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Three of the biggest news stories to hit Tokyo in 1987 -- Toshiba, SDI, and FSX -- bear a common lesson. Each of these stories suggests, in its own way, that Japan's leadership in commercial technology has enormous implications for international security relations. In May 1987, it came out that the Toshiba Machine Co., a subsidiary of Toshiba Corp., had sold sophisticated milling machines to the Soviet Union, reportedly enabling the Soviets to reduce the noise level of their nuclear submarines. U.S. Congress members staged a ceremonial declaration of war on Toshiba on the Capitol lawn, smashing Japanese-made radios in front of television cameras from around the world. Many Japanese commentators viewed the whole incident as a pretext for "Japan-bashing", pointing out that the Soviets had achieved quieter submarines before they imported the Toshiba machines. More sober analysts pointed to the Toshiba incident as a demonstration of the potential power of Japan's commercial technology. This particular export may not have altered the global military balance, but another one just might.

In July 1987, the Japanese government officially announced that Japanese firms could participate in research on the Strategic Defense Initiative (SDI). The Department of Defense awarded two contracts of $3 million to U.S.-Japan consortia to conduct architecture studies on anti-ballistic missile defense in the Western Pacific. Mitsubishi Heavy Industries (MHI) leads one consortium and LTV Corp. of the United States leads the other.[1] The SDI Office (SDIO) granted both consortiums a second one-year extension for a "Phase III" study in April 1991. In addition, Japanese companies are participating in SDI research on Josephson-Junction microprocessors and the fabrication of artificial diamonds.[2] Japanese participation in SDI is symbolic of two important trends. First, the U.S. Department of Defense is becoming more interested in tapping Japan's technology base for its own military programs. The Pentagon views SDI research cooperation as a way to gain access to Japan's advanced dual-use technology, and in somes cases, to gain control over this technology. Second, Japanese corporations have begun to cultivate the U.S. Department of Defense as an important customer for the future. Electronics companies such as Mitsubishi Electric and NEC were particularly eager to pursue involvement in SDI.

In October 1987, the Japan Defense Agency (JDA) decided that General Dynamics of the United States and MHI of Japan would co-develop Japan's next fighter plane, code-named the "Fighter Support Experimental", or FSX, based on the American F-16. In doing so, the JDA disappointed both the Americans, who wanted the JDA to buy an American plane off the shelf, and the domestic defense industry, which was pushing for indigenous development. In

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1 Nihon Keizai Shimbun (5 November 1988).

2 According to DoD sources, these two projects are designed primarily to enable SDIO to test experimental systems with Japanese components which are significantly more advanced than their American counterparts. In this way, the SDIO is able to "look into the future" and better anticipate what components they will be able to incorporate into future systems.

November 1988, the two governments signed a memorandum of understanding (MOU) whereby U.S. manufacturers would be guaranteed 35-45 percent of development work. More importantly, the MOU stipulated that technology developed under the FSX project would flow back to the United States. The FSX issue returned to the headlines in 1989 as a group of congressmen tried to pressure President George Bush to renegotiate the MOU. These congressmen argued that Japan should buy an American fighter, given the enormous trade gap between the two countries. They also expressed concern that Japan might be able to use its advantage in important high technology sectors to launch a full-fledged drive into the global aircraft production business. As it now stands, the FSX co-development project provides a crucial precedent in at least two respects. First, it represents the first large-scale attempt at U.S.-Japan joint development in the military sphere. Second, it gives Japan a golden opportunity to apply its commercial technology expertise in a military project and to assess its own system integration capabilities.[3]

Japan plays a bigger role in international security today because it controls a resource which is critical to military strength: high technology. Many Japanese themselves accept that their country is now a major power in global affairs, yet they often deny that this power has a military dimension. A report commissioned by Japan's Economic Planning Agency suggests that Japan in 1985 already had surpassed the Soviet Union and the major European powers to become the world's No.2 power in terms of its "ability to contribute to the international community."[4] Japanese leaders insist, however, that while Japan may be an international economic power, it will never be a military power. Japan may demand more influence within the Asian Development Bank or the International Monetary Fund, but it will never claim to have much impact on the global military balance.

This chapter suggests, on the contrary, that Japan is already a major military "actor" in the world, if not a military power in its own right.[5] In particular, Japan has gained leverage over its closest ally, the United States, by virtue of its strength in high technology. If Japanese firms take the "Toshiba" route, selling technology to the United States' rivals, they could undermine U.S. efforts to maintain a technological edge. If they pursue the "SDI" route and transfer their dual-use technology to the United States, these firms could help the United States to maintain long-term technological superiority. This is no less important for the United States in the era beyond the Cold War, for U.S. military strategy still relies on substantial technological superiority over potential or actual adversaries, whether they be Soviets or Iraqis.

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3 On the virtues of co-development, see Steven K. Vogel, "Let's Make a Deal: the U.S.-Japan Co-Technology Sphere," The New Republic (19 June 1989), pp. 14-16.

4 Economic Planning Agency, Planning Department, Nihon no sogo kokuryoku [Japan's Comprehensive National Strength] (Tokyo: EPA, 1987).

5 John W. Dower refers to Japan as a major military "actor" in "Japan's New Military Edge," The Nation (3 July 1989), pp. 1, 18-22.

The FSX project illustrates the tensions created by Japan's growing leverage over the United States. U.S. officials would like to use the project to gain access to Japanese dual-use technology, and to keep Japan dependent on U.S. military technology assistance. Japan would like to use the project to try out its hottest dual-use technology and to develop system integration skills, thereby becoming less dependent on U.S. military technology assistance. If the FSX project works well, both sides may realize how much they have to gain through cooperation. If it fails, as it almost did in 1989, Japan is likely to pursue a much more independent course in military development and weapon systems production.

Japan's technological strength ultimately gives it new options for maintaining its own security. Given its technological and economic strength, Japan has the capability to become a major military power within the not-too-distant future (10-25 years). Japanese ambitions for a return to power in the world are no longer constrained by technology, but only by politics.

Japan's Commercial Technology Base

Japan's economic power, and its actual and potential military power, are ultimately rooted in the strength of its commercial technology base. Japan has built up an impressive technology base through a gradual process of adoption of foreign technology and constant innovation in methods of production.[6] Although U.S. corporations invented much of the important new technology in the postwar period, Japanese firms have been more successful in developing efficient manufacturing systems. Japanese technology expert Masanori Moritani uses RCA as a paradigm for American companies' failure to maintain a technological lead. RCA led the way in the development of television, yet Sony perfected trinitron technology.[7] RCA was an early innovator in video tape recorders, but Sony and the Japan Victor Company refined the video recorder into a product small enough and inexpensive enough for the household consumer.[8] And RCA produced the first amorphous solar cell in 1976, but Sanyo was the first to

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6 See Laura D'Andrea Tyson and John Zysman, "Developmental Strategy and Production Innovation in Japan," in Chalmers Johnson, Laura D'Andrea Tyson, and John Zysman, eds., Politics and Productivity: the Real Story of Why Japan Works (Cambridge, MA: Ballinger, 1989), pp. 59-140.

7 Masanori Moritani, Gijutsu kaihatsu no showa-shi [A Showa History of Technology Development] (Tokyo: Toyo Keizai, 1986), pp. 126-30. See Jeffrey A. Hart, "The Consumer Electronics Industry in the United States: Its Decline and Future Revival," in Francois Bar, Michael Borrus, Sabina Dietrich, Jeffrey Hart and Jay Stowsky, The U.S. Electronic Industry Complex, Report to the U.S. Congress, Office of Technology Assessment (October 1988) for an overview of the decline of the U.S. consumer electronics industry; and see James E. Millstein, "Decline in an Expanding Industry: Japanese Competition in Color Television," in John Zysman and Laura Tyson, eds., American Industry in International Competition: Government Policies and Corporate Strategies (Ithaca, NY: Cornell University Press, 1983), pp. 106-41, for an analysis that focuses on Japanese firms early conversion to all solid-state technology (1971 for most Japanese producers vs. 1973-74 for RCA and Zenith).

8 Ampex, another U.S. firm, came out with the first video tape recorder in 1956. See Moritani (1986), op. cit., pp. 145-50, and Richard S. Rosenbloom and Michael A. Cusumano, "Technological Pioneering and Competitive Advantage: the Birth of the VCR Industry," California Management Review (Summer 1987).

develop it into a marketable product.[9] "In terms of commercial technology," Moritani concludes, "we don't have anything left to learn from the Americans."[10]

Japanese producers really only assaulted the heart of the U.S. high technology advantage, however, when they began to export semiconductors. Japanese manufacturers' innovations in production technology made them particularly successful in the mass-production market for dynamic random-access memories (DRAMs). From 1978 to 1986, the Japanese share of the world semiconductor market grew from 28 to 45 percent, while the U.S. share declined from 54 to 43 percent.[11] By 1986, Japan had 65 percent of the world market in metal oxide semiconductor (MOS) memories.[12] In the same year, a U.S. Panel on Materials Science concluded that Japan had the edge in the all-important area of processing materials for electronics devices.[13] In 1987, a Defense Science Board Task Force estimated that Japan led in both silicon and non-silicon products.[14] Later in the year, the U.S. government and manufacturers decided to respond to the Japanese challenge by forming their own research consortium, Sematech.[15]

