BY THE U.S. GENERAL ACCOUNTING OFFICE

Report To The Chairman, Joint Economic Committee, United States Congress

Industrial Policy: Case Studies In The Japanese Experience

Within a larger framework of monetary and fiscal policies, Japan has adopted a number of industry-specific policies to achieve its economic goals. GAO reviewed Japan's industrial policies during the post-war period in the computer, aircraft, robotics, textile, and shipbuilding industries. Although there have been basic underlying consistencies in Japanese policies, there has also been enough flexibility to effectively respond to the economic changes which have occurred during the last 30 years.

This report is a companion volume to "Industrial Policy: Japan's Flexible Approach" (GAO/ID-82-32).

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UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

INTERNATIONAL DIVISION

B-209015

The Honorable Henry Reuss
Chairman, Joint Economic Committee
Congress of the United States

Dear Mr. Chairman:

This report is a companion volume to our June 23, 1982, report "Industrial Policy: Japan's Flexible Approach" (GAO/ID-82-32) and contains case studies which explain in detail the assistance provided by the Japanese Government to five key industries. As you requested, our case studies include three high technology growth industries--computers, aircraft and robotics--and two industries faced with unfavorable world market prospects--shipbuilding and textiles.

Japan in the postwar period adopted economic policies that fostered economic growth. These policies were implemented with a mix of macro-level monetary and fiscal policies and micro-level industrial policies. Monetary and fiscal policies promoted investment by keeping interest rates low and holding government spending to a consistent share of national income. Industrial policies channeled resources to industries targeted for growth and helped to shift resources out of industries with poor market prospects.

Industry-specific policies have included tax incentives, protection and promotion of emerging industries through trade measures, loan and grant funding for research and development of basic and applied technologies, support for leasing organizations through low-interest loans, assistance to small- and medium-sized companies to modernize plant and equipment, financial assistance to scrap and/or temporarily mothball equipment, and benefits for workers in depressed industries and regions.

These measures have been employed during the course of rapidly changing economic conditions. Japan's ability to adapt its industrial policies to changing domestic and international circumstances over the last 30-odd years has been a key element in maintaining the perceived effectiveness of its industrial policy.

We also identified a number of constants in Japan's industrial policies. One near-constant characteristic of Japan's sectoral policies is the existence and continual use of a communication or "bargaining" system which encourages cooperation between different segments of the economy; another has been the government's attempts to supplement rather than supplant private sector activities.

To meet the objectives outlined by the Committee, we spoke with various government agency officials, industry representatives, trade and industry associations, labor groups, and academics in both the United States and Japan. In addition, we surveyed numerous published studies on these and related issues. Our review was performed in accordance with our Standards for Audit of Government Organizations, Programs, Activities, and Functions.

As arranged with your office, we are distributing the report to other congressional committees and to executive agencies.

Sincerely,

Frank C Conahan

Frank C. Conahan
Director

C O N T E N T S

APPENDIX

Abbreviations

CGRT	compensate gross registered tons
CPUs	central processing units
CTDC	Civil Transport Development Corporation
IHI	Ishikawajima-Harima Heavy Industries, Inc.
IPA	Information Technology Promotion Agency
JAROL	Japan Robot Leasing Corporation
JIRA	Japan Industrial Robot Association
MITI	Ministry of International Trade and Industry
NAMCO	Nihon Aeroplane Manufacturing Company, Ltd.
NEC	Nippon Electric Company
NTT	Nippon Telegraph and Telephone Corporation
R&D	research and development
VLSI	very large scale integrated circuit

Title

COMPUTERS IN AN INFORMATION SOCIETY

The computer represents the foundation of Japan's technology-based society. Not only is the health and growth of the computer industry itself important, but the use of computers throughout the economy is expected to increase productivity, conserve resources, and improve quality in a wide range of products and services. The computer industry has been one of the most constant recipients of government support throughout the postwar period. Government supported actions have:

--Established an institutional structure and legal framework for developing and implementing policies.

--Guaranteed a market for Japanese producers through commercial policies that limited imports and foreign investment and emphasized "buy Japanese" policies.

--Funded a leasing organization which ensured that Japanese manufacturers would be domestically competitive with International Business Machines, Inc. (IBM).

--Provided tax relief.

--Provided success conditional loans for development and production of directly applicable commercial technologies.

--Fully subsidized research and development (R&D) projects to develop basic and leading edge technologies.

Government assistance has varied in type and importance in response to domestic and international pressures over time. The industrial policy tools applied to the computer industry during the late 1950s and through most of the 1960s were those used for many industries during that time--protection behind high tariff walls, foreign exchange allocations, and controls on foreign investment and technology licensing. A leasing program supported by the government was successful in providing financing competitive with IBM. Tax measures were used to diffuse Japanese computers through the economy. More recently, government-supported R&D programs to develop indigenous technologies have become a major goal. Many of the industrial policy tools used by the government during the early period no longer play equivalent roles. Tariff barriers have been lowered, private leasing companies established, and tax measures reduced.

In addition to a gradually changing role for the government during the postwar period, the companies themselves have grown stronger. In 1979 a Japanese company surpassed IBM in Japanese sales for the first time and the value of computer exports exceeded the value of imports. Table 1 illustrates the growth in sales of seven major computer companies in Japan. Total

production of the Japanese computer industry in 1980 was 1.3 trillion yen.

Table 1

Computer Sales

	1976	1977	1978	1979	1980	1981
			(billion yen)			
Fujitsu	239.6	274.5	303.0	326.8	382.0	454.0
IBM Japan	275.4	293.8	315.3	324.2	338.3	429.0
Hitachi	142.0	160.0	190.0	216.0	250.0	288.0
Nippon Electric	114.0	137.5	166.8	200.7	240.3	327.5
Toshiba	59.2	59.1	43.0	50.4	80.3	100.5
Oki Electric	48.3	44.4	47.9	62.8	78.8	109.0
Nippon Univac	70.6	67.8	71.6	73.6	78.6	-
Mitsubishi Electric	32.0	38.0	45.0	53.0	62.0	89.9

Notes: (1)The term ended in December for IBM Japan. The accounting term ends in March for other companies. (2) Products included in the computer division were expanded in fiscal 1980 for Nippon Electric.

Source: Japan Economic Journal, June 9, 1981, for 1976-80 sales and International Data Corporation July 6, 1982, for 1981 sales.

COMPOSITION OF THE INDUSTRY

The same major Japanese computer manufacturers have been dominant since Japanese production began in the 1950s. Before that time, these companies manufactured communications equipment and/or industrial machinery. Today, these companies and their affiliates produce computer-related products ranging from semiconductors, integrated circuits, peripherals, and central processing units to software and telecommunications equipment. Table 2 shows the product mix of these companies and the proportion of computers in overall sales.

Japanese computer production began with second generation technology in the late 1950s, which was marked by the use of the transistor. The third generation, using an integrated circuit, was marked by IBM's introduction of the 360 series system in 1964; and the fourth generation was marked by the use of large scale integrated circuits in the late 1970s. Each new generation has seen dramatic changes in the ratio of cost to performance. Although IBM continues to provide an overall technological standard and marketing leadership, the Japanese manufacturers have gone from outright purchase of foreign technology through licensing and technical agreements to domestic production of competitive technologies, to planning and working toward developing leading edge technologies, and have increased their sales at home and abroad.

Table 2

Major Japanese Electronics/Computer Firms

Firm	Computer revenues as % of total revenues 1981	Systems market
IBM Japan	100	Wide range of computer hardware, software and related equipment
Fujitsu	68	Leader in computers
Oki Electric	51	Peripherals, telecommunications
Nippon Electric	31	Leader in integrated circuits and telecommunications, computers
Hitachi	14	Leader in diversified computer systems, producer in communications, consumer, heavy industrial, and electric machinery
Mitsubishi Electric	7	Diversified systems, small business computers, industrial and heavy electrical equipment, medium appliances
Toshiba	5	Diversified systems, especially consumer business systems, instrumentation, appliances and electrical equipment

Source: "International Competition in Advanced Industrial Sectors: Trade and Development in the Semiconductor Industry," Joint Economic Committee Print, Feb. 18, 1982, p. 66; International Data Corporation, "EDP Industry Report," July 6, 1982.

EARLY INDUSTRIAL POLICIES

The first computer projects in Japan began in the 1950s and were spurred by the first imports from the United States in 1954. During the 1950s and 1960s, the government focused on rebuilding capital intensive basic industries and on supporting industries with strong export potential. Computers were important, but not significant.

Legal and administrative framework

The Law on Extraordinary Measures for the Promotion of the Electronic Industry was passed in 1957 with several provisions which were to become important to the computer industry. The Electronics Industry Section was set up within the Ministry of International Trade and Industry (MITI). The Law established the Electronics Industry Deliberation Council, (renamed in 1971 to incorporate machinery) composed of government, corporate, trade association, and scholarly representatives, as an advisory body. The Law also authorized MITI to selectively exempt any portion of the electronics industry from the Antimonopoly Law. To represent the industry, the Japan Electronic Industry Development Association was established in 1958.

The Law included financial assistance for hardware manufacturers in three categories: (1) direct subsidies for R&D of major technologies, (2) government loans to manufacturers to support products just entering commercial production, and (3) government loans and accelerated depreciation for designated plant and equipment. Between 1957 and 1961, however, manufacturers qualified for less than $1 million in R&D subsidies. To redress the technological gap, the manufacturers themselves entered into a number of technical assistance and licensing agreements with U.S. manufacturers throughout the early 1960s.

Commercial policies

Japan's Foreign Investment Law of 1950 dissuaded entry and control by foreign firms. Permission given to IBM to manufacture and remit foreign exchange earnings in 1960 was the major exception. Computer imports were subject to quotas and high tariffs, and government approval was required on patent and technical assistance agreements. According to one observer, the government's general policy required foreign firms to license all Japanese firms requesting a specified technology and limited royalty payments by Japanese firms to one rate on each deal.

The Japanese manufacturers turned to IBM's competitors for technology licensing in the early 1960s, and a plethora of agreements resulted. Although government control over the import of technology protected the domestic market from foreign competition, the positive value of the government's licensing procedures per se, has been questioned. In fact, according to one industry

observer, it was not until the joint venture between Fujitsu and the U.S. Amdahl Corporation that the Japanese industry had access to IBM's semiconductor technology and began to produce machines compatible with IBM technology (commonly referred to as plug compatible machines). Fujitsu is today the leading Japanese manufacturer.

Leasing company set up to assist manufacturers

One early competitive pressure the Japanese companies faced was financing, so the Japan Electronic Computer Corporation, a computer leasing company was established in 1961. IBM's leasing system placed the Japanese manufacturers at a disadvantage in selling their products, and the manufacturers approached MITI for assistance. MITI suggested that a joint venture be formed between the government and the industry to purchase computers from the manufacturers and lease these systems to end users. Both the manufacturers and the Ministry of Finance objected to an equity investment by the government and a compromise was reached whereby the government, through the Japan Development Bank, provided loans to the Corporation for its operations. The Corporation was limited to Japanese manufacturers and all of the major computer manufacturers originally participated.

Increasing government involvement spurred by international competition and technological requirements

Government interest in the computer industry intensified in the mid-1960s. Development of indigenous technologies became a priority as the early postwar rebuilding of basic industries progressed. 1964 saw the introduction of third generation computers by IBM and the takeover of the largest French computer manufacturer by a U.S. firm. MITI believed that increased government support was needed if the Japanese industry was to become competitive.

The Electronics Industry Deliberation Council Report of 1966 highlighted the increased importance of the computer industry to Japan's economy and future and proposed a number of goals and objectives that represented the congruent interests of MITI and the industry. The report had the support of the Ministry of Finance and the ruling Liberal Democratic Party. The objectives were to develop domestic technological capability and to increase the domestic market share and profitability of Japanese manufacturers. Appropriations for R&D projects increased as did Japan Development Bank loans to the Japan Electronic Computer Corporation. Through 1970, the cumulative total of loans, subsidies, and tax savings through accelerated depreciation was estimated at almost $25 million.

MITI, concerned with the technological inferiority of the Japanese manufacturers, their financial position, and the number

competing for domestic market share with similar products, took a number of actions. To redress the technology constraint, a joint project was set up under MITI's Agency for Industrial Science and Technology to develop large memory, fast processing technology, and supporting software. Each of the major participating manufacturers was matched with specific responsibilities to try to encourage specialization. In 1968 in an attempt to strengthen the maufacturers' financial position, the government began to allow the manufacturers to hold tax-deferred funds to mitigate the effects of losses from mandatory repurchases of old machines from the Japan Electronic Computer Corporation. To rationalize production, MITI formed a production cartel in 1969 for peripheral equipment and standardized the design of such equipment, in which further innovation was unlikely.

RISE OF THE INFORMATION INDUSTRY

By 1970, the government had increased and broadened its attention to include the information processing industry as well as the computer manufacturers. The basis for MITI's actions from that time to the present has been contained in three laws. Two of these laws, the Kidenho, in effect from 1971-78, and the Kijoho, passed in 1978, are "temporary measures" and similar in scope. The third, the Information Technology Promotion Agency Law, passed in 1970, set up the major national institution for information processing and goals for the industry. The programs carried out under these laws represent the government's most significant assistance to the information industry over the last decade.

The Kidenho

The Law on Extraordinary Measures for the Promotion of Specific Electronic and Machinery Industries--the Kidenho--illustrates the new role that the government envisioned for itself at the beginning of the 1970s. Increased attention was spurred in part because of the government's realization that capital and trade liberalizations were increasingly unavoidable. The Kidenho called for the development of "enhancement programs" and set out major industry objectives in three categories--prototype R&D, in which Japan lagged; startup or large volume commercial production; and manufacturing processes which could reduce costs. By combining two earlier statutes, the law sought to incorporate advances in electronics into machinery industries. Projects under the enhancement programs were to be partially supported with direct government funding and low-interest Japan Development Bank loans. MITI was given responsibility for guiding manufacturers in concerted activities pertaining to procurement of raw materials and components, use of production facilities, industrial standards, and efforts to improve technology. The Kidenho also provided for corporate mergers when necessary to achieve targets of the enhancement programs and tax benefits to encourage rationalization.

Two major programs were begun in 1971. The Pattern Information Processing System project was a follow on to the Super High Performance Electronic Computer Development project of the late 1960s. Under the auspices of MITI's Agency of Industrial Science and Technology, the Agency's Electrotechnical Laboratory and nine companies developed the basic technology for a comprehensive pattern information recognition system. The initial 8-year, 35 billion yen plan was extended by 2 years, but with a reduced budget of 22 billion yen. A number of specific hardware system prototypes were developed, each by a specified participant or group of participants.

MITI also sponsored an alignment of the Japanese manufacturers in 1971 to produce a product competitive to the IBM 370 series. Oki-Mitsubishi produced the COSMOS series within the Super Highly Efficient Electronic Computer Technological Research Association, Nippon Electric (NEC)-Toshiba produced the ACOS series within the New Computer Series Technological Research Association, and Fujitsu and Hitachi jointly produced the M series. According to some participants, it is doubtful whether these pairings would have taken place without MITI's encouragement. Government subsidies for production totaled about 68.6 billion yen from 1972 to 1976.

One of the most important joint government-industry projects during this period was the successful development of a very large scale integrated circuit (VLSI). As noted earlier, all of the major Japanese computer manufacturers had inhouse semiconductor capabilities, originally produced from U.S. technology. As the consumer electronics industry became more demanding, domestic capability increased and semiconductor technology advanced, which in turn fed back to the computer industry. It was against this background that Japan set out to develop leading edge technology in memory chips.

The VLSI project grew out of dual objectives. Nippon Telegraph and Telephone Corporation (NTT) the public communications monopoly, began a joint project in April 1975 with Hitachi, NEC, and Fujitsu to develop integrated circuits with large-scale memory. In July of that year MITI, with more general objectives for the computer industry as a whole, approached NTT and in 1976 the VLSI Technology Research Association was formed which included Mitsubishi and Toshiba. Research, costing an estimated 72 billion yen, was performed by government and industry engineers over a 4-year period. Government funds totaling nearly 30 billion yen were invested in this project in the form of success conditional loans to be repaid after the research was commercialized and became profitable. 1/ It has been estimated that

1/ The VLSI project was completed in 1979. The Association remains together for production and in the fall of 1981 was negotiating repayment schedules with the government. At that time, no repayments had been made.

about 1,000 patents resulted from the project. By concentrating on the memory rather than logical elements of the integrated circuit the Japanese have sought to capture the largest segment of the market and an area where technological advances are evolutionary rather than revolutionary.

Liberalization results in loss of certain industrial policy tools

Liberalization of investment and trade in computers slowly occurred throughout the 1970s, and by the end of 1976 most legal restrictions on foreign computer manufacturers were removed. By 1978, the formal "buy Japanese" cabinet order was rescinded. Import quotas were gradually eliminated; peripheral units were exempted in February 1972, electronic calculators in April 1973, integrated circuits in December 1974, and computer parts, central processing units (CPUs), and memory and terminals in December 1975. Import tariff schedules have declined or are scheduled to decline as follows

	1965	1981	1982	1987
	(percent)			
CPUs	15	9.1	7	4.9
Discs	15	12.8	10.3	6.0
Other peripherals	25	14.6		
Parts		12.5	4.2	

The 1949 Foreign Exchange and Foreign Trade Control Law and the 1950 Foreign Investment Law governed foreign capital investment in Japan. The introduction of foreign computer technology was liberalized in July 1974; the manufacture, sale, and lease of computers in December 1975; and data processing services and software development in April 1976. Although there continue to be charges that access to the Japanese market is constrained, these actions for the most part marked the end of legal protection and a shift in the government's industrial policy tools. As the need for manufacturers to develop indigenous technologies to remain domestically competitive became more acute, support for R&D programs became the major avenue of government assistance and, hence, influence. In effect, government allocations of foreign exchange for the purchase of technology were replaced by allocations of R&D funds for the development of technology.

The Kijoho

The Law on Extraordinary Measures for the Promotion of the Specific Machinery and Information Industries--the Kijoho--has

provided the legal basis for government support to the computer industry since 1978. Like its predecessor, it is a temporary law and is slated to expire in 1985.

The major difference between the Kidenho and the Kijoho is the inclusion of software in the "specific electronic and machinery industries." Software was one of the weakest areas of Japanese manufacturers, and consequently, the government wanted to emphasize the development of software technology and the use of computers. The law also advocated joint activities to accomplish its goals rather than earlier attempts to enact mergers which, for the most part, had been unsuccessful.

The Kijoho contained enhancement programs for specific products and provided access to funds and joint activities needed to implement the programs, as had the Kidenho. However, technological goals under the Kijoho have concentrated on developing unexploited technology and leading edge technology industries.

Information Technology Promotion Agency Law

The Information Technology Promotion Agency (IPA) was established by law in 1970 as the major instrument for developing software and data processing industries. Its objective was to promote "information processing by developing the program and its utilization as well as giving assistance to those engaged in the information processing service." An Information Processing Industry Promotion Division within MITI and the Japan Software Industry Association were established in the same year.

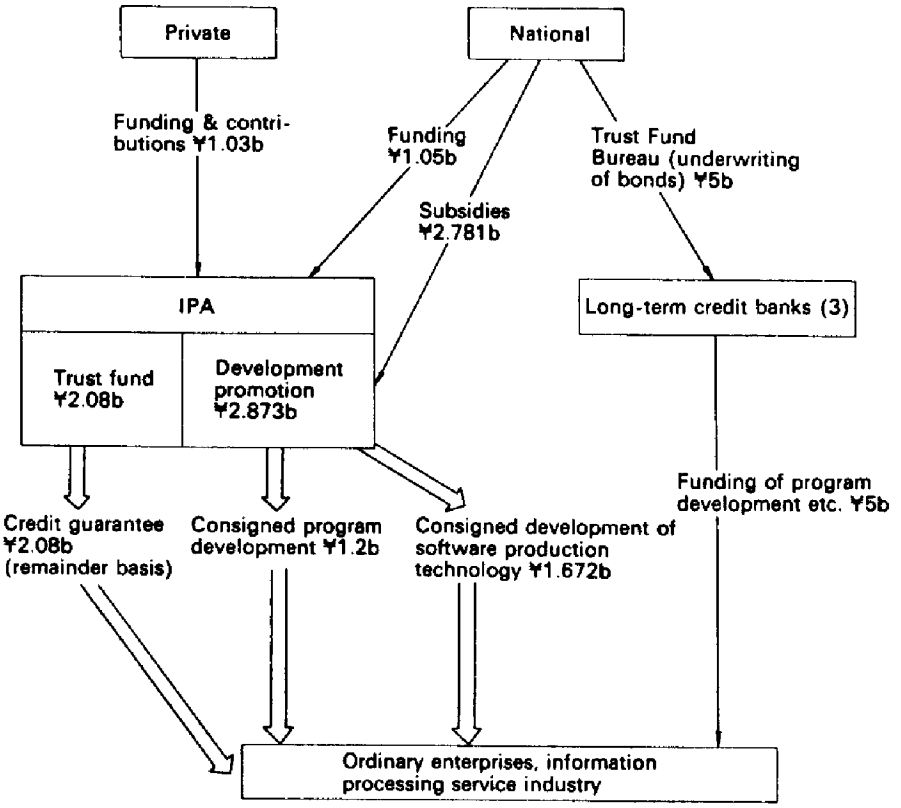
Funding for the IPA comes from a number of private and government sources and from revenues earned by the Association. Chart 1 illustrates the various funding mechanisms, with Japan fiscal year 1980 figures. 1/

Programs funded through the IPA primarily address the concerns of 1400 small- and medium-sized companies which make up the software and information processing services industry.

1/ Unless otherwise noted, fiscal years in the report are Japan fiscal years--Apr. 1 to Mar. 31.

Chart 1

IPA Funding System



Source: Computer White Paper, 1980 Edition. Published by Japan Information Processing Development Center.

BEGINNING A NEW DECADE

A number of government documents indicate Japan's concern with developing and diffusing leading edge technology. Just as the Deliberation Council Report of 1966 had set out a new role for the government's computer policies, so too did the summer 1981 report of the Industrial Structure Council's Information Industry Committee. The committee document, based on year-long deliberations, emphasized the need to establish an information-oriented society and identified the role of the computer and information processing industries in Japan's future. The document outlines two main roles for the computer industry. First, the industry itself represents a high value added and low resource and energy use industry. Second, the computer industry and related information processing industries

form the basis of Japan's drive toward a "creative, knowledge-intensive industrial structure in the 1980s." Because of the widespread applicability of computers throughout the economy, discussion of the industry's role and its problems and possible solutions have been widespread.

The government's goals are to support technological innovation in hardware and operations systems software and to integrate the computer into the economy. The focus of these goals has changed from technological catch-up to technological innovation and has broadened from developing competitive computer hardware to production and use of entire information systems. Major new R&D undertakings seek to develop the necessary technologies through cooperative government-industry ventures. Some of the tools used to diffuse computers in the past are currently being employed to diffuse applied software.

Major R&D initiatives support state-of-the-art technology

The government is currently providing total funding for a number of research projects, in which private companies participate, to develop state-of-the-art technology. A recent study prepared by the U.S. Embassy in Tokyo identifies two factors as common to planning and executing these R&D projects; (1) each project has a technical hierarchy which runs the project, usually under the name of "research association" or similar designation, and (2) each project has an office within MITI responsible for general administrative oversight and for guiding the project through the annual budget cycle.

Four such projects, in addition to the second phase of the project that developed the VLSI, 1/ are discussed below.

Promotion and Development of Technology for the Next Generation (4th Generation) Computers.

This is the second phase (fiscal years 1979-83) of a two-phase project to develop the basic hardware, operating systems software, and peripheral equipment to compete in memory capacity and computing speed with IBM's computers of the early 1970s. Phase I of this project developed the basic hardware and resulted in the VLSI. For the second phase, the participating companies (Fujitsu, Hitachi, Mitsubishi, NEC, and Toshiba for software and those companies plus Oki, Sharp, and Matsushita for peripherals and terminal equipment) formed the Electronic

1/ A sixth project, centering on production of applied software is discussed elsewhere in this chapter.

Computer Basic Technology Research Association in July 1979. Original funding plans called for the Association to contribute half of the total 47 billion yen and for MITI to provide the rest as a success-conditional loan. Beginning in July 1982, however, MITI reduced its share to 45 percent because of budgetary constraints. From 1979 through 1982, approximately 85 percent of each year's funding has been used for software development. The theme of developing Japanese information processing for the Japanese is evident in several of this project's R&D objectives.

High Speed Computer System for Scientific and Technological Uses

The overall goal of this project is to develop a super computer with speeds at least three orders of magnitude higher than currently attainable. MITI's Agency of Industrial Science and Technology is sponsoring the project, but work is being carried out within each participating company (Fujitsu, Hitachi, NEC, Toshiba, Mitsubishi and Oki) and in MITI's Electrotechnical Laboratory. The Association for the Development of High Speed Scientific Computers was formed in December 1981 by the six manufacturers and was subsequently commissioned by MITI to conduct R&D under contract. The Association will sponsor periodic meetings to exchange information and coordinate the project. The government is fully covering all project expenses, which are expected to total 23 billion yen during the 1981-89 life of the project.

One of the two subprograms is to produce processors capable of handling 40-100 million calculations (or "floating operations") per second. At least two Japanese companies, Fujitsu and Hitachi, have independently announced development of machines capable of handling speeds in excess of 500 million calulations per second.

Next Generation Industries Basic Technologies R&D Program

This project is characteristic of Japan's drive to develop basic revolutionary technologies. The government will spend 104 billion yen on developing 12 specific technologies. The project will last from 8 to 10 years with a total of 48 private companies and 10 national R&D laboratories participating.

One of the three general areas of research is in semiconductors or "new function elements." 1/ MITI's Agency of

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1/ See app. 3 for a discussion of the "new materials" segment of this project and its implications for the aircraft industry.

Industrial Science and Technology has set up a planning office to coordinate the project. The 10 participating companies (Fujitsy, Hitachi, Sumitomo Electric, NEC, Oki, Toshiba, Mitsubishi, Sanyo, Sharp, and Matsushita) formed the Research and Development Association for Future Electron Devices, which was then contracted by MITI in October 1981 to carry our research. All expenses are to be covered by nonrepayable government funds.

Optical Measurement and Control System

The goal of this 8-year project, fiscal years 1979-86, is to create a system for remote monitoring and control of large-scale industrial processes using optical elements instead of electrical impulses to sense and transmit data. Nine companies will be performing research--Fujitsu, Hitachi, NEC, Toshiba, Mitsubishi, Matsushita, Furukawa, Oki, and Sumitomo under the sponsorship of and with researchers from MITI's Agency of Industrial Science and Technology. These companies formed a research association in January 1981, which in turn established the Optoelectronics Joint Research Laboratory. The government will hire the laborary on contract and pay all project expenses, expected to total 18 billion yen.

R&D Relating to Basic Technology For Electronic Computers (5th generation)

Development of a 5th generation computer is one of the most ambitious government projects underway in Japan. The overall goal of this 12-year undertaking is to design information processing systems to deal with the basic social problems of the next decade such as low productivity in some industries, energy and resource shortages, an aging population, and international competition. The Japan Information Processing Development Center, a nonprofit institution, carried out preliminary studies from 1979 to 1981 at a cost of about 120 million yen. These studies culmirated in an international symposium held in Tokyo in October 1981. Subsequent discussions between MITI and the Ministry of Finance resulted in a February 1982 paper describing the aims of the 5th generation project. In general, 11 research themes will attempt to change computers from data processors to knowledge processors with which users can easily interact. This is thought to require, inter alia, the development of "user friendly" software and entirely new computer hardware designs.

Total funding for the entire project had not been announced as of May 1982; MITI will provide funds after 1981, which are projected at 10 billion yen through 1984. The Institute for New Generation Computer Technology was established in April 1982 as an endowed research foundation with original members

including Fujitsu, Hitachi, NEC, Toshiba, Mitsubishi, Oki, MITI's Electrotechnical Laboratory, NTT, home appliance and electronics firms, and academic institutions. Foreign enterprises are being invited to join, and the government has signed or plans to sign cooperative agreements with the governments of France, West Germany ,and the United Kingdom.

Diffusion of project technology

Patents arising from the projects discussed above (with the exception of the next generation project and perhaps the 5th generation undertaking) are owned by the government. They are available in theory upon application to the appropriate government/MITI authority. The government has stated that its policy is to make these basic technologies available to a wide range of industries. This is in keeping with the role set out for computers in MITI visions--to increase productivity, conserve resources, and improve the quality of goods and services across the economy as a whole. However, these projects are as yet too new to analyze how these policies are actually implemented. The first phase of the next generation project (the VLSI) produced about 1,000 patents, only about 5 percent of which are owned by MITI. Applications have been automatically approved by MITI to members of the VLSI Research Association for their own use and for cross licensing. The diffusion of future government-owned technology, especially with regard to foreign firms, is as yet unclear.

Implications of government support for R&D

Government subsidies for fiscal year 1982 to private companies for advanced R&D in computers, software, and integrated circuits are estimated at 11.2 billion yen. From 1976 to 1982, such subsidies totaled 78.2 billion yen. By comparison, press reports indicate that computer and semiconductor R&D expenditures in fiscal year 1982 are planned by Hitachi, at 160 billion yen, by Toshiba at more than 90 billion yen, and by Mitsubishi Electric at 70 billion yen.

According to some observers, in addition to possible technological breakthroughs which may result from these projects joint R&D projects with government funding provide an opportunity, which may not otherwise be possible, for company engineers to participate in research regardless of its commercial applicability, and for the government to use these experiences for long-term and/or wide-ranging benefits for the economy as a whole.

Nippon Telegraph and Telephone Corporation

NTT, Japan's monopoly communications corporation, although not a direct instrument of industrial policy, has had an important

impact on Japan's computer industry. NTT has traditionally had had a close relationship with NEC, Oki, Fujitsu, and Hitachi. Lacking production facilities of its own, NTT has contracted with private companies for development of major systems and components. In addition to providing a market for private company products and technologies, NTT spends an annual $350 million for R&D, licenses its technologies to private firms and provides engineers for joint industry-government R&D projects. NTT's participation in the VLSI project was described on page 7. In addition, NTT researchers have taken part in the 5th generation computer project and are focusing their own efforts in a number of areas similar to MITI interests.

Development and diffusion of applied software technology

In Japan, software accounts for about one-half of development costs but comprises only about 10 percent of the selling price. In addition, most Japanese software currently produced is custom-made. Development and diffusion of general-purpose software programs is a major MITI/IPA goal which, if successful, should lead to reduced costs and increased use of computer systems. Other goals are to reduce the cost of software in 1985 to 60 percent of its 1977 levels, to increase software sales by 3.8 times the 1977 level, and to increase the sales amount of general purpose software to 20 percent of all software packages. The following IPA programs are designed for those purposes.

To reduce costs, a project to improve software maintenance technology slated in 1981 to receive 140 million yen in the first year of a 5-year effort, is expected to cost a total of 5 billion yen. Maintenance costs account for about 70 percent of software costs. In Japan, almost all maintenance is performed manually. The project seeks to improve reliability and productivity.