With their successful advance in semiconductor technology, the Japanese have essentially surpassed the Europeans and caught up with the Americans in the overall high-technology race. Evaluating an entire country's technology base is by nature an imprecise art. The results of any evaluation will vary depending on how it values the different "qualities" of technology, such as scientific novelty, technical complexity, endurance and ease of maintenance. Nevertheless, most recent attempts to compare the overall technology base of Japan and the United States have shown rough parity between the two countries. Even the "modest" Japanese recognize this new situation of parity in the U.S.-Japan high technology race. The 1988 Ministry of International Trade and Industry (MITI) White Paper on Industrial Technology claims that by 1993 Japan will lead the United States in 11 of 41 high-technology product areas including memory devices, fine ceramics, and semiconductor lasers. The United States will only lead in four areas: satellite launching vehicles, aircraft engines, data bases, and magnetic resonance imaging (MRI).[16]

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9 Moritani (1986), op. cit., pp. 204-10.
10 Interview with Masanori Moritani, author and technology expert (Tokyo, 20 July 1987).
11 Thomas R. Howell, William A. Noellert, Janet H. MacLaughlin, and Alan Wm. Wolff, The Microelectronics Race: the Impact of Government Policy on International Competition (Boulder, CO: Westview, 1988), p. 217.
12 Ibid., p. 56.
13 National Materials Advisory Board, Panel on Materials Science, Advanced Processing of Electronic Materials in the United States and Japan (Washington D.C.: National Defense University Press, 1987), pp. 1-2. Also see Jay S. Stowsky, "Weak Links, Strong Bonds: U.S.-Japanese Competition in Semiconductor Production Equipment," in Johnson, Tyson, and Zysman, eds. (1989), op. cit., pp. 241-274.
14 Department of Defense, Office of the Under Secretary of Defense for Acquisition, Report of the Defense Science Board Task Force on Defense Semiconductor Dependency (February 1987).
15 On U.S.-Japan competition in semiconductors, see Michael Borrus, Competing for Control: America's Stake in Microelectronics (Cambridge, MA: Ballinger, 1988).
16 Ministry of International Trade and Industry, Trends and Future Tasks in Industrial Technology: Summary of the White Paper on Industrial Technology (Tokyo: MITI, 1988).

Trends in international trade confirm Japan's status as a technology leader. Japanese high-technology exports in 1988 exceeded imports by a factor of 5.2 to 1. Meanwhile, the United States ran a slight deficit in high-tech trade. Japan had a 24 percent market share of world high-tech exports in 1986, compared to 33 percent for the United States.[17]

U.S.-Japan "parity" in the high-tech race, however, is not the same as U.S.-Japan "equivalence". In fact, Japan and the United States have very different strengths and weaknesses within what is a very tight race overall. The fundamental differences in the nature of the technology which U.S. and Japanese scientists come up with follows logically from differences in the way the two countries research and develop technology. In general, researchers in the United States focus more on basic research, while their Japanese counterparts concentrate more on product development. Japanese critics themselves are fond of reminding their public that Japan only has five Nobel Prize winners in science through 1989, while the United States has 154.[18] These same analysts, however, typically take offense at characterizations of the Japanese as "uncreative", asserting that Japanese creativity merely manifests itself in different ways. Moritani, for example, has developed a distinction between U.S. "originality" and Japanese "creativity". While most original ideas to date have come from the West, he stresses that Japanese technicians have shown exceptional ingenuity in adapting these ideas in order to develop useful products.[19] This kind of "creativity" has been manifesting itself more and more on the marketplace. Japanese received 21.1 of the 95,500 patents issued byt the United States in 1989.[20] Computer Horizons Inc. of New Jersey found that Japanese actually rated higher than Americans according to an index of innovation based on how often a country's patents are cited in applications for other patents. Japan achieved an index rating of 1.34, compared to 1.06 for the United States, 0.94 for the United Kingdom, 0.80 for France and 0.79 for West Germany.[21] Japan's "original" contributions can be expected to increase as well now that Japanese technology strategy has shifted from catching up to taking the lead.

While Japan's relative inattention to basic research may become a greater weakness in the future, its almost obsessive attention to the subtleties in product development should continue to reap generous rewards. Japanese companies' emphasis on lowering production costs and constantly improving manufacturing technology has given many of them a significant price and quality advantage over their foreign competitors. In the future, the Japanese may be able to use their advantage in flexible manufacturing systems (FMS) to make inroads in the U.S. lead in the small-batch production of advanced electronic components and equipment. They have already

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17 Science and Technology Agency, Kagaku gijutsu hakusho 1990 [1990 Science and Technology White Paper] (Tokyo: STA, 1990), pp. 143-144.
18 Ibid., p. 305.
19 Moritani interview (20 July 1987).
20 Science and Technology Agency (1990), op. cit., p. 139.
21 The New York Times (7 March 1988).

achieved lower defect rates than their counterparts in mass-production sectors as diverse as automobiles and memory chips. MITI's analysis for the 1988 White Paper on Industrial Technology judges that Japanese high-technology products are more reliable than American ones in 27 of 41 areas and equally as reliable in another 8 areas.[22] The implications of this reliability advantage are enormous for the future of U.S.-Japanese competition in commercial markets, but the implications in the filed of military systems may be even more ominous. In the commercial market, a high defect rate can result in a severe loss of market share. On the field of battle, defects costs lives.

Japan's R&D activity suggests that Japan is now closing the gap in many areas of technological weakness and increasing its lead in areas of strength. The Japanese government and industry are committed to making the investment necessary to strengthen the country's high technology base. Government and business leaders will not back off from competition in any significant high-technology sector despite trade friction with the United States because they see high technology leadership as Japan's only route to long-term prosperity. Japanese leaders are painfully aware of the challenge that the Newly Industrializing Economies (NIEs) pose to Japanese heavy industries such as steel and shipbuilding and to "low" high-tech industries such as consumer electronics. They are more confident of challenging the United States in "high" high technology than they are of fending of the NIEs' challenge to Japanese supremacy in "low" high technology. In any case, they would prefer to continue moving away from labor-intensive industries toward higher value-added sectors.

The Japanese government has been remarkably successful in promoting research and development, particularly given its relatively small share in overall R&D spending. In 1988, R&D expenditure for Japan totaled 9.775 trillion yen, compared to 18.264 trillion for the United States (at $U.S. = 138.0 yen). The United States, however, spent 5.57 trillion yen on defense R&D, while Japan spent only 93 billion. The U.S. government shouldered 48.0 percent of the country's R&D burden while the Japanese government only covered 18.4 percent.[23] In part, government spending is underrepresented in spending figures because of the considerable tax incentives offered for private industry research spending. More importantly, the Japanese government has acted as an effective coordinator and facilitator of research projects without necessarily serving as the primary source of funding. The government avoids inefficient duplication of research and facilitates the diffusion of the results by aggressively promoting inter-firm cooperative research. Cooperative research forces private companies to share

22 MITI data.
23 Science and Technology Agency (1990), op. cit., pp. 250- 53.

information and allows them to standardize parts more easily. In addition, joint research projects create personal networks which facilitate future cooperation.[24]

The Military Uses of Commercial Technology

Japan's present and future technological leadership is only so relevant to international security because in recent years commercial technology has advanced more rapidly than explicitly military-use technology. In the past, the requirements of the military market were usually much stricter than those of the commercial market. Products for military procurement must be resistant to shock, heat and radiation in a way that few commercial products need be. Military technology was generally considered to be more advanced than commercial technology so that one could expect considerable commercial spin-offs from military research. Today, commercial technology is at the forefront in many areas. It is difficult to compare the level of technology in the commercial and military sectors in any comprehensive way, but the commercial sector now leads substantially in the critical area of microelectronics. Due to the long production cycle in the defense industry, most U.S. military systems now use devices which are 5-7 years out of date. U.S. and Japanese producers introduce a whole new generation of devices every 2-3 years, whereas most military systems evolve on a 5-20 year cycle. The commercial market in many high-technology products has the advantage of greater size, which means greater incentives for producers and higher profits which can be recycled into more R & D. The commercial market also offers more immediate and more widespread feedback on product performance. This encourages producers to put a premium on cutting production costs and improving manufacturing processes. Finally, increased competition for reliability and endurance in commercial markets means that these products now have to be as reliable if not more reliable than military-use products. A 1986 Defense Science Board report on "The Use of Commercial Components in Military Equipment" judged that commercial electronic systems such as computers, radios, and displays were just as durable in harsh environments, 1-3 times more advanced, 2-10 times cheaper, five times faster to acquire, and more reliable than their military equivalents.[25] In the foreseeable future, commercial-to-military "spin-ons" are likely to boom while military-to-commercial "spin-offs" decline.[26]

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24 See Richard J. Samuels, Research Collaboration in Japan, M.I.T.-Japan Science and Technology Program Working Paper (February 1987). A number of authors have suggested that the impact of Japan's cooperative research projects is often overrated. See, for example, George R. Heaton, Jr., "The Truth About Japan's Cooperative R & D," Issues in Science and Technology (Fall 1988).

25 Jacques S. Gansler, "The Need and Opportunity for Greater Integration of Defense and Civilian Technologies in the United States," unpublished paper (1987), p. 13.

26 For a discussion of the Japanese perspective on "spin- ons", see Richard J. Samuels and Benjamin C. Whipple, "Defense Production and Industrial Development: the Case of Japanese Aircraft," in Johnson, Tyson, and Zysman, eds. (1989), op. cit., pp. 275-318.