To increase sales and development of general purpose software, IPA set up a consignment program, funded in 1981 at 1,350 million yen, to develop programs with wide application and which are not likely to be developed by a private company. In addition, a system of reserve funds was established as part of the tax reform in fiscal year 1979. Individuals and corporations may temporarily set aside a tax-free reserve of up to 40 percent (reduced in 1981 from 50 percent) of the income accruing from software program transactions and accompanying technological services. The programs developed must be registered with IPA.

Software Production Technology Development Program

This has been IPA's most ambitious attempt to develop state-of-the-art technology. In 1976, 17 major software companies formed the Joint Systems Development Corporation with capital participation from a number of private banks. MITI

the Corporation to develop automated software production over a 5-year period. The original project goals were scaled back as too ambitious, funding was decreased, and the project was lengthened by 1 year. The total program budget was 6,626 million yen over a 6-year period which ended in 1981. No funds have been repaid and the technology which has resulted belongs to IPA.

A new software technology center has been set up within IPA to develop data processing technology; 395 million yen was allocated for fiscal year 1981 and 711 million yen for 1982. The industry originally proposed that a separate laboratory be set up, such as those established in the past for other electronics industries. Apparently because of budgetary concerns, however, the center will be part of IPA.

In 1981, IPA's budget was decreased for the first time. In that year, subsidies from the general account were projected at 2,658 million yen. Most government sponsored software projects, including those discussed above, are funded from this budget. As an apparent result of budgetary pressures, some conditions for this funding are becoming more stringent.

As a measure of general support for the industry, and by some accounts one of the most important, IPA guarantees bank loans to individual software companies, because it believes that banks won't lend to software companies because they lack tangible assets. Additional government-supported measures deal with safeguards and training for information processing engineers.

Computer leasing loses impact

Although the Japan Development Bank continues to lend to the Japan Electronic Computer Corporation, the importance of the Corporation has decreased as the financial strength of the participating manufacturers has improved. In late 1976, MITI and the Corporation requested a 5 billion yen capital increase from the computer manufacturers. Hitachi refused because it has set up its own leasing program and Toshiba, Mitsubishi, and Oki refused because they were not using the Corporation to the extent of their equity percentages. In September 1977, Fujitsu paid 80 percent of the increase and NEC the remaining 20 percent.

The Japan Development Bank's loans to the Corporation fell from a high of 53.3 billion yen in fiscal year 1978, to less than 48 billion yen in fiscal year 1980, and 1981 loans are budgeted for less than 46 billion yen. MITI and Corporation officials both agree that the Corporation's utility has decreased. There are no current plans to expand its scope of operations.

Tax incentives decreasing

Although we do not have specific figures on the impact of tax measures on the computer industry, it has been estimated that, in general, total revenue losses resulting from technology related tax measures have declined since the early 1970s. One of the major tax benefits to computer manufacturers was the Japan Electronic Computer Corporation's reserve fund for the repurchase of computers. Although the reserve fund was extended for 2 years in 1981, as the Corporation's computer leasing business declines, total revenue losses from this tax measure have declined.

Special depreciation measures are available for R&D in general. Up to one-third of the initial value of facilities used to produce MITI-approved technologies (many of which are developed by the information industry) can be depreciated in the first year, in addition to usual depreciation schedules. Under the Kijoho, firms installing designated types of machines are eligible for an additional 13 percent first-year writeoff, and under a 1979 tax system revision, a special depreciation system for users of high-performance remote data processing equipment was established. Also, 20 percent of total computer purchases can be deducted for asset valuation for local taxes.

Deductions from income are allowed for technology exports and a small reserve is allowed for losses from overseas investment. However, many earlier tax measures to promote exports have ceased.

SOME OBSERVATIONS

At the beginning of the 1980s, Japanese manufacturers are well established, successful in Japan, and are exporting. Their dependence on the government has diminished as their financial and technological positions have strengthened. At the same time, MITI's means of control over the industry have diminished; e.g., it no longer controls foreign exchange allocations for imports. However, the industry still has a "carrot and stick" perception of the government. One computer industry official told us the government is able to exert influence because (1) government officials are highly respected, (2) government-business relations are grounded in a fear of retaliation and an expectation of favors, and (3) the consensus management process allows all sectors to present their views.

Government tools used to support the goals outlined in the most recent MITI plans for the information industry are familiar. Projects to improve production technology for applied software are funded by the government with company participation and an emphasis has been placed on diffusing the resulting advances. A tax deferred reserve fund, much like that used for the Japan Electronics Computer Corporation, has been set up for

the sale and development of software. Software company borrowings from private sources are facilitated by guarantees, and the government is stimulating demand for general-purpose software through the Information Technology Promotion Agency's consignment programs. For the computer industry as a whole, MITI provides loan and grant funding for joint R&D projects.

The role of the government has been of obvious importance in the history of Japan's computer industry. Strategies have changed over the past three decades and, in retrospect, the changes generally appear to have been effective in helping the industry. Trade measures today are limited, however, and are increasingly more dangerous in a slow growing international economy because of the potential for retaliation. The current R&D supported by the government focuses on leading edge technologies which will have applications across many sectors of the economy--projects which are further removed from the marketplace than Japan's past attempts to improve production and manufacturing technologies.

JAPAN GEARS UP FOR ROBOTS

A robot is basically a manipulator that can be programmed to carry out a variety of functions. Much of the early robot technology came out of the machine tool industry, while more recent applications have been made possible by advances in microprocessors. Japan's interest in industrial robots began in the early 1960s when a few companies began importing simple technologies. 1967 marked the first Japanese import and installation of industrial robots and Japanese production began a year later.

Growth of the Japanese industry began in earnest in the mid-1970s and was spurred by the prospect of labor shortages and the impact of rapidly rising oil prices. Japan today reportedly has about one-half of the world's installed industrial robots, and leads in robot production. Not only is development of the robots themselves important, but also how they are used in developing larger automated manufacturing systems. These systems depend on software, computer-aided design, and automated materials handling, as well as robots.

The Japanese Government sees the robot as an important part of its goals to improve productivity and produce higher value added products. In addition, the robot is envisioned as a means to improve the quality of life of the Japanese worker by taking over the more dangerous and dirty tasks. Government involvement in the robotics industry has been directed toward expanding the use of robots in small-and medium-sized companies and supporting basic R&D and projects to develop flexible manufacturing systems.

DEFINITION OF A ROBOT

International comparisons of the production and use of robots are difficult because definitions vary. The Japan Industrial Robot Association (JIRA), with perhaps the broadest characterization, defines a robot as a manipulator:

--that is worked by an operator (manual); or

--which repetitively performs successive steps of a given operation according to a predetermined sequence, condition, and position, and whose set information cannot be easily changed (fixed sequence robot); or

--which repetitively performs successive steps of a given operation according to a predetermined sequence, condition, and position, and whose set information can be easily changed (variable sequence robot); or

--which can recall instructions from a memory bank, and execute operations automatically (playback robot); or

--that can perform a given task according to the sequence, condition and position, as commanded via numerical data, using punched tapes, cards, and digital switches (numerical control robot); or

--which, with sensory perception (visual or tactile) can detect changes by itself in the work environment or work condition and, by its own decisionmaking faculty, proceed with its operation accordingly (intelligent robot).

The first two categories are often eliminated in other countries' definitions. Table 3, employing a similar categorization, shows the state of the robot industry across a wide range of countries and in a number of different categories. (Type A are the most sophisticated machines.)

Table 3

International Robot Populations, Prices, and Growth

	Population Breakdown on Five Types of Robots						Robot Prices	Robot Growth			
Country	Type A	B	C	D	E	Total	U.S. Dollars	1985	Monetary Value	1990	Monetary Value
Japan		6,899		7,347	53,189	67,435	$6,825-$100,000	16,000	$1.0 billion	29,000	$1.9 billion
USA	400	3,000	1,700	600	40,000	44,700	$10,000-$150,000	7,715	$445 million	31,350	$2.1 billion
West Germany	290	830	200	100	10,000	11,420	$13,200-$123,200	5,000	$350 million	12,000	$950 million
USSR						3,000*	Figures not available	Figures not available			
Switzerland	10	40			8,000	8,050	$35,000-$100,000	600	$30 million	5,000	$125 million
Czechoslovakia	150	50	100	30	200	530	$14,000-$130,000	3,000		12,000	
Great Britain	356	223	54	80		713	$17,400-$110,400	3,000		21,500	
Poland	60	115	15	50	120	360	$30,000	200	$20 million	1,200-1,500	
Denmark	11	25	30	0	110	176	Figures not available	110		250	
Finland	35	16	43	22	51	167	$15,000-$200,000	950		3,000	
Belgium	22	20	0	0	82	124	$52,000-$103,000	150-200			
Netherlands	48	3	5	0	15	71	Figures not available	Figures not available			
Yugoslavia	2	3	5	0	15	25	$5,000-$45,000	100-150		300	
Sweden	250	150	250	50	100	800	$8,860-$90,000	2,300	$88.6 million	5,000	$177.2 million
Norway	20	50	120	20	50	260	$8,519-$85,175	1,000	$51.11 million	2,000	$102.21 million
France	120	500			38,000	38,620	$4,000-$160,000	1,000		1,300	
Australia			62		120	182	$10,000-$150,000	320-600	Figures not available		
Italy					400	753‡	$10,000-$150,000	Figures not available			
Total	1,774	10,924	2,584	8,299	150,452	177,386					

* Excluding existing robots and mechanical transfer devices.

* Figures on the Soviet Union were supplied by Daiwa Securities, New York, NY
‡ Italian figures based on 1980 completed survey

Type A—Programmable, servo-controlled, continuous path
Type B—Programmable, servo-controlled, point-to-point
Type C—Programmable, non-servo general purpose robots
Type D—Programmable, non-servo robots for die casting and molding machines
Type E—Machine transfer devices (pick and place)

Source: Iron Age, Mar. 19, 1982.

ROBOTS BENEFICIAL FOR A VARIETY OF REASONS

Japan expects robots to play a number of economic and social roles -- to increase productivity, humanize working conditions, eliminate skilled labor shortages, develop new energy sources and industries, and improve products and production processes. Officials we spoke with cited a number of reasons why robots are in more frequent use; improved industrial productivity is among the most frequently cited (although no studies documenting the actual improvements have been made publicly available) also flexibility, efficiency, accuracy, and the capacity to work 24 hours a day and perform dirty and dangerous work considered undesirable for humans.

Perhaps the most significant characteristic of the robot is its programmable function. With this feature, the action of the robot can be altered easily by simply changing the program, a function particularly important for small-batch production. In the auto industry for example, one assembly line may produce 10 small car models and the more sophisticated robots can be programmed to accommodate these different models; automated machines, such as multispot welders cannot be reprogrammed and new attachments have to be added to the welders for each different car model. Parts handlers attached to other machines, and tool handlers with more independent capabilities can both contribute to an overall increase in productivity.

Cost of robots-vs-cost of labor is declining

Robots in Japan are becoming more economically feasible as labor costs continue to rise. According to figures cited in Robots in the Japanese Economy, 1/ Japanese labor expenses soared from 990,000 yen per person per year in 1970 to 3 million yen in 1978 while robot prices have remained almost constant. The ratio of robot costs to labor costs dropped to an average of 1:7 by 1978, as shown below.

	1970	1975	1978
		(Y10,000)	
Total labor cost per worker per year (A)	99	230	300
Average robot price (B)	460	410	520
Mean price of playback robots (C)	1,200	1,100	1,100
(B)/(A)	4:6	1:8	1:7
(C)/(A)	12:1	4:8	3:7

1/ Kuni Sadamoto, ed., Robots in the Japanese Economy (Tokyo: Survey Japan, 1981).

THE MARKET: MAJOR ROBOT USERS AND PRODUCERS

In many cases, the large manufacturing companies in Japan have been in the lead in robot applications. Robot manufacturers, however, vary widely in size; 55 small companies (less than 100 million yen capitalization) make up about 41 percent of the industry, while very large firms (over 3 billion yen capitalization) make up about 35 percent.

Leading markets for robots (with 1980 market share) are electrical machinery (36%), automobile industry (30%), plastic moulding products (10%), metal working (5%), and metal working machinery (4%).

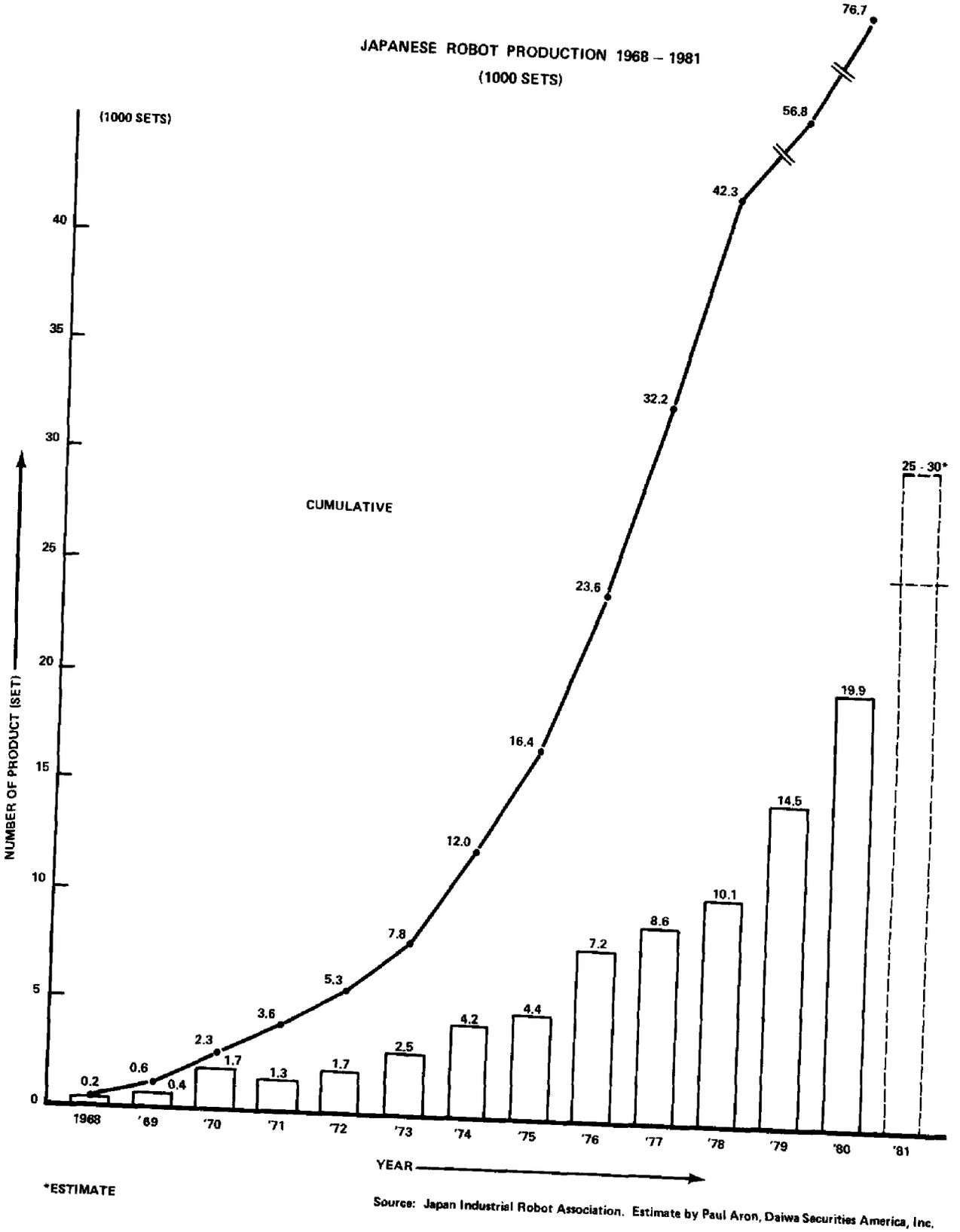
The automotive industry has been particularly important in spurring the installation of robots. Auto manufacturers were among the first to shift to automated production lines using robots. An estimated one-third of Japan's robots are operated by motor vehicle producers. Playback robots for use in foreign auto industries make up an important segment of Japanese robotics exports. Auto manufacturers use robots primarily for spot welding car and truck frames, body sides, underbodies, front structures, and subassemblies, and for spray painting, an increasingly important application. Gains are also expected in such areas as arc welding and dimensional inspection. Other examples of robot applications abound in the auto industry, including machine tool loading and unloading, die casting, permanent mold casting, conveyor transfer, glass handling, and palletizing.