Japanese producers are particularly likely to benefit from technological "spin-ons" because their most important area of technological strength, electronics, is becoming increasingly critical to military systems. The U.S. Electronics Industries Association estimates that the electronics content of defense systems has grown from 34 percent in 1981 to 40 percent in 1990, and will increase to 43 percent by the end of the century.[27] Richard A. Linder, president of Westinghouse's Defense Electronics Group, suggests that electronics will be even more important for the emerging military technologies of the future, particularly stealth and multi-spectral systems. He argues that four technologies which will make crucial contributions to military systems are: 1) very high-speed integrated circuits (VHSIC), 2) digital gallium arsenide (GaAs) circuits, 3) microwave monolithic integrated circuits, and 4) mercury cadmium telluride (HgCdTe) for infrared detectors.[28] Japanese corporations excel in all four of these technologies. "Thanks to the 'electronics-ization' of defense," says Mitsubishi Electric Managing Director Takeshi Abe, "the stage is finally set for Japan to build weapons even better than those made in the U.S.A."[29]

Japan leads in other important dual-use areas as well. (See Table 1). Japan, for example, leads in advanced industrial ceramics, which can be used to coat aircraft engines or to hermetically insulate missile guidance systems and warheads. Japan's advanced carbon composites and radar technology have enabled it to achieve world leadership in important subsystems for the FSX.[30] The Technical Research and Development Institute (TRDI) has been successful in adapting commercial computer technology for use in cockpit control systems. The Japanese are particularly advanced in the miniaturization of electronic hardware which is so valuable for military aircraft. The Japanese journal Voice estimates that Japan leads the United States in thirteen categories of technology of important military use, while the United States leads in seven and the two countries are even in two.[31] According to a U.S. Department of Defense and Department of Energy report, Japan is significantly ahead of the United States in some niches of 5 of 20 technologies which are critical to national security and "the long-term qualitative superiority of U.S. weapon systems":

Semiconductor materials and microelectronic circuits *
Software producibility
Parallel computer architectures
Machine intelligence and robotics *
Simulation and modeling

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27 Aviation Week and Space Technology (19 March 1990).
28 Bruce D. Nordwall, "Electronic Technology to Dominate Next Generation of Weapons," Aviation Week and Space Technology (6 June 1988), pp. 81-85.
29 Nikkei Business (11 May 1987), p. 15.
30 These will be discussed in more detail below.
31 Voice (September 1987), p. 95.

Photonics *
Sensitive radars
Passive sensors
Signal processing
Signature control
Weapon system environment
Data fusion
Computational fluid dynamics
Air-breathing propulsion
Pulsed power
Hypervelocity projectiles
High energy density materials
Composite materials
Superconductivity *
Biotechnology materials and processes *

*Areas where Japan leads significantly in some niches[32]

The United States' primary rival for pre-eminence in these technologies is no longer the Soviet Union, but Japan.

32 Department of Defense (for the Committees on the Armed Services, U.S. Congress), Critical Technologies Plan (15 March 1990), p. 11.

TABLE 1

SOME EXAMPLES OF JAPANESE DUAL-USE TECHNOLOGY

Civilian technology	Producer	Military Use
Materials		
Radar-proof ferrite paint	TDK	Stealth Aircraft
Carbon composite materials	Toray	FSX wing
Components		
Charge coupled devices	Mitsubishi Electric	Missile guidance
Television camera	Hitachi	Remotely piloted vehicle
Subsystems		
Doppler radar (for cars)	Fujitsu	Aircraft guidance
Satellite ground receiver	NEC	Military receiver
Systems		
BK 117 A3 helicopter	KHI	Could be equipped with anti-tank missiles

The U.S. Department of Defense (DoD) has not overlooked the enormous potential for the military use of Japanese commercial technology. In fact, the Pentagon already depends heavily on Japanese components, particularly memory devices, for its weapon systems. In 1980, the DoD and the Japan Defense Agency (JDA) established the Systems and Technology Forum to explore avenues for cooperation in military research and development, production and procurement. In 1983, Prime Minister Yasuhiro Nakasone announced that Japan would make an exception to the country's arms export ban for exports of military technology, but not for military systems, to the United States. In November 1983, Japan and the United States signed notes establishing a Joint Military Technology Commission (JMTC) comprised of State and Defense representatives from the American embassy in Tokyo and Japanese representatives from the Defense Agency, the Ministry of International Trade and Industry, and the Ministry of Foreign Affairs. In December 1985, the two sides followed up with detailed arrangements for the transfer of military technology.[33]

To date, there have been three examples of such technology transfers, all of which were contrived more for their role as precedents than for any immediate benefit to the United States. Gregg Rubinstein, one of the original architects of the agreement, suggests that the DoD pushed for the exchange procedures not with any expectation of significant transfers in the short term, but in the hope of setting up an apparatus which could bring real payoffs in the 1990s and beyond.[34] The first case involved the guidance and control system for the Toshiba portable "Keiko" surface-to-air missile (SAM), a system heralded in Japan but nonetheless of questionable value to the U.S. military. The JMTC approved the government-to-government transfer at a price of approximately $700,000 in December 1986, but the sale was never made due to the political fallout from the Toshiba Machine incident. In the second case, an industry-to-industry transfer, Ishikawajima-Harima Heavy Industries (IHI) sold shipbuilding technology for tactical auxiliary oil tankers to the Pennsylvania Shipyards of the Military Sealift Command. In the final case, an industry-to-government transfer, IHI sold its expertise to the U.S. Navy's Philadelphia Shipyard for overhauling the U.S. aircraft carrier Kitty Hawk under a service-life extension program. Both of the latter two transfers met real needs of the U.S. Navy, but they probably could have been arranged as commercial technology transfers if they had not been such convenient trial cases for the new military technology transfer arrangements.[35] In any case, the DoD has always been more interested in Japanese dual-use technology than in strictly military technology.

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33 Department of Defense, Office of the Under Secretary of Defense for Acquisition, Japanese Military Technology: Procedures for Transfers to the United States (1986).

34 Interview with Gregg Rubinstein, director, plans and policy, international operations, Grumman International, Inc. (Washington D.C., 3 June 1987).

35 Interview with Jamieson C. Allen, director, research and development exchange, Mutual Defense Assistance Office (Tokyo, 26 June 1987); and JEI Report, No. 30A (7 August 1987).

Since 1983, the DoD has sent a series of technology assessment teams to Japan to evaluate Japanese technologies of potential military use. The first such team, a Defense Science Board task force which toured Japan in November 1983, cited 16 primary areas of interest in Japanese technology:

Gallium arsenide devices-- microwave, high-speed logic
Microwave integrated circuits
Fiber-optic communications
Millimeter-waves
Sub-micron lithography
Image recognition
Speech recognition/ translation
Artificial intelligence
(knowledge-based computer architecture)
Electro-optical devices
Flat displays
Ceramics (for engines, electronics)
Composite materials
High temperature materials
Rocket Propulsion
Computer-aided design
Production technology
(including robotics/ mechatronics)[36]

The DoD sent a technology team to Japan in July 1984 and April 1985 to look specifically at electro-optics and millimeter/microwave technology and sent a follow-up team in August 1986.[37] In January 1987, Dr. Clinton Kelly led a Defense Advanced Research Projects Agency (DARPA) mission to look into Japanese manufacturing technology in electronics, heavy machinery and avionics.[38] Jamieson C. Allen, former director of military R&D exchange at the U.S. embassy in Tokyo, argues that these efforts failed to result in significant transfers of

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36 Department of Defense, Office of the Undersecretary of Defense for Research and Engineering, Defense Science Board Task Force Report, Industry-to-Industry International Armaments Cooperation Phase II-- Japan (1984).

37 Department of Defense, Office of the Undersecretary of Defense (Acquisition) Research and Advanced Technology, Electro-Optics and Millimeter Wave Technology in Japan: Final Report of the DoD Technology Team (May 1987).

38 The U.S. government has published a number of reports stressing the benefits of gaining access to Japanese dual-use technology. These include Department of Defense, Office of the Under Secretary of Defense for Acquisition, Defense Science Board Report, Defense Industrial Cooperation with Pacific Rim Nations (October 1989); and U.S. Congress, Office of Technology Assessment, Arming Our Allies: Cooperation and Competition in Defense Technology (Washington D.C.: GPO, 1990).

Japanese technology primarily because U.S. defense contractors were largely uninterested in Japanese technology.[39]

In 1988, Japan proposed that the United States and Japan work together on research and development in five areas of military technology. In 1990, the two sides agreed to work together on three of these five areas: ducted pocket technology, for rocket engines; hybrid seeker technology, for missiles; and closed loop degaussing technology, which makes submarines less susceptible to detection. During the same year, the United States proposed seven more areas of cooperation. The DoD and the JDA formed working groups on two of these: fighting vehicle propulsion using ceramic materials and advanced steel for ships and armored vehicles. As noted above, the SDIO is handling cooperation in another two of these areas: Josephson-Junction microprocessors and the fabrication of artificial diamonds. The DoD and JDA have not yet decided whether to work on the final three areas: ferro-electric technology, military dynamic random access memories, and opto-electronics and optical components.[40]

Needless to say, the Japan Defense Agency (JDA) and Japanese defense contractors are also exploring the possible military applications of their commercial technology. The JDA's Technical Research and Development Institute (TRDI) has set up a small bureau to gather information on such dual-use technology, and to coordinate the process of directing this technology into military applications. In July 1987, the TRDI reorganized in order better to concentrate on areas of Japan's greatest potential strength such as optics, electronics, and command, control, communications and intelligence (C3I). The TRDI and the defense contractors are particularly eager to incorporate some of the hottest new dual-use technology into weapon systems, particularly the FSX. In order to maximize the benefits from their dual-use technology, the Japanese must be able not only to adapt this technology to new uses, but to mix and match a whole range of such dual-use components to produce an integrated weapon system. Those who are most skeptical about Japan's ability to catch up with the Soviet Union or the United States in military technology stress the difficulty in bridging the gap between producing isolated parts and producing complete systems. The Japanese may have the necessary technology, the argument goes, but they can not integrate a system.