The other major group of robot users are electrical appliance and electronics firms. Industry analysts and representatives agree that current robot applications across all industries in many countries do not come close to tapping the technology and expertise that robot builders have to offer.

Japanese robot industry is growing rapidly

Robots were introduced in Japan in 1967, and in 1968 Kawasaki Heavy Industries, Ltd., entered into a licensing agreement with Unimation, Inc., a U.S. robot manufacturer. During the initial phase of robot production in the late 1960s and early 1970s, production volume was small and was primarily absorbed by the robot manufacturers themselves. As shown in chart 2, production began to increase rapidly in 1976. Japanese auto companies began to produce some of their own robots for internal use and to develop long-term plans for increasing the number of robots in their plants.

Chart 2



Source: Japan Industrial Robot Association. Estimate by Paul Aron, Daiwa Securities America, Inc.

The Japanese robot industry is continuing to grow at a faster pace than analysts had previously estimated. According to one U.S. analyst, the Japan Industrial Robot Association had initially estimated 1980 shipments at 43 billion yen but later revised this forecast to 65 billion yen. Shipments actually totaled 78.4 billion yen, 82.3 percent above the original estimate. Most of this increased supply has been absorbed by the Japanese market, and current exports account for only about 3 percent of total production value. However, JIRA is predicting that Japanese robot exports will reach 15 to 20 percent of total production value by 1985.

Structure of Japan's robot industry has proved advantageous

Three major robot manufacturers accounted for only 13.3 percent of the value of Japanese robot production in 1980. According to one industry analyst, about 140 companies actually manufacture robots in Japan. The major Japanese robot builders are large, diversified corporations that generate only a small fraction of their total revenues from robot sales.

The early 1970s "rush" by Japanese firms to enter the robotics industry was halted by the oil crisis and resulting economic slowdown in the mid-1970s. The industry today is composed of a number of large corporations (Kawasaki Heavy Industries, Hitachi, and Mitsubishi Heavy Industries), producers of numerically controlled machine tools or large manufacturing systems (Fujitsu Fanuc), and companies that originally produced special purpose robots for their own use (Sailor Pen Company, Seiko Watches, Okamura Manufacturing Co.). Because the robots were used within their own factories, some robot manufacturers were able to sell already tested manufacturing systems. This in turn compelled other Japanese companies that had originally produced only robots to begin developing total production systems.

JAPANESE GOVERNMENT POLICY PROMOTES DISPERSION OF ROBOT TECHNOLOGY

The Japanese robot industry developed with little or no government assistance until the late 1970s, when the government officially recognized the industrial robot as a means of boosting productivity, lowering labor and material costs, and improving product quality. Early government interest in robots stemmed, in part, from policymakers' concerns about potential labor shortages.

Industry association established

By the late 1960s, Japan had held a number of symposiums in robotics, and in 1968 a committee was established by the Electronics Industry Promotion Committee and began conducting market

research. In 1971, the Industrial Robot Roundtable was established and reorganized a year later to become the Japan Industrial Robot Association, a government corporation. In 1973, JIRA's legal status changed and, with MITI's acquiesence, it became an incorporated private association. JIRA represents about one-third of Japan's robotics manufacturers as well as both Japanese and foreign robot users. It receives funds from the revenues generated by sports events sponsored by the machinery industry.

This pattern of government industry relations is one with parallels in other industries. According to one analyst, MITI normally encourages companies to form an industry association once the industry begins to grow because MITI is then able to work with the industries through the associations without having to deal with individual firms.

JIRA was established to promote the development of the industry and, as such, conducts domestic and international marketing surveys, tracks technological advances, performs public relations activities, and develops new robot systems applications.

Legislation for growth industries

The 1971 Law on Extraordinary Measures for the Promotion of Specific Electronic and Machinery Industries was directed toward improving production technology. The industry was designated as eligible to receive tax and financial assistance. One R&D project was begun to develop technology for an unmanned factory, but it was abandoned in the early 1970s as too ambitious.

It was not until the late 1970s that the government began directing significant attention to robotics. In 1978, the Law on Extraordinary Measures for the Promotion of Specific Machinery and Information Industries, the "Kijoho", went into effect and provided the framework for encouraging the dispersion and widespread application of robot technology.

Government assistance emphasized the need to diffuse robots to small- and medium-sized firms which, for the most part have less capital and a harder time attracting workers. The government backed the establishment of a leasing company and provided tax benefits and low-interest loans to assist the spread of robot installation.

Leasing company established

The Japan Robot Leasing Company, Ltd., (JAROL) was established in April 1980 to lease robots to small- and medium-sized firms. Japanese private and government officials we spoke with

consider JAROL to be the government's major and most widely used measure for promoting the use of industrial robots. JAROL was originally jointly owned by 24 major robot makers and 10 insurance companies, which provided it with 100 million yen in capital. By December 1980, 7 general leasing companies had joined JAROL, providing an additional 14 million yen in capitalization. JAROL received no initial capital contribution from the government but receives about 60 percent of its operating funds from the Japan Development Bank in the form of low-interest loans; in fiscal year 1980, this totaled 420 million yen. The other 40 percent is provided by the Long-Term Credit Bank, the Industrial Bank of Japan, and various city banks.

Many robot manufacturers were apparently against participating in such a leasing company, and government-industry discussions to resolve conflicts continued for about a year prior to its formation. A representative from one robot firm indicated that the robot manufacturers believed they had to join JAROL because it was a government-backed effort.

In the first full year of its existence, JAROL negotiated 1.143 billion yen in leases, or more than twice the expected 500 million yen. All told, 52 leases were concluded, with the average lease being 21.9 million yen and the average leasing period 60 to 63 months.

Large companies are not precluded from leasing robots through JAROL, but MITI officials estimated that small- or medium-sized firms account for 90 percent of the leases. These firms are the ones most likely to suffer from labor shortages and have the hardest time attracting labor and capital. According to Japanese officials, private leasing companies often do not want to lease to smaller companies. According to one official, JAROL should be able to meet the needs of these smaller companies because it

--is a non-profit organization and can therefore offer more favorable leasing terms;

--has access to Japan Development Bank funds at lower than commercial interest rates; also, the Bank will release the entire loan, whereas city banks will retain perhaps 10 to 20 percent as a deposit; and

--is attempting to provide engineering consultants to small and medium firms.

Private leasing companies do not provide the same benefits. According to one JAROL official, JAROL also helps robot manufacturers because they receive full payment for their robots when the lease is arranged. JAROL leases only robots and larger manufacturing systems manufactured by its member companies.

JAROL has recently been studying the possiblity of leasing robots to foreign customers. According to one Japanese industry analyst, JAROL and the industry association are discussing the possibility of drawing up an export promotion plan to present to MITI for approval. One barrier to government-supported leasing is funding. Because the Japan Development Bank is chartered to lend only for domestic development, JAROL would need to use Japan Export-Import Bank funding to lease robots overseas. According to one JAROL official, neither MITI nor the Export-Import Bank has become involved in helping JAROL to lease robots overseas because the contracts involved are not large enough. This official believes that as JAROL's business increases, however, MITI may get more involved and might encourage the Export-Import Bank to do likewise.

Tax and financial programs promote diffusion

The government established a program in 1980 to finance the purchase of industrial robots for occupational safety by providing low-interest loans to small- and medium-sized firms to encourage robot installation in dirty or dangerous industrial processes. Funding is provided by the Small Business Finance Corporation and the People's Public Finance Corporation. Loans are for 10 years with repayment beginning after the second year. JIRA participates in designating which machines can be purchased with these low-interest loans. The fiscal year 1980 budget for the program was 5.8 billion yen.

The central and regional governments have set up a fund, on a 50/50 basis, to make loans to modernize small- and medium-sized businesses. Robots were included as eligible for purchase and lease through this program in 1980.

A 3-year plan to provide a special depreciation allowance for computerized industrial robots was established in April 1980. Under this plan, manufacturers that install such robots are permitted to depreciate a percentage of the initial purchase price in the first year, in addition to taking ordinary depreciation allowances. This was 13 percent for the first 2 years and 10 percent for third year of the plan. According to one estimate, a firm can depreciate as much as 52.5 percent in the first year by using available depreciation allowances. The special depreciation is in effect from April 1, 1980 to March 31, 1983. The industry association is also attempting to get the depreciable life of the robot substantially reduced.

MITI also promotes basic R&D

MITI is concerned not only with dispersing existing robot technology but also with promoting basic robot technology research. Such research in Japan falls into three categories--that

done by universities and research institutions, by private industry, and by special government task forces. Basically, public research has concentrated on basic research and theoretical problems such as vision and sensory technology, while private research has concentrated on applied R&D. According to a 1980 survey conducted by JIRA, 85 of Japan's university and government research institutes are involved in industrial robot research encompassing a total annual budget of 322 million yen. This figure, however, is understated because it does not include personnel expenditures.

MITI officials indicated they have relied on private companies for R&D and to determine the direction and scale of production. To date, although private expenditures have not been made public, according to at least one industry analyst, these funds have provided the "overwhelming source" of R&D in robotics. 1/ In addition, a 1979 JIRA survey found that over two-thirds of 107 robot manufacturers were conducting their own R&D.

There have been exceptions to this policy, however. One is the project noted earlier that was abandoned as too ambitious. More recently, MITI announced plans to introduce a 7-year, 30 billion yen national robot research program aimed at developing highly sophisticated robots. The program was supposed to have begun in April 1982, but it has been postponed due to budget constraints.

A third effort, one of Japan's major "large scale projects," involves developing complex production systems in which mechanical components for small-batch production of diversified products can be flexibly and rapidly produced from metallic materials in an integrated system. The total budget for the project, slated to run from 1977 to 1983, is about 13 billion yen. Totally automated manufacturing systems are becoming more important as unit costs have decreased and robot use has expanded in industries, such as electronics, that had previously moved offshore to gain the advantage of lower labor costs. Again, the auto manufacturers have been among the first to adopt entirely automated production systems.

Industry and government officials disagree on value of government assistance

Japanese Government officials and industry experts we spoke with emphasized the fact that government efforts to

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1/ Paul Aron, Testimony before the House Science and Technology Committee, Subcommittee on Investigations and Oversight, June 2, 1982.

promote industrial robots are aimed primarily at small- and medium-sized robot users. However, these experts disagree as to how valuable and necessary this assistance has been in dispersing this technology. One analyst believes MITI's assistance to the robot industry is unnecessary because the robot manufacturers are all large, highly diversified companies able to support R&D on their own. Major robot producers, such as Fujitsu Fanuc and Fuji Heavy Industries, are able to use resources from their affiliated or parent organizations. This was not the case when industries, such as steel and autos, first got started.

Not surprisingly, MITI officials we spoke with believed that MITI has an important role to play in assisting growing industries, such as robotics. They acknowledged that it is too early to assess the impact of this assistance, since the government-backed programs did not began until April 1980. However, in their view, MITI must take the initiative in supporting basic, long-range research, since private firms tend to be more short-sighted. MITI officials also believe they must help small- and medium-sized firms to purchase or lease robots because these firms are unwilling and/or unable to do so on their own. By the same token, it is the small firms which can least afford the initial capital costs of installing robots and which suffer especially from labor shortages.

Some Japanese industry representatives we spoke with also believe the government serves a useful purpose in creating demand for robots and in eliminating dirty and/or dangerous work for laborers in small- and medium-sized firms. However, they acknowledged that the robot industry would have continued to develop without this assistance.

THE FUTURE: JAPAN EXPECTS TO DEVELOP ROBOT EXPORT POTENTIAL

Estimates of Japan's exports are about 3 percent of its production for 1980 and about double that for 1981. Projections are that by 1985 this will rise to 15 percent. Unlike such industries as electronics, computers, and automobiles in which the Japanese focused on catching up with and surpassing the world leader--the United States--the robotics industry in all major industrialized countries is in a similar, relatively young stage. According to some U.S. and Japanese sources, the Japanese feel they are in a position to lead the world in industrial robots in the coming years as they develop export markets. Japan has been criticized for lacking the creativity and innovativeness needed to develop new technologies, and the Japanese believe their success in exporting industrial robots will prove they can excel not only in improvement and application technology but in pioneer technology as well. Japanese projections also show a 30-percent increase in domestic demand during the 1985-1990 period.

Export approaches studied

According to one industry expert, successful robot sales must include highly sophisticated systems engineering prior to installation and adequate maintenance services after installation. For these reasons, he suggests that Japanese robot manufacturers must team up with foreign engineering firms. Some Japanese companies are already moving in this direction through linkages with U.S. firms, establishing joint licensing, production, and marketing agreements. For example, IBM has recently introduced a robot built by Sankyo Seiki Manufacturing Company, Ltd.; Westinghouse is marketing welding robots built by Komatsu and Mitsubishi Electric; General Motors and Fujitsu Fanuc, Ltd., have formed a joint venture to produce industrial robots; and General Electric has concluded an agreement to purchase Hitachi's robotics technology.

JIRA and JAROL are exploring the possibility of leasing robots overseas as a means of developing export markets for robots. Some Japanese robot industry representatives we spoke with believe that JAROL will probably succeed in doing so if it leases robots to the United States, because U.S. companies are more familiar with leasing and JAROL could fit easily into the well-established U.S. leasing system. Nevertheless, the Japanese will face problems they have not encountered in other industries, because the U.S. market for robots is relatively undeveloped; one problem is the lack of software standards to program robots. And, as one JIRA official notes, some countries seem unprepared to accept an influx of robots. If this is indeed the case, Japan's robot exports will continue to account for only a small percentage of total production until the situation changes.

Labor opposition may hinder domestic and foreign sales

Opposition by labor may be perhaps the most significant problem Japan's robot manufacturers will face in trying to expand foreign sales. In America and Western Europe, the crucial debate concerns the unemployment problem, which the introduction of robots could exacerbate. According to one U.S. analyst, to date this is less often discussed in Japan; instead, the positive effects are noted--improved quality and productivity and greater safety for employees.

In fact, a number of Japanese labor practices appear to have aided in the success of robot production. For example, unions are established on a companywide basis and cover all members of the bargaining unit and not those of one craft, skill, or occupation. As a result, the worker identifies with the company, not with a particular skill. Lifetime employment exists in many of Japan's larger corporations, and they assume the responsibility for retraining employees who have been displaced by robots. Robots spread relatively quickly through these companies and it

may be that workers with guaranteed jobs welcome the introduction of robots more easily. Workers benefit directly from the increased savings and profits created by robots through the use of bonuses.

Even in Japan, though, labor opposition cannot be ruled out. As noted in Robots in the Japanese Economy, 1/ unemployment may become an issue once the assembly robot begins to receive wide application. The Ministry of Labor and MITI have recently undertaken a number of studies, one at the request of Japanese unions, on the potential effects of automation in Japan.