Japanese Weapon Systems

To those who claim that the Japanese cannot integrate weapon systems, one could simply respond by pointing out that they already do. The Japanese produce military aircraft, warships, tanks, and missiles, some under license but others on their own. But this response begs two more difficult questions. First, to what extent do the Japanese rely on U.S. technology and U.S. parts?

39 Allen interview (11 July 1988).
40 DoD sources.

And second, just how good a system can they produce? To better understand Japan's technological capabilities and limitations, we need to disaggregate the know-how required to build a weapon system. As noted in the previous two sections, Japan excels in all areas of basic technology needed to produce a complex weapon system such as a fighter aircraft. Japan may in fact surpass the United States in selected areas such as electronic devices and coating materials. Moving one level up on the ladder of integration, Japan has some decided weaknesses when it comes to large subsytems, particularly jet engines. In fact, even under the plan for domestically developing the FSX, JDA officials were resigned to the fact that they would have to import the engines. Japanese manufacturers are more accomplished at producing other subsystems such as the computer and communications systems for an aircraft cockpit. Japan's greatest weakness comes in the realm of overall technological know-how in areas such as aerodynamics, and of course, in system integration. (See Table 2). Japanese contractors lag in these areas primarily because of their inexperience in developing their own weapon systems. They have advanced considerably through the repeated exercise of producing under license, but they will only be able to master the subtleties of system integration through the experience of developing their own new systems or at least co-developing them with foreign producers. It is not surprising, therefore, that these contractors were so determined to develop the FSX indigenously.

TABLE 2

THE TECHNOLOGY NECESSARY TO MAKE AN AIRPLANE

AREA	EXAMPLES
Materials and components	
Advanced materials	aluminum composites, ceramics
Electronic parts	integrated circuits, gyros
General parts	seats, ventilation system
Structure	welding, hardening
Subsystems	
Flight control	automatic pilot, sensors
Operation	radar, cockpit controls
Propulsion *	engine, exhaust system
Know-how	
Aerodynamics *	wing design, computer analysis
Production technology	laser processing, FMS
Testing & evaluation *	weather tunnel, simulation
System integration *	overall design, simulation

* Areas where Japan lags considerably behind the United States

Source: Compiled by the author, based in part on information from the Japan Aerospace Industry Association.

The U.S.-Japan technology gap in weapon systems should not be underestimated. In most weapon systems, the United States is a full generation (five or more years) ahead of Japan. Furthermore, the Japanese defense industry has learned practically everything it knows from its senior partner in the United States. At the same time, however, we should not underestimate Japan's ability to close the gap, given the political will. Japanese defense contractors have managed to license essential know-how from the United States and to expand their own capabilities to the point where they are now positioned to develop their own weapon systems within a reasonably short period of time. The Japan Defense Agency continues to import those systems which can not be produced at home, while doing its best with its limited budget to close the technological gap with the United States. The JDA has been remarkably successful at staying not-too-far behind with only a very modest investment in military R&D. "Up until now," remarks Sanshiro Hosaka of the TRDI, "we have always been running behind the United States. That's why we have been able to research and develop so efficiently, learning from the Americans' mistakes. And now, all of the sudden, we have some of the best technology in the world."[41] In recent years, the JDA has significantly boosted the portion of the defense budget directed at R&D, reaching 93 billion yen, or 2.2 percent of the defense budget, in fiscal 1990. (See Table 3).

41 "Wagakuni no boei sobi-- sono gijutsu to gyokai no doko" [Our Country's Defense Equipment-- Technology and Trends in the Industry], part two of a seven part series, Kokubo (November 1986), p. 109.

TABLE 3

COMPOSITION OF THE DEFENSE BUDGET, FISCAL 1986-90

	1986	1987	1988	1989	1990
Personnel and Provisions	45.1%	43.9%	42.7%	41.2%	40.1%
Supplies	54.9	65.1	57.3	58.8	59.9
Equipment acquisition	26.9	27.5	28.1	28.0	27.4
Research & development	1.7	1.9	2.0	2.1	2.2
Facility improvements	1.7	1.9	2.0	2.1	3.2
Maintenance	14.4	14.2	14.1	15.1	16.1
Base countermeasures	9.0	9.4	9.2	9.5	9.8
Other	1.2	1.1	1.1	1.2	1.2

Source: Japan Defense Agency, Boei hakusho 1990 [Defense White Paper 1990], p. 304.

The JDA has consistently sought to decrease its reliance on foreign technology. It is impossible to judge precisely how much of Japan's defense equipment is produced domestically because JDA figures grossly overestimate this percentage by only accounting for completed systems. The JDA counts a system produced in Japan under U.S. license, for example, as 100-percent domestically produced. JDA figures for 1988 show that 91.3 percent of total defense procurement is domestically purchased.[42] Nevertheless, Japan still produces many of its more sophisticated systems under license and it relies on the United States for many of the most important parts. The Japanese contractors themselves estimate that U.S. manufacturers produce 15 to 40 percent of the total value of Japanese defense production. JDA officials give several

42 Japan Defense Agency, Boei hakusho 1990 [Defense White Paper 1990] (Tokyo: JDA, 1990), p. 332.

reasons for not wanting to rely on foreign producers. First, they say that they want to have the ability to maintain and repair their systems at home. These officials still remember when they had to overhaul 14 reconnaissance versions of the F-4E which were delivered to Japan in 1977-78. "A Japanese contractor would send out a team of technicians immediately if there were any problem with an aircraft," declares Ken Adachi, former lieutenant general in the Ground Self-Defense Forces (SDF), "and they probably would not even charge for repairs."[43] Second, they argue that they are able to get better systems at a lower price from the United States when they have the option of domestic production. In essence, however, they simply do not like the idea of having to depend on the United States for military hardware. "It gives me chills to think how much we rely on U.S. parts," laments Yasuo Komoda, a former major general in the Ground SDF.[44]

Although the prospects vary between subsectors, there is some evidence which suggests that Japanese defense contractors could become competitive producers of major weapon systems within 10-25 years. For one thing, the TRDI has successfully tapped Japan's commercial technology base in developing several world-class military subsystems, the two most famous of which are ready for use in the FSX project. General Dynamics has shown a keen interest in gaining access to the Japanese technology for producing the aircraft's wings out of carbon composite materials. U.S. producers are able to produce carbon composite wings, but they have to cure the wing's two surfaces and the ribs and spars separately. The TRDI and a consortium of Japanese producers have developed a production process whereby the bottom surface of the wing is "co-cured" with the ribs and spars. This alleviates the need for the huge number of heavy rivets which join the bottom surface to the ribs and spars in other aircraft. The result is a wing that is stronger and 40 percent lighter than a more conventional alternative.[45] The other widely heralded subsytem being developed for the FSX is Mitsubishi Electric's (Melco) active phased-array radar. Melco and the TRDI are substantially ahead of U.S. producers of similar radars in that they have been able to make the radar small enough to put on a fighter aircraft and they have developed an extremely efficient cooling system. They have already produced two prototypes and have tested them on a C-1 aircraft at the TRDI's Gifu test center. The radar, which has more than a thousand "active" radiating elements, boasts ultra-high resolution and unprecedented terrain-mapping capabilities.[46] The Asahi Shimbun's economic news desk, in its book on the power of military technology, or "militech power", points out that the TRDI was only able to make the radar small enough to put on a military aircraft because of civilian

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43 Interview with Ken Adachi, chief engineer, Radio Group, NEC Corporation, and former lieutenant general, Ground Self-Defense Forces (Tokyo, 14 July 1988).
44 Interview with Yasuo Komoda, manager, R & D Coordination Office, Fujitsu System Integration Laboratories Ltd., and former major general, Ground Self-Defense Forces (Tokyo, 14 July 1988).
45 Interview with senior JDA official (July 1988).
46 Ibid.

industries' development of high-performance Gallium Arsenide semiconductors and high-density integrated circuits.[47]

Although most JDA officials and the primary contractors would have preferred to develop the FSX indigenously, they still hope to use the co-development experience to try out their best dual-use technology and to improve their skills in system integration. The TRDI has been relatively successful in developing those technologies which the U.S. will not transfer. The TRDI, for example, has developed its own control configured vehicle (CCV) technology. CCV aircraft are inherently unstable as they have smaller "canard" wings, but they are much more agile than conventional aircraft. They can "slide" horizontally where a traditional aircraft would have to make a banking turn. The FSX will use a new digital fly-by-wire system to continuously monitor flight parameters and instantly readjust in order to maintain balance. The TRDI has already tested CCV technology on a remodeled T-2 trainer. TRDI officials have been forced to develop their own source codes (software) for the FSX's flight control system because the United States decided to "black-box" this technology in response to the congressional uproar of 1989. The TRDI and MHI may not be able to develop the FSX into an airplane which can challenge the U.S. aircraft that are now being developed, but they will gain invaluable experience in the process. "We would like to catch up with the generation after the FSX," declares Sakichiro Ono of the Japan Defense Industry Association.[48]

The TRDI has been remarkably successful in indigenously developing some of the smaller weapon systems, particularly air-to-surface and surface-to-surface missiles (ASMs and SSMs). Mitsubishi Heavy Industries started developing the ASM-1 (Type 80) missile in 1973, and began production in 1980. The F-1 and other fighter aircraft now carry the 50-kilometer range, Mach 1 speed missile for attacks on surface ships. The missile uses inertial guidance in mid-course and active radar homing in its terminal phase.[49] MHI has been lauded for completing development within budget and on schedule, and for producing a missile that has achieved exceptional hit-rates in field tests. In 1979, MHI began development of a surface-to-surface missile, the SSM-1, based on the ASM-1. MHI designed the missile for the Ground SDF with a range of 150 kilometers so that it can be launched from points approximately 100 kilometers inland and still strike enemy ships well offshore. The missile is launched by rocket off a special MHI truck. The turbojet-powered cruise missile then uses inertial guidance in its overland phase and part of its oversea phase, but switches to active radar homing as it skims over

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47 Asahi Shimbun Economic News Desk, Miriteku pawaa: kyukyoku no nichibei masatsu [Militech Power: the Ultimate U.S.-Japan Friction] (Tokyo: Asahi, 1989), p. 70.
48 Interview with Sakichiro Ono, chief executive director, Japan Defense Industry Association, and former major general, Self-Defense Forces (Tokyo, 6 July 1987).
49 John O'Connell, "Strategic Implications of the Japanese SSM-1 Cruise Missile," Journal of Northeast Asian Studies (Summer 1987), p. 54.

the water toward its target.[50] The Ground SDF tested the missile at Point Mugu, California in 1987, and MHI executives claim that American observers were astounded by its superb hit-rate.[51] The Asahi Shimbun reported that nine out of ten firings either hit the target or landed close enough to be considered as "hits".[52]

With the success of the SSM-1, the TRDI and MHI are now working on three more ASM-1 derivatives: an XSSM-1B ship-to-ship missile, an XASM-1C air-to-surface missile for use on P3C aircraft, and an XASM-2 air-to-surface missile for use on F-1 and FSX aircraft. On the XASM-2, the TRDI is using a highly advanced infrared image homing system. The TRDI is also working on an XAAM-3 air-to-air dogfight missile for the Air SDF as a successor to the U.S. AIM-9 (Sidewinder) series. In 1989, the institute began developing an improved version of the short-range surface-to-air missile, the "Tan-SAM". The new Tan-SAM will have independent active radar homing and infrared image homing capabilities.[53] The TRDI is also considering indigenous development of a mid-range surface-to-air missile (SAM) as a successor to the American "Hawk", although it has not made any official announcement of its plans.[54] "We have caught up with the Americans in missile technology," claims one TRDI bureaucrat, "but we have only been able to do so because of the high-performance semiconductors, high-density integrated circuits, quality control, and microprocessors that have come from Japan's industrial technology base."[55] (See Table 4).

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50 "Japan Uses SSM-1 Expertise to Develop Cruise Missile," Aviation Week and Space Technology (21 March 1988), p. 59.
51 Interview with Hiroshi Tajima, deputy general manager, Guided Weapons Department, and Takeki Wani, deputy general manager, Planning Department, Aircraft and Special Vehicle Headquarters, Mitsubishi Heavy Industries, Ltd. (Tokyo, 8 July 1988).
52 Asahi Shimbun Economic News Desk (1989), op.cit., pp. 13- 14. For a more in-depth look at Japanese missile development, see parts one (October 1986) and two (November 1986) of seven part series in Kokubo, op. cit.
53 Interview with senior JDA official (July 1988).
54 Nihon Keizai Shimbun (4 January 1991).
55 Kokubo (October 1986), p. 31.

TABLE 4

SOME WEAPON SYSTEMS CURRENTLY BEING DEVELOPED BY THE TRDI

YEAR R&D STARTED	SYSTEM
Aircraft	
1983	(Shipboard) anti-submarine helicopter
1988	Fighter support aircraft (FSX)
1991	Unmanned aerial observation vehicle
Guided Weapons	
1988	Air-to-surface missile (XASM-2)
1989	Improved surface-to-air missile "Tan-SAM"
1990	Anti-ship/anti-tank missile (XATM-4)
Electronics and Communications	
1988	Improved division communications system
1990	Shipboard fire control system
1991	Expendable electronic jammer

Source: Japan Defense Agency

Japan's success in integrating sophisticated space systems also supports the assertion that the Japanese might meet with success in the integration of military systems, if they were willing to make the requisite investment. The National Space Development Agency (NASDA) has gradually decreased its technological reliance on the United States. NASDA's early launch vehicles, the N-1 and the N-2, were approximately 60 percent domestically produced. They

were first used in 1975 and 1988, respectively. The H-1, which was first used in 1986, was more than 80 percent domestically produced. The H-1 marked an important transition in Japan's space development, as Japan developed its own cryogenic propulsion technology for the second stage because the United States did not want to relinquish its own technology. NASDA has refused all assistance in developing the H-2, which will be able to launch 4400 pounds, more than a U.S. Air Force Titan 34 D. The H-2 was expected to be ready for launch by late 1992.[56] NASDA has been equally successful with satellites. For example, the BS-1, launched in 1978, was 90 percent U.S.-produced. The BS-2A and BS-2B, launched in 1984 and 1986, respectively, were 70-percent U.S.-made. And the BS-3A, launched in 1990, was almost entirely domestically produced.[57] The Space Activities Commission's (SAC) Long-Term Policy Council produced a report on May 26, 1987 declaring that Japan is aiming for no less than a "central role" in the global space market by the beginning of the 21st Century. The report states that Japan will complete the Engineering Test Satellite-6 (ETS-6) and the H-2 booster without foreign assistance, and will launch a Japan Experiment Module (JEM) by the mid-1990s.[58] From the late 1990s into the beginning of the new century, Japan will develop an operating space station and will move on to manned space activity, moon and planet exploration.[59]

One weapon system which the Japanese have chosen not to produce is the nuclear weapon. The choice is primarily, of course, a political one and not one dictated by a lack of technological capability. Japan has a small amount of low-quality uranium in Okayama, but this would not be enough for a significant nuclear arsenal. The Chinese have pointed to the fact that this uranium has never been used for energy purposes as evidence that Japan intends to go nuclear, but the Japanese contend that it simply would not be economical to try to dig it up. In order to divert its uranium from energy use, Japan would have to choose between trying to fool the International Atomic Energy Agency (IAEA) inspectors-- a formidable task-- or abrogating the Non-Proliferation Treaty (NPT).[60] Japan has a "pilot scale" enrichment plant at Ningyo Pass which produces uranium enriched to three percent (of the U-235 isotope), but which could be relatively easily converted to produce weapons grade, 93-percent enriched uranium. Yatsuhiro Nakagawa, a professor of international politics at Tsukuba University and Japan's self-proclaimed "lone advocate" of nuclear armament for Japan, estimates that Japan could be

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56 Interview with Shigeru Aoe, director, Space Planning Bureau, Research and Development Division, Science and Technology Agency (Tokyo, 13 July 1988).
57 Interview with James G. Beitchman, vice president, Communications Satellite Corporation, Comsat Far East Operations (Tokyo, 23 July 1987).
58 Japan has decided to join the international space station project proposed by U.S. President Ronald Reagan at the Toronto Summit in 1988. Japan will produce one capsule for the space station at a cost of 300 billion yen. (Aoe interview, 13 July 1988).
59 Science and Technology in Japan (August 1987), pp. 18-19.
60 Japan signed the NPT in 1976.

producing weapons-grade uranium within two years if it chose to do so.[61] Alternatively, Japan could use plutonium for nuclear weapons. Japan has large stockpiles of plutonium from spent fuel that was reprocessed in Europe. Under an April 1988 agreement with the United States, for the next 30 years Japan no longer needs to request U.S. permission on a case-by-case basis to send its used nuclear fuel to Europe for reprocessing. Japan also has a "pilot scale" reprocessing (plutonium extraction) plant of its own, and is planning to build a larger one within the next decade. Japan could adapt its nuclear reactors in order to produce weapons-grade plutonium, but this would be considerably more difficult and more costly than converting uranium enrichment plants so they can produce weapons-grade uranium.[62] Japan has a variety of delivery systems-- tactical aircraft, missiles, and long-range artillery-- which could be equipped to deliver nuclear warheads.