Japan expects world robot demand to increase

Robot manufacturers and users, at some point, will need to weigh the potential social costs of introducing industrial robots on a large scale against the benefits of increasing productivity, flexibility, and quality control. Some predictions are that the major industrialized countries will have little choice, because without the increased use of robots, they will be unable to maintain internationally competitive industrial bases. It is clear the Japanese believe that automation is crucial and they are counting on reindustrialization efforts in the United States and elsewhere to increase the world demand for robots.

1/ Kuni Sadamoto, ed., Robots in the Japanese Economy (Tokyo: Survey Japan, 1981).

REBUILDING AN AIRCRAFT INDUSTRY

Japan's aircraft industry has had a mixed history. From its beginnings in the 1920s the industry grew to become a major international producer of military aircraft. After World War II, the occupation authorities prohibited aircraft R&D and production facilities were either removed or destroyed. 1952 marked the resumption of activity, and the industry has gradually increased its production and sophistication since that time.

The government's industrial policy tools for the aircraft industry are both similar to and different from those used for other growing industries. This appendix focuses on industrial policy for the civil aircraft industry. 1/ Early government funding to encourage the industry's development focused on producing and marketing domestic aircraft based on existing technology; the major project was technologically but not commercially successful. The type of assistance has changed, but in many ways follows a pattern seen in computers and robotics. Today, the government has shifted its support from participating in production to funding research and prototype development of new products and/or new technologies in public laboratories. In many cases, private industry has participated in government-supported projects.

MITI has lead responsibility for the industry and has established a system for communication between the government and the industry similar to those in many other industrial sectors. One key difference in government policy toward the aircraft industry, however, stems from the nature of aircraft demand. The Japanese domestic market is too small to support an aircraft industry and, consequently, protection behind trade barriers, an "infant industry" development strategy, is not viable. In addition, the risks associated with developing and bringing to market a new aircraft, the need for a service and maintenance network, and the intense international competition all point to a complex system of agreements among a number of producers. Consequently, by necessity government support for civil aircraft manufacturers has concentrated on their participation in international joint ventures. The incorporation of non-Japanese companies and governments in these projects may limit the control and/or influence of the Japanese Government over the direction of the industry.

1/ For a fuller discussion of Japan's military production and coproduction programs, see GAO's report, "U.S. Military Coproduction Programs Assist Japan in Developing Its Civil Aircraft Industry," Mar. 18, 1982, (ID-82-23).

The government's ability to achieve successful implementation of industrial policy goals has been further constrained by the extremely large amounts of money needed to develop a new aircraft or engine. Such funding is difficult to provide under the tight budget position in which Japan increasingly finds itself.

The aircraft industry is important to Japan because it fits the profile of industries the government believes are necessary for the future health of Japan's economy. Aircraft is a high value added industry, twice as high as steel for example. Technological innovations in the electronics and computer industries have applications in avionics, and technological advances in aircraft R&D (the development of new materials, for example) can be transferred to other manufacturing sectors.

EARLY AIRCRAFT ACTIVITY CLOSELY TIED TO MILITARY AND DEFENSE NEEDS

The Japanese aircraft companies began postwar activities in 1952, concentrating on the service and repair of American military and foreign commercial aircraft. Throughout the 1950s, a number of Japanese companies entered into technical and licensing agreements with U.S. firms to produce a variety of aircraft.

The Aircraft Manufacturing Enterprises Law and the establishment of Japan's Self-Defense Agency in 1954 guided the development and production of the emerging industry. Engine production, for example, was aimed at defense applications and military demand determined overall output.

Civil aircraft production resumes

The passage of the Aircraft Industry Promotion Law in 1958 marked the government's entrance into civil aircraft production. The Nihon Aeroplane Manufacturing Company, Ltd. (NAMCO), a 50-50 joint venture between the government and a number of companies, was established to design and manufacture the YS-11 transport, a 52 to 60 passenger twin turbo-prop jet. The NAMCO arrangement at the time was thought to be the optimal way to provide funds to the aircraft industry. The Japanese believed that if they could produce a technologically competitive airplane, it would be a commercial success. Each company produced airplane parts and Mitsubishi was responsible for assembly. Deliveries began in 1965.

The aircraft, was, in fact, technologically competitive but a commercial failure. This failure marked an important shift in government policy toward the industry. First, MITI

believed that the production and sales of aircraft should be handled by the companies alone; because NAMCO, rather than the participating companies, had been responsible for the YS-11, the companies had no incentive to reduce costs. The government continued to believe, however, that R&D was too large an undertaking for individual or even joint company ventures. Because of the high risks and high costs involved, the government believed that government assistance to industry R&D efforts was warranted and international joint ventures should be encouraged. The marketing failures of the YS-11 reinforced this last point. Japanese companies needed the marketing experience they could gain from successful aircraft companies.

Industry observers believe that the 1958 promotional law establishing NAMCO, although useful at the time, was not very effective in encouraging development of an industry if judged by the criterion of increased aircraft industry production, which in 1980 was only about 280 billion yen. The general goals which arose from these early experiences have guided the government's support of the aircraft industry up to the present. 1/

By the second half of the 1960s, Japanese companies themselves began to develop small business planes, such as Mitsubishi's MU-2 and Fuji's FA-200, based on domestic technology. The industry also began to develop military aircraft, such as the submarine reconnaissance PS-1 and P-2J, and to produce aircraft and engines under license from U.S. manfacturers.

STRUCTURE AND DEVELOPMENT OF TODAY'S INDUSTRY

The Japanese aircraft industry is divided into major segments of airframe and engine producers and a third group of parts and components suppliers. Three companies accounted for 87 percent of the 106 planes assembled in 1979. Mitsubishi Heavy Industries is by far the largest airframe producer, with almost 75 percent of total 1979 production, followed by Fuji Heavy Industries (about 8 percent) and Kawasaki Heavy Industries (about 5 percent). Ishikawajima-Harima Heavy Industries (IHI), Mitsubishi, and Kawasaki are the major producers of aircraft engines. These companies produce a wide range of machinery, and aircraft accounts for only 5 to 10 percent of their sales. By contrast, U.S. and European companies have about 80 to 90 percent of their production in aircraft.

1/ Production of the YS-11 ceased in 1974. A summer 1981 recommendation from the Policy Subcommittee of the Aircraft and Machinery Industry Council, an advisory group to MITI, supported disbanding NAMCO.

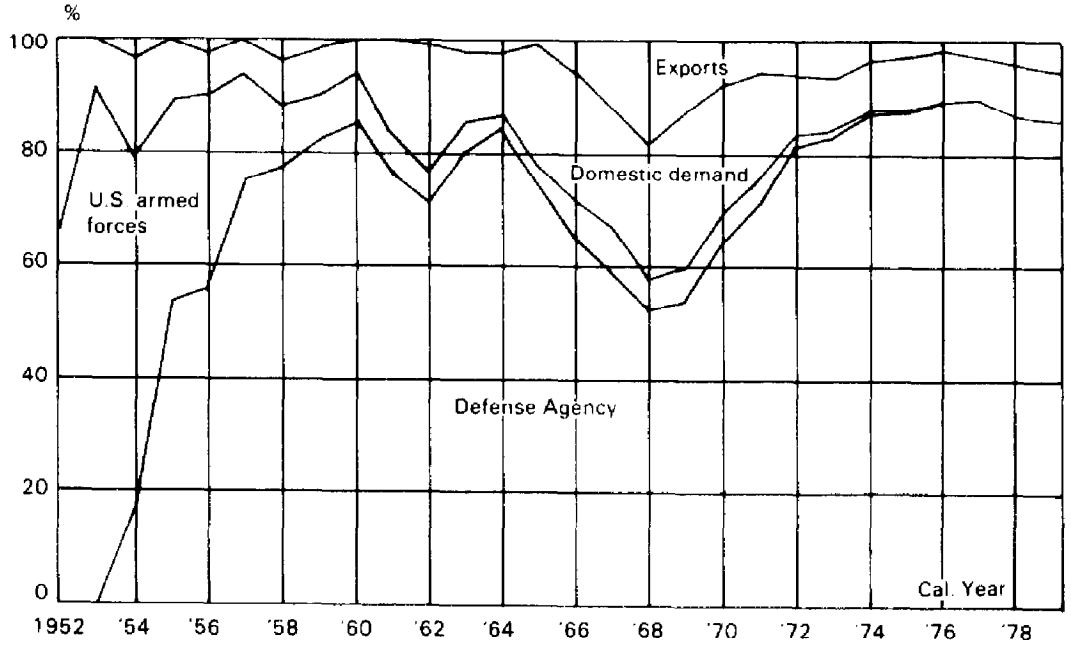
All of the major Japanese companies have or have had licensing and production agreements with U.S. firms. Kawasaki has built a number of U.S. planes since 1953, including Lockheed fixed-wing aircraft and Bell helicopters. Mitsubishi holds license agreements to manufacture Sikorsky helicopters and, in the past, held such licenses for McDonnell Douglas fighter planes. IHI produces engines under license to General Electric, and Mitsubishi produces engines under license to Pratt & Whitney. Domestically produced planes are limited to defense aircraft or small commercial planes, such as Mitsubishi's MU-300 business jet.

The Japanese industry's production profile has had two consequences for the industry's development. According to industry observers, MITI believes the industry can weather fluctuating demand by relying on other production lines and, therefore is not too concerned with providing a stable market. Conversely, because aircraft plays such a small part in company operations, the companies have not aggressively pursued new ventures.

As shown in chart 3, aircraft production is concencentrated in military applications with about 85 percent of annual sales in defense-related aircraft. Government prohibitions rule out military aircraft exports.

Chart 3

Percentage Distribution of Value of Production by Type of Demand (1952-1979)



Source: Society of Japanese Aerospace Companies, Inc.

The government has a great deal of oversight of military production and the companies usually participate under contract. Mitsubishi is frequently the prime airframe contractor for the Self-Defense Agency and handles most of the design work; Fuji and Kawasaki are subcontractors. IHI is prime contractor for engines, with Kawasaki and Mitsubishi as subcontractors.

Civil fixed-wing aircraft produced solely by Japanese companies have been limited to the jointly produced YS-11 and Mitsubishi's MU-2 turboprop and MU-300 fan jet. 1/ Other significant production ventures are being jointly carried out with foreign partners.

INDUSTRIAL POLICY TOOLS FOR THE CIVIL AIRCRAFT INDUSTRY

Advisory councils propel decisionmaking

The functional bureau within MITI responsible for the industry is the Aircraft and Ordnance Division of the Machinery and Information Industries Bureau. As in other industries, a council consisting of members from industry, finance, labor, consumers, etc. advises the government on aerospace issues. The Aircraft and Machinery Industry Council with its Aircraft Industry Committee is one of the most active groups. The Industrial Structure Council has a subcouncil for the aerospace industry which prepares long-range visions for the industry. The Industrial Technology Council (a subcommittee of which has aerospace industry representatives) has provided MITI with recommendations for aerospace R&D projects. The Society of Japanese Aerospace Companies, Inc. is among the most active of the industry groups, representing the industry's interest to the government.

The underlying rationale for MITI's current industrial policies for the aircraft industry began appearing during the mid-1960s. The framework for developing and implementing these policies is similar to that found in other high-technology industries.

A recent MITI plan specifies the importance of aircraft in Japan's industrial structure. Greater domestic production (as opposed to limited subassembly, for example) could increase Japan's stated goal of producing higher value added products. 2/

1/ The engine for this plane, however, is supplied by Pratt & Whitney Canada.

2/ In the defense area, MITI's intentions to increase domestic production are also evident. MITI reportedly pressed to develop defense-related transports because they "offer the last chance for achieving the independent development of domestic planes."

The aircraft industry also fits Japan's familiar practice of targeting linkage and feeder industries--providing demand for a number of related input industries and developing technologies which can spin off to electronics and other machinery industries. The industry needs relatively few natural resources and causes little pollution. Also desirable from the Japanese perspective is a reduction of their aerospace trade deficit. Lastly, aircraft is not an industry in which Japan is apt to face competition from the newly industrialized countries in the near future.

The Law on Extraordinary Measures for the Promotion of the Specific Machinery and Information Industries (discussed in app. I and II), stresses the development of basic indigenous technologies and provides the basis for MITI's support of such projects in the aerospace industry.

MITI's recent financial support has concentrated on providing a portion of the money required by Japanese companies to participate in joint ventures in the research and development stages of projects for new engines and aircraft. These funds have been loaned on a success-conditional basis. In addition, funds have been provided for research in basic technologies with eventual applications for the aircraft industry by government laboratories and agencies and industry associations. Antitrust considerations in Japan allow for joint activities, and consequently the aircraft producers have entered into a number of joint production and R&D arrangements.

Soaring costs and other factors hamper development of new aircraft

The mid-1960s marked a period in which Japan had successfully completed rebuilding its basic industries and began looking toward advanced technology and value added industries. With the cessation of the YS-11 project, the Japanese began exploring alternatives for further projects to develop a significant commercial aircraft. Initial plans for a follow-up project called for developing a small (90 passenger), local transport commercial plane. The advent of wide-body aircraft, however, made development of a larger plane more attractive. The tremendous costs associated with such a project pointed to a joint venture as a means of sharing risk. In addition, the need for marketing and follow-up support made international cooperation attractive to the companies which did not possess worldwide sales and services networks. In the fiscal year 1972 budget, the Japanese Government offered to provide 200 million yen to finance a joint project with those characteristics. The industry association estimates for such a project, however, ran to well over 100 billion yen and the project languished until the agreement to participate with Boeing in developing the 767 went into effect in 1979.

Development of YX Aircraft

The major Japanese airframe effort since the YS-11 has been the YX project, culminating in the Boeing 767 jointly produced by Japan, the United States, and Italy. The germination of the YX project began in 1966 and involved the government, the three major airframe producers, and a number of advisory councils.

In 1966, MITI commissioned the Japan Society for the Promotion of Machine Industry to study the form that a future commercial aircraft should take. In 1967, MITI provided the Japanese Aircraft Industry Association with 20 million yen to research the development of commercial aircraft, and by 1971 the Aircraft Industry Council was considering international joint development projects. The Civil Transport Development Corporation (CTDC) was established on April 1, 1973, to manage, on behalf of government and industry, the YX program to design and develop a civil transport aircraft using the experience of the YS-11. Boeing at that time was the most likely joint venture partner. Japan's Fair Trade Commission approved the CTDC's establishment. The CTDC was capitalized by Mitsubishi, Kawasaki, and Fuji and operating funds were obtained from MITI and other member companies. MITI is not a partner, but the CTDC submits planned activities, budgets, financial statements, etc., to MITI.