In the long term, a re-emergence of the Japanese defense industry could have some rather ominous implications. One 1982 report estimated that Japan would eventually capture 60 percent of the market for naval ships, 40 percent of military electronics, 46 percent of military automobiles and up to 30 percent of the aerospace market.[63] These estimates may be unrealistic, but nonetheless there are indications that Japanese companies could be successful in exporting military equipment. Japan's "reliability" advantage already extends into the military sector. Fujitsu's Yasuo Komoda complains that the quality of the U.S.-made chips he buys for military requirements is abysmal: "Sometimes only 10 percent work."[64] The Westinghouse APQ 120 radar for the F-4 fighter reportedly lasts an average of eight hours before failure, while the Mitsubishi Electric equivalent for the F-4EJ lasts an average of 40 hours.[65] And the readiness rate for the Japanese-made F-15J is higher than that for the U.S.-made F-15.[66] Although the Japanese weapon systems may have been used under less demanding conditions than the American systems, they have still fared astonishingly well. In the future, Japanese producers may be able to use flexible production systems to bring the low-cost advantages of mass production to the specialized production of advanced military systems. They also may be able to achieve shorter product cycles which will enable them to incorporate more advanced commercial components into their weapon systems.[67]

Japan's technological strengths could play right into the needs of the warfare of the future. In the 21st Century, much of the United States' and the Soviet Union's present hardware

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61 Interview with Yatsuhiro Nakagawa, professor of international politics, Tsukuba University (Tokyo, 29 July 1987).
62 See Leonard S. Spector, Going Nuclear (Cambridge, MA: Ballinger, 1987) on nuclear technology.
63 Malcolm McIntosh, Japan Rearmed (London: Frances Pinter, 1986), p. 58.
64 Komoda interview (14 July 1988).
65 Interview with senior American executive (July 1987).
66 Interview with W. Stephen Piper, president, InTecTran, Inc. (Washington D.C., 31 May 1988).
67 This argument is made at greater length in the first chapter of this volume (Borrus and Zysman).

may be obsolete. Meanwhile, laser weapons and robot soldiers could become a reality.[68] The U.S. and Soviet military establishments would probably not be caught entirely by surprise with such developments, but they would certainly not enjoy the technological lead over Japan which they now have. To the extent that new technology makes present technology obsolete, it will be that much easier for Japan to catch up. Robert J. Art illustrates this point in his discussion of the British development of the dreadnought in 1906. The dreadnought, with its greater power and range, made all other battleships obsolete. By developing the dreadnought, however, the British inadvertently wiped out their own significant lead in pre-dreadnought battleships.[69]

The Political Context

Ultimately, the future of the Japanese defense industry depends on the course of Japanese defense policy. Many commentators, particularly Japanese ones, have argued that Japanese military expansion is strictly constrained by domestic political forces. While this was certainly true in the 1950s and the 1960s, it was less so in the 1980s-- and is even less so in the 1990s. Over the course of the 1970s, the Yoshida "consensus" on national strategy gave way to one which points in a very different direction. The Yoshida consensus refers to a policy originally adopted under the administration of Prime Minister Shigeru Yoshida (1948-54), under which Japan would control internal security while depending primarily on the United States for protection from external threats. According to Article Nine of the postwar constitution, "war potential will never be maintained." The consensus was gradually embodied in a series of explicit constraints on defense expansion, including the three non-nuclear principles, the ban on arms exports, and the ceiling on defense spending of one percent of GNP. A number of developments throughout the 1970s served to erode this consensus. The simultaneous rise of Japan as an economic power and the relative decline of the United States provided the most basic impetus behind the transition. The Japanese became increasingly aware of this shift in world power as the United States suspended the convertability of the dollar into gold in 1971 and withdrew from Vietnam in 1975, and as Japan recovered remarkably well from the oil shocks of 1973 and 1978. Japanese leaders began at the same time to question American protection and to reconsider their country's role in the world. In the late 1970s, a major Soviet build-up in the Far East moved many of these leaders to re-examine their benign view of the Soviet threat. During the same period, officials in the Carter administration (1977-81) and U.S. congressmen began to

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68 Japanese analysts have not refrained from speculating about the military potential of Japan's high technology. In Haitcku boci no susume [A Case for the High-Tech Defense of Japan] (Tokyo: Simul, 1985), Kaoru Murakami suggests that rather than trying to imitate the superpowers, Japan should exploit its technological strengths and defend itself with high-tech weaponry. In Gunji robotto senso [Military Robot War] (Tokyo: Diamond, 1982), Masahiro Miyazaki envisions a world in which Japan's advanced robots, rather than its citizens, fight the country's wars.

69 Robert J. Art and Kenneth N. Waltz, eds., The Use of Force (Lanham, MD: University Press, 1983), p. 186.

call for greater Japanese efforts on defense. This "foreign pressure" had a tremendous impact on Japanese attitudes, for Japanese leaders are acutely aware of their dependence on the United States in the economic as well as in the security realm.[70]

The new mainstream policy did not kill off those within the Liberal Democratic Party (LDP) and within the ministries who favor strict limits on defense, but it did strike a forceful blow against them. By the late 1970s, the majority of Diet members had come to accept the "realist" position which favors gradual defense expansion, essential cooperation with U.S. requests for sharing a greater portion of the defense burden, and an effort to make Japan's defense more closely designed to meet specific military threats. In 1980, a Nihon Keizai Shimbun poll showed that 78.6 percent of the LDP Lower House Diet members advocated expansion of the Self Defense Forces while only a handful were opposed. 41.4 percent said that the Soviet Union posed a "major threat" while 50.5 said it presented a "potential threat". 46.4 percent opposed the arms export ban and 36.7 favored revision of the Peace Constitution.[71] A group of Dietmen known as the Defense Tribe (boei-zoku) successfully lobbied to make defense a top priority item within the budget in the 1980s, and the one percent of GNP ceiling was surpassed in 1987. (See Table 5) With the new direction in policy, a new group of "military realists" tried to come up with a strategy to match Japan's new role. Previously, Japanese defense policy was designed simply to meet a vaguely defined "limited small-scale" attack. Beginnng in 1980, Defense White Papers have referred to the Soviet Union by name as the principal military threat and have justified force levels by the need to defend Japan against a possible Soviet attack. In a May 1981 meeting with U.S. President Ronald Reagan, Prime Minister Zenko Suzuki extended Japanese commitments by agreeing that Japan would defend its own sea lanes out for a distance of 1000 nautical miles. Japanese acceptance of this mission implies a need for much greater reconnaissance and anti-submarine warfare (ASW) capabilities. U.S. and Japanese officials have exchanged information on defense planning more freely since the establishment of the "Guidelines for U.S.-Japan Defense Cooperation" in 1978, and U.S. and Japanese forces have performed combined military exercises involving all branches of the services since 1986.[72]

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70 The Japanese defense debate is discussed at greater length in Steven K. Vogel, A New Direction in Japanese Defense Policy: Views From the Liberal Democratic Party Diet Members, Occasional Papers/ Reprints Series in Contemporary Asian Studies, University of Maryland School of Law (1984); and Mike M. Mochizuki, "Japan's Search for Strategy," International Security (Winter 1983-84).

71 Nihon Keizai Shimbun (27 and 29 April 1980).

72 On U.S.-Japan defense cooperation, see Gregg Rubinstein, "U.S.-Japan Security Relations," The Fletcher Forum (Winter 1988); and Norman D. Levin, Japan's Changing Defense Posture, RAND Note (June 1988).

TABLE 5

THE DEFENSE BUDGET 1955-91 (billion yen)

Year	Defense budget	% increase over previous year	As % of GNP	As % of total budget
1955	134.9	3.3	1.78	13.61
.....				
1965	301.4	9.6	1.07	8.24
.....				
1975	1327.3	21.4	0.84	6.23
1976	1512.4	13.9	0.90	6.22
1977	1690.6	11.8	0.88	5.93
1978	1901.0	12.4	0.90	5.54
1979	2094.5	10.2	0.90	5.43
1980	2230.2	6.5	0.90	5.24
1981	2400.0	7.6	0.91	5.13
1982	2586.1	7.8	0.93	5.21
1983	2754.2	6.5	0.98	5.47
1984	2934.6	6.6	0.99	5.80
1985	3137.1	6.9	0.997	5.98
1986	3343.5	6.6	0.993	6.18
1987	3517.4	5.2	1.004	6.50
1988	3700.3	5.2	1.013	6.53
1989	3919.8	5.9	1.006	6.49
1990	4159.7	6.1	0.997	6.28
1991 *	4387.0	5.5		

Source: Japan Defense Agency, Boei hakusho 1990 (Tokyo: JDA, 1990).

* 1991 figures are estimated (Nihon Keizai Shimbun, 29 December 1990).

In the future, the Japanese defense industry may become an important political force in favor of military expansion. Defense production accounts for a meager 0.5 percent of total production for Japanese industry, and even for the largest contractors defense production only accounts for a small portion of sales.[73] Yet at the same time, Japan's top defense contractors are also some of its largest and most powerful corporations. (See Table 6). These corporations expend more resources and more political capital on their defense business than might be justified by defense sales alone. "Defense may only account for three percent of our business," says Kunio Saito, general manager of NEC's 1st Defense Sales Division, "but it certainly takes up more than three percent of our energy."[74] Defense requires more political effort because it is a political business. Defense contractors have only one client, the Japan Defense Agency, so the incentives to lobby are great. Companies see defense as a secure business, insulated from the pitfalls of the business cycle, and they expect the defense sector to continue to grow steadily. "By the year 2000, we are confident that our sales will grow to a level warranting the kind of investment we are making today," declares Yotaro Iida, president of Mitsubishi Heavy Industries.[75] Even more importantly, Japanese firms see involvement in the defense business as an imperative so as not to fall behind in the high-tech race. They envision commercial spinoffs from defense production, and they fear that they may miss out if they are not at least peripherally involved in the defense business. They see the defense industry as one which may drive innovations in other areas, such as electronic components.[76] "We are being challenged by the NICs in traditional consumer markets," explain's Fujitsu's Komoda. "We have to go value-added, and all that is left is space and defense."[77]

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73 The Boei hakusho 1990 [Defense White Paper 1990] states that defense production accounted for 0.54 percent of total production in 1988, up from 0.36 percent in 1980.