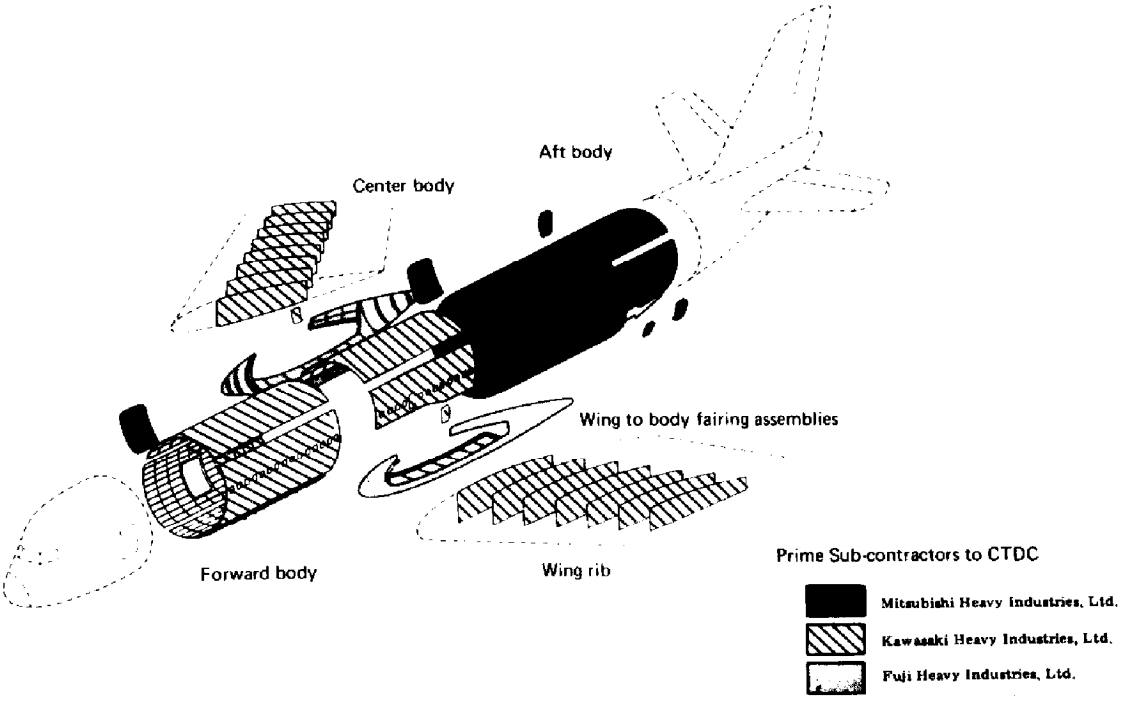
According to CTDC officials, the Japanese chose to participate in the Boeing 767 venture to (1) gain technology which can be transferred to other industries, (2) give Japanese parts manufacturers the experience needed to be internationally competitive, and (3) construct a plane that could be used by Japanese airlines. Pursuit of these goals through an international joint venture was required to diversify the high risks, share the enormous costs, and pool marketing and technological capabilities.

Japan, as represented by the CTDC, has 15 percent of the total Boeing 767 project. The following diagram shows the work shares of the participating Japanese companies. Fuji is responsible, through subcontract to CTDC, for building wing/fuselage body fairings and main landing-gear doors. Kawasaki builds forward and mid fuselage sections and wing ribs, and Mitsubishi the aft fuselage sections. Part of that work has been subcontracted out to other firms, and other Japanese companies are supplying parts under direct contracts with Boeing.

The YX program is expected to end in fiscal year 1982. Because CTDC's responsibility has been limited to the development stage of the project, a separate entity may be formed for actual production of the airplane.

CIVIL TRANSPORT DEVELOPMENT CORPORATION

WORK ALLOCATION FOR THE BOEING 767



Source: Society of Japanese Aerospace Companies, Inc.

The 5-year Japanese development cost is estimated at 33.6 billion yen. Government subsidies reached 14.3 billion yen through fiscal year 1981 and are expected to total 16.8 billion yen. These funds have been granted to CTDC on a success-conditional basis and, with deliveries starting in 1982, negotiations are expected to begin between MITI and the manufacturers on repaying subsidies.

Future generation airframe project YXX

As the YX development project moves into production, MITI and the manufacturers are looking for a new generation aircraft development project, currently referred to as the YXX. The rationale

for entering international joint ventures to develop the Boeing 767 is still applicable. An August 1980 report by the Policy Subcommittee of the Aircraft Industry Department of the Aircraft and Machine Industry Deliberation Council reiterated the government's intention to support joint international development of a civilian transport, most likely a 130- to 150-seater aircraft. According to recent statements by government and industry representatives, the decision on the nature of the next venture and joint venture partners has been postponed. Recent downturns in the airline industry have delayed new orders, and future demand is not clear.

With their performance record on the Boeing 767 project, the Japanese are in a good negotiating position to enter a new joint venture. According to some in the industry, MITI will fund only that part of the next joint venture which is new to Japanese companies and incorporates new technologies and processes, etc. If that position is correct, any new joint venture will involve a much larger Japanese share than did the 767 project in production as well as marketing and sales.

Beginning with the fiscal year 1981 budget, the government has allocated over 350 million yen for research and study into the desirable characteristics of a new joint project. JTDC has designated a subgroup to conduct such studies, but a new, although similar, organization may be created to coordinate any new project. One of the factors that Japan is supposedly considering for a new aircraft project is the incorporation of a Japanese engine.

Engine development has proceeded in conjunction with government assistance

Modern aircraft engine development for civilian transport was begun with MITI's FJR-710 project (Fan Jet Research) in 1971. MITI's Agency of Industrial Science and Technology provided 100 percent of the funding for this 11-year project, whose purpose was to develop technologies for commercial jet engines. Total R&D costs were about 20 billion yen, with fiscal year 1981 funding of 1.9 billion yen and 1980 funding of 2.1 billion yen. The Engineering Research Association for Aerojet Engines was created by IHI (with a 55 percent share in the venture), Kawasaki and Mitsubishi to work with the National Aerospace Laboratory.

The prototype engines developed marked the first all-Japanese commercial engines. However, because Japan lacks high-altitude testing capability, the engines were sent to Britain for testing. The British Rolls-Royce Company was trying to develop a similar engine. These two factors resulted in the RJ-500 joint venture project which began in 1980.

The original RJ-500 project was to take 8 years at a total cost of 140 billion yen, borne equally by Japan and Britain. MITI encouraged the Japanese manufacturers to establish the Japanese

Aeroengine Corporation, Ltd., to represent Japan, with shares divided as follows: IHI 60 percent, Kawasaki 25 percent, and Mitsubishi 15 percent. This Corporation is accountable for the project and provides a central focus for the industry.

Rolls-Royce and the Japanese Aeroengine Corporation, Ltd., are jointly committed to the initial phase of the RJ-500 program, which includes design, testing and prototype production. The government funding will total 4,720 million yen. The RJ-500 project's objective is to conduct an R&D project whose results companies could then apply to produce technologically advanced engines.

The project's goal has been changed from developing an engine to power a 130- to 150-seat aircraft to developing a larger engine; time delays have led to increased cost projections; the Japanese Government does not appear willing to commit more funds, and at least two U.S. producers have expressed interest in participating. All of these factors point to a probable increase in the number of partners in the RJ-500 project.

Support for basic technology enhances industry development

Japan has taken several steps to support the development of basic technologies. The Science and Technology Agency has been working on a short takeoff and landing aircraft (STOL) since 1972. The National Aerospace Laboratory, a government body responsible for R&D in aeronautical and space sciences, began work on an experimental fanjet STOL in 1977. The project is based on a Kawasaki airframe (the C-1) and will use FJR-710 engines. The total cost of the development program is estimated at 23 billion yen. The National Aerospace Laboratory was allotted 3,455 million yen in fiscal year 1981 for this project. Because the project is not directly applicable for commercial purposes, the government has taken both the initiative and the responsibility for it. Private companies have participated under contract. Kawasaki will reportedly receive about 5,244 million yen from the fiscal year 1982 budget to assemble a prototype from its C-1 transport plane. Test flights of prototypes are scheduled from 1983 through 1985. It is hoped that the results of this program will enable the Laboratory to develop a commercial STOL aircraft in cooperation with Japanese industry. Tentative completion has been set for 1990.

The 1978 Law on Extraordinary Measures for the Promotion of Specific Machinery and Information Industries, or Kijoho, provided "enhancement programs" for certain products or processes in order to improve manufacturing technology and productivity. Specific emphasis was given to unexploited technology and leading edge technology industries. Aircraft "qualifies" as a high value added, knowledge-intensive industry in which technological developments will have spillover effects, criteria set out in MITI's plans.

In pursuit of these goals, the Society of Japanese Aerospace Companies, Inc., established the Revolutionary Aircraft Development Center which, with representatives from universities, governments, and manufacturers, decides on R&D themes and then allocates specific projects to individual companies or groups. 1981 marked the first year of operations. Government funding provides 40 to 45 percent of research costs. The Society, with some funding from auto and bicycle racing revenues, performs the administrative functions for the Center.

The projects cover a wide array of R&D themes; those submitted for 1981 fiscal year included

--data processing systems using optical fibers;

--combustion control systems using microprocessors;

--high temperature and high load turbines to establish engine core technology;

--machining processes for lightweight structures; and

--aerodynamic shapes of fuel efficient transonic aircraft.

MITI's project to develop "basic technologies for the next generation industries," begun in 1981, has applications to the aircraft industry. Twelve subjects, determined by MITI's Industrial Technology Council, include the development of new composite materials. These materials are expected to be lightweight, strong, and rigid to resist extreme temperatures. The 8-year project is expected to cost 11 billion yen, and the government will own any resulting technology.

THE ROLE OF INDUSTRIAL POLICY

The development and implementation of industrial policies for the aircraft industry has followed a familiar pattern. MITI determines objectives with the advice and council of manufacturing and other interested groups. Direct funding is provided to associations formed for the purpose of conducting R&D. The development of basic technologies with cross-industry applications is becoming more important as Japan directs its economy up the technology ladder in order to maintain a comparative advantage.

However, there have also been differences in Japan's aircraft policies. Unlike the treatment of many earlier growth industries, commercial policies were not used to protect an "infant" industry. The domestic market alone could not support a Japanese civil aircraft industry. Tax measures have not been directed specifically to the industry, although aircraft manufacturers can use the general accelerated depreciation provisions for R&D equipment.

Conflicts over an appropriate government role in the aircraft industry have occurred within the government, between government and industry, and within the industry. The Ministry of Finance, which has overall budgetary responsibilities, has in the past had a different perspective from MITI about the need to assist the aircraft industry. The government has clearly stated that its proper role is limited to R&D, but the industry feels that more support is required to develop independent Japanese capability. And government objectives have not always had unanimous support from the industry.

The world market for aircraft is such that future demand for large aircraft will probably be supplied with products from international joint ventures. Most analysts believe that there is excess commercial aircraft production and is not likely that one company will undertake total R&D and production of new aircraft. Because of Japan's production to date and its participation in international joint ventures, according to U.S. industry representatives, its aircraft industry will likely have an important role in future international aircraft ventures.

Some analysts have characterized MITI's enthusiasm for the aerospace industry as "moderating over the last few years." The government is not funding manufacturing or marketing and has stressed the limited role it sees for itself in the industry's future. In many industrialized countries, governments have played an important role in supporting an aircraft industry directly and indirectly. In Japan, that support has not yet resulted in the commercial success of a 100-percent Japanese product in a significant segment of the market. Given the probable future demand for new aircraft, it is not likely to do so in the near future. As a joint venture partner, however, Japan has been successful and may be expected to continue in that role in the future.

TEXTILES: EFFORTS TO COPE WITH LONG TERM DECLINE

Segments of the Japanese textile industry have been declining steadily over a period of years due to rising raw materials costs and wage rates, increasing competition from newly industrializing countries, and foreign market import restrictions. As a result, government programs to assist the industry have existed in one form or another without interruption since the 1950s.

The government's long-term strategy has been to focus on shifting resources from uncompetitive segments of the industry into higher value-added sectors, such as apparel; at the same time, efforts have also been made to upgrade existing production facilities and scrap excess capacity. Despite such efforts, the industry continues to face difficulties and it is evident that the Japanese Government will have to continue to address how best to deal with uncompetitive segments of the industry.

STRUCTURE OF THE INDUSTRY

Within the Japanese textile industry, the pattern of growth and decline has varied by type of material and manufacturing process. It is therefore important to understand the basic structure of the industry, which can be broken down into three broad categories:

1. upstream, consisting of man-made fiber manufacturers;

2. midstream, consisting of textile mill products manufacturers; and

3. downstream, consisting of apparel manufacturers, wholesalers and distributors.

Table 4 shows the relative size of these three segments compared with all manufacturing industries in 1978.

Seven large companies 1/ dominate the production of man-made fiber, which includes synthetic fibers (e.g. acrylics, nylon, and polyester) and rayon and acetate. In 1977, for example, these seven accounted for 81 percent of nylon production capacity and 76 percent of polyester capacity.

The midstream sector manufactures textile mill products, using such processes as spinning, 2/ weaving, knitting, twisting,

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1/ Teijin, Toray Industries, Kuraray, Asahi Chemical Industry, Unitika, Mitsubishi Rayon, and Toho Rayon.

2/ Spinning is sometimes included in the upstream segment; however, since it is covered in legislation pertaining to textile mill products, we are including it in this sector.

or dyeing. Most textile mill products manufacturers are small, with many employing less than 20 workers. According to representatives of the Japan Chemical Fibres Association, many firms in this midstream sector do not operate independently; there is a linkage between this sector and the large synthetic fiber producers which install the textile mill products companies' facilities, determine their product lines, and guide their sales operations. This vertical integration accounts for about 50 percent of the production capacity of midstream textile activity. The other 40 to 50 percent of capacity is in the hands of independent mills, and it is these mills in particular that tend to have poor production facilities.

The downstream segment of the industry, composed of apparel manufacturers, is currently the primary focus of government efforts to enhance the textile industry's competitiveness and increase value added.

Table 4

Textile Industry Compared with
All Manufacturing Industries (1978)

	Establishments	Employees	Shipments (million yen)	Production (million yen)	Value Added (million yen)
Textile Mill Products (a)	106,741	866,843	7,236,427	7,214,260	2,707,033
Apparel and Related Products	46,180	547,015	2,763,843	2,768,951	1,240,478
Man-made Fiber Manufacturing	96	43,344	911,054	–	289,771
Total (b)	153,017	1,457,202	10,911,324	–	4,237,282
All Manufacturing (c)	744,337	10,890,121	164,810,378	164,081,506	57,162,452
(a)/(c)	14.3%	8.0%	4.4%	4.4%	4.7%
(b)/(c)	20.6%	13.4%	6.6%	–	7.4%

Source : Ministry of International Trade and Industry

Source: Japan Spinners' Association

CHANGING PATTERNS OF COMPETITIVENESS WITHIN THE INDUSTRY

Over the past three decades, the competitiveness of various segments of Japan's textile industry has varied considerably, affected by changing market demand, raw materials costs, and the increasing challenge from other textile producers.

Overall, the pattern has been one of decline, but one that has varied by type of raw material (natural or man-made fibers) and manufacturing process (yarn, cloth and apparel). As a whole, textiles no longer constitute the significant share of either manufacturing or exports that they did in the early postwar years, although the industry remains an important domestic manufacturer in absolute terms. In 1955, the textile industry accounted for 19.1 percent of all manufacturing industry product shipments; by 1965 it accounted for 11.7 percent, and by 1975 for only 7.8 percent. Textile exports relative to all Japanese exports registered similar decreases over the same period.

The industry in the 1950s

Much of Japan's textile capacity was either damaged or destroyed during World War II, and postwar efforts focused on rehabilitating the industry. By 1951, the value of Japan's textile products exports had exceeded the 1934-36 level, and by 1955 cotton textile exports to the United States increased to the point that Japan accepted "voluntary" export restrictions at the behest of the U.S. Government.

The Japanese Government also promoted the development of man-made fibers. Some assistance to the rayon and acetate segment of the industry had been provided in the prewar years, and reconstruction of that industry began 4 years after the war ended. Synthetic fiber production began 3 years later. A national project was begun in 1952 to train production workers. All of the related programs were in effect until the late 1950s or early 1960s--the nylon training program was discontinued in 1958; vinyl in 1960; polyester in 1961 and acrylic in 1962. The government also secured the necessary raw materials, provided low-interest investment loans through such financial institutions as the Japan Development Bank and the Long-Term Credit Bank, and encouraged public servants to purchase uniforms made from Japanese synthetic fabrics. The Japan Development Bank provided the major portion of the loans for the purchase of facilities and equipment.

Even in the 1950s, however, all was not smooth sailing. Overcapacity in the cotton spinning industry led to efforts beginning in 1956 to control installation of new spindles, an action that was to foreshadow further government measures to deal with persistent overcapacity in the industry in the 1960s.

The 1960s--the shift to synthetics

The 1960s marked a shift from natural to synthetic fibers, as the Japanese industry moved from cotton to multifibers. Between 1963-70 synthetic fiber production jumped from 239,400 to 1,028,000 metric tons, an increase of over 300 percent, while cotton fiber production decreased as a percentage of all fibers

produced domestically. In 1960 the industry produced 758,065 tons of natural fiber yarns and 512,085 tons of manmade fiber yarns; by 1970, natural fiber yarn production had dropped slightly to 746,164 tons, while manmade fiber yarn production roughly doubled to 1,289,613 tons.

The conclusion of the Long Term Arrangement Regarding International Trade in Cotton Textiles 1/ in the early 1960s represented a continued limitation on the growth of Japanese cotton textile exports. This, in effect provided an incentive to expand man-made fiber exports, which did not face similar restrictions.

The limits on Japanese cotton exports gave developing countries the opportunity to establish or expand their own textile industries, thereby presenting Japan with increasing competition in overseas markets. Japan's industry was also becoming less competitive owing to higher domestic manufacturing costs and rising wage rates.

Domestic demand also affected the cotton textile industry; as synthetic fibers become more widely available, Japanese consumers were drawn toward synthetics and away from cotton.

The 1970s--new problems

Changing economic conditions in the 1970s helped to further weaken the competitiveness of the Japanese textile industry. The rapid appreciation of the yen between 1971 and 1973 had a negative impact on Japanese trade. The Generalized System of Preferential Tariffs, implemented by Japan in 1971, provided preferential treatment for imports from developing countries, thus giving these countries better access to the Japanese market. One event which affected only the textile industry was Japan's acceptance of a Voluntary Export Restriction on synthetic fiber exports to the United States. This agreement was negotiated on a government-to-government basis in 1971.

Unlike the textile mill products industries, the Japanese synthetic fiber industry was strong at the time the 1973-74 oil crisis began. That industry had grown over a period of 30 years to become one of the largest in the world, second only to that of the United States. According to information from the U.S. Embassy in Tokyo, the industry's production capacity grew at a compound annual rate of 12 percent between 1969-73. Actual production increased at a compound rate of 13 percent, led by a 22 percent compound growth rate in exports. Korea, Taiwan, and Hong Kong were the fastest growing export markets for Japanese fibers at that time.

1/ The Long Term Arrangement, later replaced by the Multifiber Arrangement, governed textile trade between major textile exporting and importing countries from Oct. 1962 to Dec. 1973.

Following the oil crisis, the synthetic fiber industry experienced a sudden, substantial drop in domestic demand. Initially, increased exports served as a buffer, as the synthetic fiber export ratio moved from 37 percent of production in 1973 to 51 percent in 1975. By 1977, however, exports also contracted as the Japanese industry lost its comparative advantage. The loss can be attributed to a number of factors, including

--the prices of domestically produced synthetic fiber raw materials, which the Government held higher than the world price;

--increased competition from the Southeast Asian countries, which had become either self-sufficient or net exporters;

--sluggish world demand for synthetic fibers; and

--the rapid appreciation of the yen.

Japan has thus had to deal with a long-term gradual decline of various segments of the textile industry, traceable from the problems of the textile mill products sector to the difficulties encountered by the synthetic fiber industry.

GOVERNMENT AND INDUSTRY RESPONSE

As segments of Japan's textile industry have declined, the government has stepped in with measures designed to help the industry in adjusting. As noted in one study of the textile industry's adjustment process, 1/ these measures were generally designed to deal with a number of problems, including overcompetition among domestic textile firms, excess production capacity, and the loss of international competitiveness. MITI, which is responsible for developing government policy toward the textile industry, has attempted to alleviate these problems by helping firms to scrap old equipment, accelerating the shift of workers out of the industry, trying to reduce the number of firms through horizontal and/or vertical groupings, and encouraging uncompetitive firms to shift into other economic activities. These efforts have been aimed at helping the industry to realize economies of scale, cut production costs, regain competitive advantage, and improve profit and wage rates.

Legal basis for assistance

The government has passed various laws since the mid-1950s to help segments of the textile industry cope with the problems.

1/ Yoshie Yonezawa, Analysis and Evaluation of the Adjustment Process and Policies of Japanese Textile Industry (Japan Economic Research Center, 1981).

The Textile Act of 1967 and the Textile Act of 1974 1/ were designed to deal with longer term problems of the industry. The former law, in force until 1974, focused on specific textile mill products sectors and emphasized scrapping of surplus equipment, modernizing equipment, and encouraging horizontal mergers. The Textile Act of 1974, which has been extended to 1984, highlights assistance to the apparel sector and also advocates the development of new technologies and vertical integration of firms.

Other legislation has been enacted to cope with short-term problems; for example, the Temporary Textile Act in effect from 1971 to 1973 was designed to assist firms hurt by voluntary restraints on exports to the United States.

In addition, there are comprehensive policies designed to assist industrial firms in general; e.g., the Act for the Promotion of Rationalization by Enterprises, the Act for the Modernization by Small and Medium Enterprises, and the Act for the Joint Activity by Small and Medium Enterprises. The former two acts are long-term and are designed to help improve production; the latter act provides the framework for short-term action, such as formation of recession cartels.

More recently, the government enacted legislation specifically designed to deal with industries considered "structurally depressed." Synthetic fibers was one of the industries so classified under the Structurally Depressed Industries Law passed in May 1978, and certain measures were implemented under the law to restructure the industry.

Chart 4 depicts the myriad laws and agreements affecting the textile industry during the postwar period.

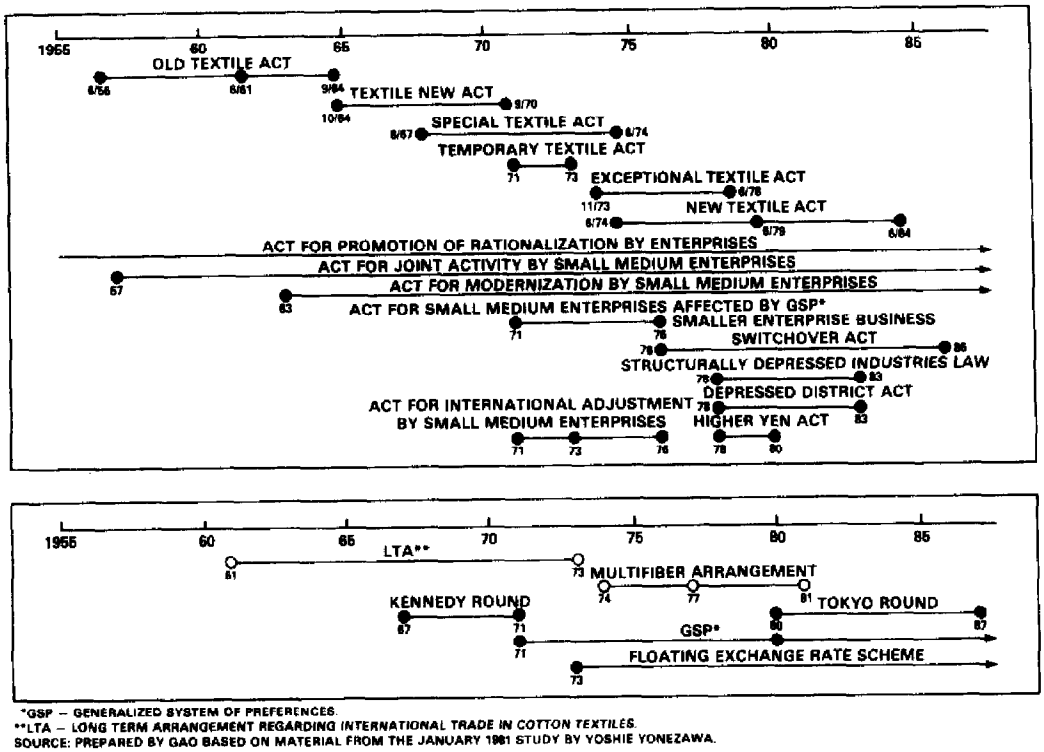
Programs to assist textile mills

Initial efforts by the government to deal with overcapacity in the spinning industry--essentially limiting spindle installation under laws passed in 1956 and 1964--were followed by a major policy starting in the mid-1960s to rationalize and modernize the midstream segment of the industry. A series of scrapping programs was instituted to reduce capacity, and preferential financing and tax incentives were provided to encourage equipment modernization. Firms that scrapped equipment had access to low-interest loans, and in one instance the government paid outright for the scrapping of some equipment in order to ameliorate the impact of the Voluntary Export Restriction agreement concluded with the United States in 1971.

1/ The Textile Act of 1967 is also referred to as the Act for Temporary Measures for Structural Improvement of Specific Textile Sectors, or the Special Textile Act; similarly, the Textile Act of 1974 is also cited as the New Textile Act.

Chart 4

Chronology of Actions
Affecting the Textile Industry



*GSP – GENERALIZED SYSTEM OF PREFERENCES.
**LTA – LONG TERM ARRANGEMENT REGARDING INTERNATIONAL TRADE IN COTTON TEXTILES.
SOURCE: PREPARED BY GAO BASED ON MATERIAL FROM THE JANUARY 1981 STUDY BY YOSHIE YONEZAWA.

Scrapping efforts not totally successful

The scrapping programs implemented during the period covered by the Textile Act of 1967 (roughly 1968-74) did not meet with uniform success. Although accounts vary as to the actual number of spindles scrapped by the spinning industry, there is general agreement that the results fell short of intended targets. Yonezawa's study of the textile industry (see p. 49) noted that the number of spinning machines (spindles) was supposed to have been reduced by 2.62 million but, in fact, this number increased by 204,000 spindles. Similarly, the government planned to dispose of 116,000 weaving machines for cotton, spun rayon, silk, and rayon. The actual number scrapped was only 26,000. Overall, Yonezawa found that government efforts to assist these

industries enjoyed only mixed results--the economic condition of the designated knitting, dyeing, and finishing mills was improved but efforts to assist the spinning mills were not successful. 1/

Industry representatives also acknowledged that the programs administered under the Act were not totally successful. Officials from one industry association blamed imports from less developed countries as well as the government's reluctance to impose import restrictions as major factors in the failure of the rationalization efforts. Other problems, though, were caused by the companies themselves who undermined the scrapping efforts by simply mothballing the equipment for reuse as business conditions improved.

Government efforts to encourage the merging of like firms were also not very successful. For example, only about 350 of the 10,000 or so knitting mills in existence in the late 1960s participated in this effort and formed 50 larger mills.

Use of cartels to adjust production

The spinning industry also formed a series of recession cartels during 1965-67, 1975, 1977-78 and May-September 1981 to cut production and increase prices. These cartels are not designed to cope with long-term restructuring, but rather with short-term price and production problems. To accomplish this, supply is artificially restricted in a period of low domestic prices in order to force up the price. Japan's Fair Trade Commission, along with MITI, will monitor the progress of a cartel and if prices recover, will refuse to grant the cartel an extension. According to Japan Chemical Fibres Association officials, the latest cartel lasted only 4 months because the Commission determined that the position of the spinning industry was improving.

More recent scrapping efforts

The most recent scrapping efforts occurred from 1978 to 1980, when various midstream industries scrapped between 10 and 20 percent of their production capacity, as shown in table 5.

Funding for this program was provided by the Small Business Finance Corporation in the form of 16-year, no-interest loans. According to MITI officials, under the Small- and Medium-Sized Enterprises Law, companies formed industry associations which purchased and then scrapped equipment and facilities. Representatives from one industry association indicated that their joint

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1/Yoshie Yonezawa, Analysis and Evaluation of the Adjustment Process and Policies of Japanese Textile Industry (Japan Economic Research Center, 1981).

scrapping association has placed 40 percent of these loans into interest-bearing accounts in order to finance repayment of the loans.

Table 5

Textile Industry Joint Scrapping Efforts, 1978-80

Industry	Total scrapped	Equipment scrapped as percent of total capacity	Funds used to purchase scrapped (note a) equipment (¥ billion)
1) Short fiber spinning	1,040,000 spindles	11	23.9
2) Wool spinning	220,000 "	10	5.0
3) Twisted yarn manufacturing	1,480,000 "	16	17.4
4) Bulk yarn manufacturing	80,000 "	14	10.9
5) Cotton weaving	56,000 units	20	26.6
6) Man-made long fiber weaving	19,000 "	12	9.7
7) Wool fabrics	8,000 "	12	5.3
8) Knitting	23,000	19	36.6
9) Other	--	--	32.9
		Total	168.3

a/ Industry associations received these funds from the government to purchase and scrap equipment.

Source: Japan Chemical Fibres Association

Adjustment efforts by the synthetic fiber industry

As noted earlier, Japan's synthetic fiber industry maintained a healthy growth record during the 1960s and early 1970s, but by 1978--largely owing to the effects of the oil crisis--that industry had joined the ranks of structurally depressed industries in need of government assistance. A cartel was formed to cope in the short term with price and production problems; later, scrapping efforts taken under the Structurally Depressed Industries Law were designed to help the industry adjust permanently to changing domestic and international conditions.

Forming a recession cartel

By 1977, synthetic fiber industry representatives and government officials began exploring ways to help the slumping industry. The presidents of 10 synthetic fiber companies and MITI formed a President's Forum to look at the state of the industry and to develop a survival plan. As the end of 1977 approached, companies within the industry still were not able to agree on an approach. In October, MITI decided to take a stronger role and urged the industry to limit the production of nylon and

polyester filaments and polyester acrylic staples to 70 or 80 percent of capacity. According to information provided by the U.S. Embassy in Tokyo, this production cutback was not cleared with the Fair Trade Commission and, as a result, controversy erupted as to its legality. In spite of this, the cutbacks lasted for 6 months under MITI's guidance and reportedly helped to firm up prices for nylon and polyester yarn.

By April 1978, most of the major synthetic fiber producers had agreed to form a cartel to regulate production. Consequently, a 3-month, legally sanctioned recession cartel was formally organized at that time, then subsequently extended through 1978 and finally terminated at the end of March 1979.

Government and industry develop scrapping plan

The synthetic fiber industry was designated a depressed industry under the 1978 Structurally Depressed Industries Law, which basically enables companies to undertake joint scrapping activities and exempts them from the Antimonopoly Law. The law requires that the appropriate government agency (in this case MITI) draw up a basic stabilization plan for the designated industry. MITI's plan for restructuring the synthetic fiber industry called for equipment to be scrapped or mothballed as follows.

	Planned capacity reduction (metric tons)	Reductions as % of total capacity
Nylon filament	71,500	19.5
Acrylic staple	73,200	17
Polyester filament	36,800	10.5
Polyester staple	67,600	17

Source: U.S. Embassy, Tokyo.

The plan suggested that scrapping be completed by the end of January 1979 and mothballing continue until March 1981.

The joint scrapping effort was carried out within the Japan Chemical Fibres Association. The Association has committees broken down by type of fiber, and each committee decided how much its member companies should scrap. According to one company representative, these company-specific decisions on how much equipment to scrap were based on two major factors--the company's existing production capacity and its share in the domestic and international markets.

This effort, coupled with the earlier measures taken under the recession cartel, did result in lowering synthetic fiber production capacity, although not at the levels envisioned under the stabilization plan. For one thing, the plan called for equipment to be scrapped or mothballed and it now appears that not enough equipment was scrapped. According to one synthetic fiber producer, the companies actually mothballed two-thirds of the equipment and only scrapped one-third, with the idea of using the mothballed equipment as demand picked up. Even though production capacity increased slightly between 1979 and 1980, by late 1981 the companies were reportedly beginning to scrap the mothballed equipment as well, and the capacity reduction program has in fact been extended until March 1983 to accomplish further scrapping. Table 6 illustrates the changes in the industry's capacity on a daily basis between December 1978 and December 1980.