74 Interview with Kunio Saito, general manager, 1st Defense Sales Division, NEC Corporation (Tokyo, 3 August 1987).

75 Nikkei Business (11 May 1987), p. 13.

76 Samuels and Whipple (1989), op. cit., use the metaphor of a tree to explain why some Japanese planners feel that the aerospace industry is so important to technological development. The aerospace industry is a stem which is connected to both the "roots" (underlying technologies) and the "fruits" (related industries) of the tree. The point is not so much that one part of the tree is more important than another, but that the parts depend on each other for their own healthy development.

77 Komoda interview (14 July 1988).

TABLE 6

JAPAN'S TOP TEN DEFENSE CONTRACTORS, FISCAL 1989 (billion yen)

Company	Sales	defense % of total sales
1. Mitsubishi Heavy Industries	363.6	17.4
2. Kawasaki Heavy Industries	174.9	21.5
3. Mitsubishi Electric	111.7	4.7
4. NEC Corporation	71.0	2.6
5. Toshiba	68.3	2.2
6. Ishikawajima-Harima Heavy Industries	62.8	9.9
7. Nihon Seikosho	31.2	26.3
8. Hitachi	26.2	8.5
9. Komatsu	23.6	3.8
10.Fuji Heavy Industries	21.6	0.8

Source: Federation of Economic Organizations (Keidanren)

Defense contractors use three primary channels to lobby the government. First, they hire retired Self-Defense Forces officers to serve as intermediaries with the JDA and the forces. Top bureaucrats have long had a tradition of "descending from heaven" (amakudari) into prominent roles in private industry after retirement at age 55 or 60, and military officers have followed this same practice. A defense contractor, it is said, should have at least one military "old boy" for every 20 billion yen in annual defense sales. Second, they work through the industry associations, the most important of which is the Japan Defense Industry Association (nihon boei sobi kogyokai). Established in 1951 as the Japan Ordnance Association (nihon heiki kogyokai), the association was renamed and reorganized in September 1988. It is now an incorporated association officially affiliated with both the JDA and MITI.[78] Finally, the contractors join

78 Asahi Shimbun (17 September 1988).

forces in the Defense Production Committee of the Federation of Economic Organizations (Keidanren), Japan's most powerful business organization and a primary source of funding for the ruling LDP. In 1989, Keidanren came out with a public position paper on the Mid-Term Defense Plan for 1991-95, demanding that R & D spending be doubled and that the domestic content of JDA procurement be raised further.

In the wake of the U.S. response to the FSX agreement in 1989, a number of prominent LDP Dietmen and JDA officials have called for a renewed push to decrease reliance on U.S. military technology. Popular LDP Dietman Shintaro Ishihara, for one, argues that Japan should build the FSX on its own. The fact that Japan gave in to the U.S. demand to co-develop the plane, he stresses, confirms that Japanese leaders are still excessively deferential to U.S. power.[79] Even JDA officials suggest that they may not want to do any more co-development with the United States. They estimate that they have lost at least one year because of the U.S. delay in approving the agreement. "Frankly," proclaims one senior JDA official, "we are no longer open-minded about co-development. The United States caused the delay, but we have paid the price."[80]

The opposition parties, particularly the Japan Socialist Party (JSP) and the Japanese Communist Party (JCP), have taken the lead in criticizing LDP policies on defense. To date, their protests have not had much effect on the ruling LDP, which has enjoyed a stable majority in both houses of the Diet. The opposition parties gained a bit more of a voice with their victory over the LDP in the July 1989 Upper House (House of Councillors) elections, but the LDP managed to stay in power by retaining its majority in the more powerful Lower House (House of Representatives) after the February 1990 elections.[81] According to the Constitution, the Lower House can pass the budget without the approval of the Upper House, but it needs a two-thirds majority to override the Upper House on ordinary bills.[82] In recent years, the JSP and the Komeito have become much more moderate in their opposition to the LDP's defense policy, and some members of the Democratic Socialist Party have become downright hawkish. The JCP has stuck to its principles, but it has found itself increasingly isolated.

The present "realist" consensus is not likely to give way to a more assertive defense posture for Japan unless international developments once again transform the national consensus on strategy as they did in the 1970s. In general, Japanese defense policy is more responsive to the state of the U.S.-Japan relationship than to the actual military threat to Japan. Japanese leader's desire to increase their country's military role will grow to the extent that they perceive a

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79 Chuo Koron (July 1989), pp. 184-98.
80 Interview with senior JDA official (July 1988).
81 In the Lower House, the LDP won 286 seats, compared to 141 for the JSP, 46 for Komeito, 16 for the JCP, 14 for the DSP, 5 for others, and 4 for independents.
82 See J.A.A. Stockwin, Japan: Divided Politics in a Growth Economy, Second Edition (London: Norton, 1982), pp. 89-91.

decline in the U.S. capability or intention to protect Japan. In short, if the United States cannot or will not protect Japan, Japan will defend itself. Some U.S. policy-makers may welcome such a development, but if Japan does choose to take over full responsibility for defense, the United States will lose control over Japanese force levels and military doctrine, and the United States will sacrifice much of its leverage over Japanese foreign policy. Japanese leaders will be particularly sensitive to 1) U.S. economic weakness, 2) U.S. military weakness, 3) U.S. pressure on Japan to do more for itself, and 4) a partial or complete withdrawal of U.S. forces from Japan.

JDA officials are particularly sensitive to the United States' unwillingness to share its latest military technology. They claim that the U.S. Defense Department has been much less forthcoming with defense information and technology since 1980.[83] The defense industry has been particularly attuned to the efforts of U.S. companies to "black box" military technology sold to Japan so that Japanese firms will not be able to copy it. Although U.S. leaders see this as nothing more than good business and the protection of America's own security interests, the Japanese perceive this as a sign of U.S. distrust and an important reason why Japan should build up its own military production capability.

The Japanese media used the thirtieth anniversary of the U.S.-Japan Security Treaty in 1990 as an opportunity to re- evaluate Japan's dependence on the United States in a variety of special feature articles. With the end of bipolarity, some analysts suggest the Japanese should seriously question the American commitment to defend Japan. An Asahi Shimbun poll reported that only 31 percent of Japanese said that "Japan should continue to depend on the United States," while 40 percent argued that "Japan should build up an independent defense system."[84]

The Japanese desire for greater autonomy has only grown as U.S.-Japan trade friction gets worse. Japanese government officials are already bitter about what they see as unjustified "Japan-bashing" by the United States. They feel that a lack of diligence and poor management has reduced the competitiveness of U.S. products, and that U.S. critics of Japan are simply using Japan as a scapegoat for their own woes. A 1987 feature article on U.S.-Japan trade friction in the Tokyo Shimbun carried a disturbing headline: "This Would Have Meant War in the Old Days."

While Japanese military strategists finally found a clearly identifiable enemy in the Soviet Union in the 1980s, they may have lost it again in the 1990s. JDA officials argued in the 1990 Defense White Paper that Soviet President Mikhail Gorbachev's reforms had not altered the basic military threat posed by the Soviet Union. Former JDA Director-General Koichi Kato even suggests that a decrease in the Soviet nuclear threat implies an increase in the conventional

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83 Interview with Kunio Kinjo, senior staff, Public Relations Committee, Liberal Democratic Party (Tokyo, 23 June 1987); and interview with Masakatsu Shinkai, director, Communications Division, Equipment Bureau, Japan Defense Agency (Tokyo, 24 June 1987).

84 Asahi Shimbun (29 May 1990).

threat, which is what Japan is most concerned with in the first place.[85] Most LDP leaders, however, feel that they are compelled to respond to the end of the Cold War by slowing down the expansion of the defense budget. In December 1990, the Cabinet compromised on a total outlay of 22.7 trillion yen for the five-year period of the mid- term defense plan for 1991-96. This figure implies annual spending growth of only about 2.9 percent.[86]

In the future, Japanese leaders may be more sensitive to military threats from countries other than the Soviet Union. They continue to closely monitor events in China, and they are particularly concerned with the political instability which plagues South Korea and the Philippines. Japan will react strongly to heightened tension between the Koreas or to a weakening of the U.S. commitment to South Korea. In addition, Japanese leaders may be more unsettled than relieved if Korea becomes reunified.

The 1990-91 Gulf War between Iraq and U.S.-led multinational forces provided a new stimulus to the Japanese debate over defense policy. Prime Minister Toshiki Kaifu, with considerable prodding from the United States, tried to push through a bill which would have sent Japanese non-military personnel to support the multinational forces in the Persian Gulf region. Kaifu and LDP Secretary General Ichiro Ozawa were unable to unify their own party behind the plan, and thus Japan ended up contributing money, about $9 billion of it, but not manpower to the war effort. The debate over this bill reopened discussion over one of the most powerful constraints on Japan's military role: the ban on sending military forces overseas. The war also revitalized the perennial national debate over Japan's role in the world. Some Japanese leaders were ashamed that their country was not able to act more decisively, while others simply accused the United States of making Japan pay for its own follies.

The Power Behind Technology

Japanese leaders may or may not ever decide to pursue a truly independent defense strategy. But even if they do not, Japan will have more influence over international security relations in the years to come by virtue of its economic and technological strength alone. Japanese technological leadership gives Japan more power within the international system in three respects. First, Japan will gain leverage in its relationship with the United States as the Department of Defense relies more on Japanese technology and the Japan Defense Agency relies less on U.S. technology. Martin Libicki et. al. suggest that U.S. dependence on foreign components and technology impairs the country's "surge capability"-- its ability to accelerate the production, maintenance and repair of critical items during a conflict. In addition, this

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85 Interview with Koichi Kato, member, House of Representatives (Liberal Democratic Party), and former director-general of the Japan Defense Agency (Tokyo, 12 July 1988).
86 Japan Times (20 December 1990).

dependence creates "technology base vulnerability" because the United States may lose access to the most advanced technology for the development and production of weapons.[87] The Defense Science Board Task Force on Semiconductor Dependency suggests that DoD reliance on Japanese semiconductors seriously threatens U.S. national security interests because the United States cannot count on maintaining a technological lead over the Soviet Union if it does not control the production of crucial electronic components.[88]

Those who downplay U.S. dependence argue that the United States could produce just about anything that the Japanese can, albeit at a higher cost. This begs three more important questions: At what cost? How quickly? And most importantly, just how good would the U.S. substitute be? Cost is a factor, even in military affairs. The United States will not suffer seriously even if it has to pay $1 million for a crucial semiconductor. It will lose out, however, if it has to pay more for a whole variety of components ranging from semiconductors to costly subsystems. In addition, there is a difference between being able to produce something eventually and being able to produce something today. In a crisis situation, the U.S. military may not be able to wait around for domestic producers to come up with an item that had been previously "Made in Japan". The U.S. military will not be able to escape its dependence if U.S. products, at any cost, are not as reliable as the Japanese ones. A domestic substitute will do more harm than good if it does not function properly. Furthermore, even if U.S. manufacturers have the ability to produce many of the components now imported from Japan, they may lose further ground if they are not actually producing them. Through a gradual process of product improvement and production innovation, the Japanese firms that manufacture these components may come up with advances that their idle American competitors will not be able to emulate. Semiconductor dependence is particularly problematic because Japan's top semiconductor manufacturers are also Japan's top computer manufacturers. NEC, for example, might find it to be in its interest to withhold the technology for its most advanced semiconductors so that it would have an advantage in competition with U.S. computer makers. Alternatively, Japanese producers might be more interested in the more lucrative commercial market, and therefore might be unwilling to produce their parts to military specification.[89]

How will this dependence translate into political leverage? Japan could use the threat of halting exports at a crucial period to gain its own political goals. Libicki suggests that this could only work once because the United States would quickly move to compensate for its dependence

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87 Martin Libicki, Jack Nunn, and Bill Taylor, U.S. Industrial Base Dependence/ Vulnerability: Phase II--Analysis, Report for the Mobilization Concepts Development Center, Institute for National Strategic Studies, National Defense University (November 1987), pp. 5-7.
88 Department of Defense (February 1987), op. cit.
89 U.S. Congress, Office of Technology Assessment, The Defense Technology Base: Introduction and Overview (Washington D.C.: U.S. Government Printing Office, 1988), p. 40.

on Japan through research and development.[90] The cycle of offering and selectively denying the United States advanced Japanese technology could, however, develop into an ongoing process. The United States would lose out if Japan began to refuse to export the best of its advanced technology, or if Japan used this as a threat to gain U.S. concessions in other areas. As the well-known Japanese commentator Hajime Karatsu puts it: "If Japan stopped exporting semiconductors, the United States would be turned upside down. This gives Japan an extraordinary amount of bargaining power."[91] In reality, of course, Japan is not likely to stop exporting semiconductors to the United States. U.S. dependence simply means that Japanese officials and businessmen have more leverage in their dealings with their American counterparts. In other words, the balance of power within the bilateral relationship is evening out.

Japanese leaders also feel that they have achieved a more balanced relationship with the United States because they are less dependent on U.S. military technology. The Japanese are confident that they can develop the military technology they need with or without U.S. support. Japanese contractors and the JDA hoped to develop the FSX indigenously in part because they wanted to prove that they could do it on their own. They began R&D work years before the 1987 procurement decision in order to prove that they could do so. Now they can use the U.S. renegotiation of the original memorandum of understanding for the FSX as a pretext for developing future weapon systems independently. Even if they do continue to work with U.S. defense contractors, the Japanese feel that they gain a more even hand in a wide array of negotiations with the United States by maintaining a credible threat of going it alone. "Thanks to our military technology base," notes one senior JDA official, "we are bargaining from a stronger position."[92]

Second, Japan now has the ability to play a pivotal role in the global race for superiority in military technology. Although the U.S.-Soviet rivalry for technological superiority is no longer so intense as it once was, U.S. military strategy still relies on a substantial technological lead over potential and real adversaries, whether they be Soviets or Iraqis. Pentagon planners are all too aware that Japan can help the United States to keep this technological edge, and that is why they have pursued Japanese military and dual-use technology transfers so vigorously. The combination of U.S. strength in basic research with Japanese prowess in applied research, and U.S. sophistication with Japanese reliability, would be unbeatable. At some point, of course, Japanese officials could threaten to withhold their cooperation if they were dissatisfied with the direction of U.S. foreign policy.

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90 Interview with Martin C. Libicki, professor, National Defense University (Tokyo, 20 June 1987).
91 Sekai (January 1988), p. 82.
92 Interview with senior JDA official (July 1988).

Conversely, even occasional technology exports from Japan to U.S. adversaries could undermine the most valiant of American efforts to retain a technological edge. In the wake of the Toshiba Machine affair, the Ministry of International Trade and Industry (MITI) has expanded its corps of technology export control inspectors from 15 to 100 and has established some of the most severe penalties for export violations among U.S. allies. In April 1988 the Japanese government agreed to protect U.S. military technology with registered, classified patents.[93] Nevertheless, most of Japan's best dual-use technology is still readily available, and Japanese companies remain unaccustomed to security controls. Robert L. Mullen, assistant deputy undersecretary of defense for trade security policy, suggests that the problem will intensify by the mid-1990s, after Japan has completed the H-2 rocket launch vehicle. By that time, Japan will have developed a whole array of important components for use in space. Japan may be able to export these as commercial-use products, but the purchasers are more likely to be interested in them for their military uses.[94]

Third, Japan's advances in commercial technology give it the ability to become a major military power in its own right by the early 21st Century. Japan already has the economic resources to become a military superpower. Japan has enough money to buy itself a world-class defense establishment if it wants to. Japan's gross national product (GNP) for fiscal 1989 (through March 31, 1990) reached 398.2 trillion yen.[95] Japanese GNP growth has outpaced that of the other major industrialized countries throughout most of the postwar period, and it can be expected to continue at a rate of 3 to 5 percent per year in the near-term future. David DeNoon has estimated that Japan could double defense spending without any substantial negative impact on GNP growth. "Within anticipated ranges," he concludes, "limitations on defense spending are political and not due to economic constraints."[96] Japan also has the human resources to develop a competitive defense industry and to manage a powerful military establishment. Japanese literacy rates are among the highest in the world, and the quality of Japanese education, particularly at the secondary level, is the best in the world. In 1988, Japan had more than five million students specializing in science and engineering in high school, more than two million in college, and 80,000 in post graduate courses.[97] Furthermore, the Japanese government has been extremely successful at directing its economic and human resources into productive uses. If Japan were to militarize, Japan's strong, centralized state would serve it well. The Japanese

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93 Allen interview (11 July 1988) and JEI Report, No. 16B (22 April 1988), p.9.
94 Interview with Robert L. Mullen, assistant deputy undersecretary of defense for trade security policy (Washington D.C., 31 May 1988).
95 Science and Technology Agency (1990), op. cit., p. 250.
96 David B.H. Denoon, ed., Constraints on Strategy: the Economics of Western Security (Washington D.C.: Pergamon-Brassey's, 1986), p. 208. Also see the chapter in this book on "Japan and South Korea" written by Walter Galenson and David W. Galenson, pp. 152-194.
97 Science and Technology Agency, Kagaku gijutsu yoran [Indicators of Science and Technology] (Tokyo: STA, 1990), pp. 150- 53.

government would be well poised to coordinate national research efforts and to stimulate private-sector investment. In addition, the government would have the ability to rapidly and efficiently divert resources from the civilian to the military sector.

Japan's technological leadership provides the final link in giving the country the potential to become a military power. As discussed above, Japan has a technology base unsurpassed even by the United States, and it leads the world in a number of critical dual-use technologies. Japanese producers have gone from a position of clear inferiority to superiority in a whole range of sectors within a remarkably short period of time. Could they do the same in the military sector? The skeptics argue that the technology necessary to produce a fighter plane differs fundamentally from that necessary to produce a Sony Walkman or a Toyota Corolla, and of course they are right. Yet Japanese producers already have some experience in integrating complex military systems, and they have had striking successes in producing some of the smaller weapon systems. Nevertheless, the defense industry would need substantial support from the government before it could make the enormous investment necessary to become truly competitive in a business like military aircraft production. Without some major changes in the political climate, the government is not likely to offer this kind of full-fledged support.

Even if Japanese leaders never choose to exercise the country's military potential, the mere fact that Japan can become a military superpower will affect international relations in the years to come. The Soviet Union and China will grow more concerned about Japan's technological superiority, and they are likely to be more cautious about making any move that could push Japan to accelerate rearmament. The smaller countries of Asia may look more to Japan than to the United States for capital, technology, and perhaps even military protection. They will do so not out of any love for the Japanese, but rather from a recognition that Japan has replaced the United States as the dominant economic power in the region. The United States will also have to consider the costs and benefits of a more powerful Japan, and may be willing to make concessions to Japan in order to ensure that Japan remains a steadfast ally. Whether it is a military superpower or not, Japan at the turn of the century will wield considerable influence in global power politics. Japan will be a "great power" in the international system, although it may be a great power of a new and different kind.