Table 6

Changes in Synthetic Fiber Production Capacity

	Daily production, metric tons				
Type of fiber	Dec. 1978	Dec. 1979	% cutback (compared to 1978)	Dec. 1980	% cutback (compared to 1978)
Nylon filament	1,028	839	18.4	872	15.2
Acrylic staple	1,243	1,074	13.6	1,102	11.3
Polyester filament	1,039	977	6	1,033	0.6
Polyester staple	1,092	907	16.9	937	14.2

Compiled from data provided by the Japanese Federation of Textile, Garment, Chemical, Distributive and Allied Industry Workers' Unions (Zensen Domei)

In its publication, Man-Made Fibers of Japan 1980/1981, the Japan Chemical Fibres Association suggests the industry may need to make more adjustments in the face of increasing raw materials costs, a deteriorating export environment, and the slump in domestic demand.

Employment adjustments

The Japanese economy has mechanisms for enabling industries to make large-scale adjustments in employment. (See app. 5 for a discussion of employment adjustment in the shipbuilding industry.) Workers are entitled to benefits under a variety of employment assistance programs, but, when able, the companies themselves take the lead in helping their excess workers adjust.

As shown in table 7, textile industry employment grew in the 1960s, but by 1975 had started to drop off, a decline that was to accelerate by the end of the decade. According to statistics compiled by Zensen Domei, (the labor union representing textile workers), the textile workforce, including hoisery and apparel, decreased by approximately 323,000, or 25.3 percent from April 1974 to April 1980. The decline in certain segments of the industry over that same period was even more dramatic; employment in the cotton spinning industry dropped over 47 percent while the chemical industry registered a 43.6 percent decrease.

Table 7

Textile Industry Employment

Industry	1960	1965	1970	1975	1977
	(000 omitted)				
Textile mills	1,264	1,327	1,264	996	892
Silk reeling	46	35	26	18	14
Spinning mills	297	277	255	155	134
Twisting and texturizing	60	69	70	53	48
Woven fabric mills	477	471	392	299	263
Knitting mills	113	174	215	203	194
Dyeing and finishing	156	168	163	148	133
Others	116	133	143	119	106
Apparel and other finished products manufacturing	210	311	414	531	529
Man-made fibers	76	82	72	63	50
Rayon	54	31	16	10	9
Acetate	2	3	2	-	-
Synthetic fibers	20	49	54	52	41
Total	1,551	1,720	1,750	1,589	1,470

Source: Japan Chemical Fibres Association

During the greatest period of decline, other expanding industries, such as automobiles, were able to absorb many of the excess workers. For example, the cotton spinning industry was hit particularly hard because it is more labor-intensive than the synthetic fiber industry; in the mid-1970s, spinning workers in Nagoya, the city most affected by the industry's decline, were able to find jobs at a nearby auto plant. MITI officials told us they did not trace the movement of the labor force to determine where the displaced workers went, but they indicated that since

many of these workers were women, they probably went into one of the service industries or dropped out of the job market altogether. In the textile industry, women account for about 71 percent of the workforce as a whole, and they represent a similar percentage of all textile workers displaced between April 1974 and April 1980.

The cost of textile industry assistance is difficult to determine

The textile industry has received direct and indirect subsidies through a variety of general as well as industry-specific programs. As a result, it is difficult to calculate a "bottom line" cost figure. According to figures compiled by Yonezawa, cumulative government fiscal expenditures to aid the textile industry, excluding interest rate subsidies, reached almost 49.5 billion yen from 1956 through the end of fiscal year 1978. 1/

OBSERVATIONS AND ASSESSMENT

The textile industry and the Japanese Government are continuing to grapple with the problem of assisting this declining industry. The textile mill products and synthetic fiber industries continue to face problems in the domestic and international markets, even though efforts have been made to rationalize these sectors.

The government's strategy for dealing with the industry contains both phaseout and modernization elements. According to one Japanese economist, the Textile Act of 1974 declares more clearly the need for the Japanese textile mill products industry to convert to other economic activities than did the Textile Act of 1967. The textile subcommittee of the Industrial Structure Council presented its recommendations on how the industry could be revitalized. The Council suggested that the industry

--increase its vertical integration,

--become more consumer-oriented,

--emphasize the importance of the apparels sector, or

--shift into other activities when appropriate.

This essentially two-faceted approach--encouraging the development of a more efficient, higher value added industry and also advocating a conversion to other industrial activities--is not easy to achieve. Government officials acknowledged that it is

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1/ Yoshie Yonezawa, Analysis and Evaluation of the Adjustment Process and Policies of Japanese Textile Industry (Japan Economic Research Center, 1981).

politically difficult to declare that an industry, or segments of an industry, should be phased out. Even though MITI may want to phase out the cotton spinning or textile mill products industries, it cannot present such a recommendation to the industry. MITI officials explained that this is why the government has instituted measures aimed at revitalizing the industry, while at the same time trying to lure these firms into other industries or into other more promising sectors within the same industry. MITI officials explained this is all part of the bargaining process--to get firms and workers to shift out of the industry, the government has to offer the industry a comprehensive assistance plan that includes measures to encourage modernization as well as phaseout.

MAINTAINING A COMPETITIVE SHIPBUILDING INDUSTRY

The Japanese shipbuilding industry, following a period of relatively sustained growth during the 1950s and 1960s, faced a rather abrupt change in fortune as a result of the 1973-74 oil crisis. Unlike the textile industry, which has experienced a slower, steadier erosion of comparative advantage over a period of years, the shipbuilding industry was forced to adjust to a drastic worldwide drop in demand for ships, notably tankers. The Japanese industry was by then launching roughly 50 percent of the world's new shipping tonnage, so it was particularly hard hit.

The Japanese Government employed a series of measures to enable the industry to adapt to these changed economic circumstances. A scrapping program was instituted to reduce shipbuilding capacity; shipbuilders agreed to temporary production cutbacks; and the government helped to generate demand for new vessels. The industry rationalization program appears to have achieved some success in enabling the industry to scale back production in the face of a shrinking world market. It remains to be seen, however, whether these efforts will sustain the industry's ability to meet growing competition from such countries as Taiwan and Korea.

POSTWAR DEVELOPMENT OF THE INDUSTRY

In the years following World War II, Japan focused on rebuilding basic industries considered central to economic reconstruction and development. The shipbuilding industry was one of those industries accorded priority, and the government instituted a number of measures to encourage the industry's growth.

As early as 1947, Japan embarked on a "planned shipbuilding" program. The government announced annual ship tonnage to be constructed under the plan, and those shipyards selected to construct the vessels were then provided with loans from the Japan Development Bank at highly favorable terms; ship purchasers also had access to favorable financing from the Japan Development Bank. This program provided the industry with a stable source of demand and in the 1950s and 1960s accounted for a significant portion of all ships built in Japan for the domestic market.

Government support was by no means limited to arranging favorable loans to shipbuilders. The industry had access to significant tax benefits, including special depreciation allowances and incentives to invest in developing overseas markets. To encourage demand, interest rates were subsidized for shipping companies in Japan to purchase Japanese ships. Perhaps of key importance were the measures employed to encourage exports, notably the financing provided by the Japan Export-Import Bank and the more unusual "link trading" arrangement. Under the latter scheme, shipbuilders were licensed to import raw sugar, which, because of the then-prevailing exchange and import restrictions,

could be sold at a lucrative profit on the domestic market. These profits in effect subsidized the shipbuilders' exports of ships.

The shipbuilding industry's access to advantageous financing and other government support, coupled with the availability of relatively low-cost steel and labor, the major cost components in ship construction, contributed substantially to the industry's rapid growth and strong competitive position. In the space of two decades Japan had become the world's lowest cost producer of ships and by the mid-1960s was launching close to 50 percent of all shipping tonnage constructed worldwide. (See table 8.)

Table 8

Launching of New Shipping Tonnage

Year	Worldwide (note a)	Japan	Percent launched by Japan
	(gross tons)		
1963	8,538,513	2,367,353	27.7
64	10,263,803	4,085,190	39.8
65	12,215,817	5,363,232	43.9
66	14,307,202	6,685,461	46.7
67	15,780,111	7,496,876	47.5
68	16,907,743	8,582,970	50.8
69	19,315,290	9,303,453	48.2
70	21,689,513	10,475,804	48.3
71	24,859,701	11,992,495	48.2
72	26,714,386	12,865,851	48.2
73	31,520,373	15,673,115	49.7
74	34,624,410	17,609,276	50.9
75	35,897,515	17,987,322	50.1
76	31,046,859	14,310,286	46.1
77	24,167,025	9,943,064	41.1
78	15,406,752	4,921,129	31.9
79	11,787,960	4,317,017	36.6

a/ Excludes the People's Republic of China, Romania, and the Soviet Union.

Source: Lloyd's Register of Shipping Statistical Table, 1980

The industry in the 1970s

The 1973-74 oil crisis precipitated a drastic worldwide drop in demand for ships in general and the collapse of the world tanker market. New building orders worldwide plummeted from 72.8 million gross tons in 1973 to 13.8 million gross tons in 1975, roughly 81 percent over this 2-year period.

To appreciate how severely the Japanese shipbuilding industry was affected by this drastic drop, it is useful to understand the nature of the world shipbuilding industry and Japan's position in that industry. The Japanese shipbuilding industry relies heavily on exports and is therefore particularly vulnerable to changes in the world demand for vessels. This world demand is derived from the shipping industry. In turn, the demand for shipping depends on the volume of trade and on the world gross national product. The size of, and changes in, the demand for shipbuilding are thus influenced by worldwide economic trends and growth.

Shipbuilding demand has certain characteristics that make it susceptible to fairly wide fluctuations. The annual requirement for new vessels is derived from the difference between the stock of ships the shipping industry holds and the necessary tonnages, which must be projected using the above economic factors. A period of 2 or 3 years is normally required from the time a shipbuilding order is received until construction is completed. Fluctuations in the factors that determine the demand for ships, the long service life of ships, and the long lead time between placing orders and taking delivery can produce large swings in the demand for new ships.

During the early 1970s, a great many speculators were ordering ships, including tankers, because they assumed the demand for oil and other commodities would increase. When the oil crisis hit, shipping companies found they had contracted for too many tankers, so they canceled some of their orders. Contracts on bulk carriers were also canceled due to the worldwide recession that followed the oil crisis. According to one Japanese shipbuilding industry representative we spoke with, Japanese shipbuilding companies lost a lot of money on these canceled contracts because they were forced to sell the vessels in a very soft market at much lower prices than those contracted for.

Because of the 2 to 3 year lag between the placement of orders and ship completions, the full impact of the oil crisis was not immediate; the shipbuilding industry actually "bottomed out" during 1978 and 1979. Japan launched nearly 18 million gross tons in 1975; by 1979, launchings had fallen to approximately 4.3 million gross tons, a drop of 76 percent. At the same time, Japan's share of new ship orders dropped from roughly 35 million gross tons in 1973 to 3.65 million gross tons in 1978, registering a decrease of almost 90 percent.

GOVERNMENT AND INDUSTRY RESPONSE

The 1973-74 oil crisis and the recession that followed severely affected the Japanese economy and caused structural recessions in several major industries, including shipbuilding. Government and industry worked together to develop and implement programs to help the shipbuilding industry restructure itself and adapt to the changed economic environment.

Developing a plan to assist the industry

Although initial efforts were made to cope with the effects of the oil crisis--shipbuilding capacity utilization was adjusted downward for fiscal years 1977 and 1978--by 1978 it had become increasingly apparent that the industry was facing a structural depression and would require more drastic measures to recover.

During this period, after the Standing Committee on Transportation solicited opinions from shipbuilding industry associations and other industry representatives, the Diet adopted a resolution recommending that the government

--support measures for structural improvement to stabilize shipbuilding operations;

--develop measures to create demand for ships; and

--design measures to improve the employment situation.

In response to the Diet's recommendations, the Ministry of Transport asked the Shipping and Shipbuilding Rationalization Council, an advisory body, to make specific recommendations for rationalizing the industry. The Council, which consists of scholars, labor officials, and industry representatives, made its assessment and presented it in July 1978. The Council concluded that the volume of new construction of Japanese-built ocean-going vessels would never return to the high levels achieved before the oil crisis. It predicted that construction volumes would decrease until 1980, then begin a slight upturn, with the volume of new construction estimated to reach 6.4 million compensate gross registered tons (CGRT) in 1985. In contrast, the aggregated total building capacity of those facilities capable of building vessels 5,000 gross tons or above was 9.8 million CGRT, which would leave a surplus capacity of 3.4 million CGRT by 1985.

To alleviate this supply/demand imbalance, the Council recommended that this excess capacity be scrapped and that special financing measures be provided to small- and medium-sized enterprises to assist them in disposing of surplus building facilities. The Council also suggested that capacity reductions might not be sufficient to resolve the supply/demand imbalance, so demand creation and adjustments in operating levels might also be required.

Implementing capacity cutbacks

In August 1978, one month after the Council issued its recommendations to the Ministry of Transport, shipbuilding was designated one of the structurally depressed industries to be covered

in the Structurally Depressed Industries Law. 1/ The basic plan for the shipbuilding industry was to be the one recommended by the Shipping and Shipbuilding Rationalization Council--to scrap 3.4 million CGRT, or approximately 35 percent, of the production capacity of those shipbuilders equipped with building berths or docks for the construction of vessels of 5,000 gross tons or more.

Various sources indicate that industry and government had difficulty reaching an agreement on how the plan should be carried out. Large and small firms disagreed as to which should bear the burden of capacity reductions. The smaller firms claimed the larger firms could afford to bear a greater portion of the burden, while the larger firms felt all should suffer equally. The larger firms also disagreed among themselves as to the appropriate mix of capacity reductions. One industry representative we spoke with noted it was difficult to reach a consensus because the plan called for the seven major companies (Mitsubishi, IHI, Kawasaki, Hitachi, Mitsui, Sumitomo, and Nippon Kokan) to become guarantors of government loans to the industry and to help in the loan repayments, even though these seven would receive no government assistance.

Nevertheless, the proposed rationalization plan went into effect in 1979, with capacity cutbacks to be completed by March 1980. Capacity cutbacks were determined based on categories of shipbuilders; altogether, 61 firms participated. This scrapping program was developed within two industry associations--the Shipbuilders' Association of Japan and the Cooperative Association of Japan Shipbuilders. These associations represent all but the smallest ship and boat manufacturers, who were not included in the rationalization plan. Table 9 shows the capacity cutback plan.

To accomplish the objectives of the rationalization plan, the government assisted the smaller firms but not the seven major shipbuilders. The government felt that these companies would be financially capable of handling the cutbacks themselves and of shifting resources into other industrial activities within their own companies. For smaller firms that were to cut back, the Ministry of Transport set up the Designated Shipbuilding Enterprises Stabilization Association, which was administered by the two industry associations. The Stabilization Association purchased nine shipyards, with a total aggregate building capacity of 490,000 CGRT, at a cost of 36.8 billion yen. To finance these purchases, the Stabilization Association obtained loans from the Japan Development Bank and various commercial banks and raised 2 billion yen--1 billion from the government and 1 billion from private sources.

1/ This law, passed in May 1978, is slated to expire June 30, 1983.

Table 9

Disposal of Surplus Shipbuilding Facilities

Category of builders (% capacity cutbacks)	Planned stablization (CGRT) Before disposal	Planned stablization (CGRT) Planned disposal	Actual disposal (CGRT) (% Achievement) (note a)
	(000 omitted)		
7 major (40 percent)	5,690	2,280	2,240 (98)
17 quasi-major (30 percent)	2,890	870	1,040 (120) (note b)
16 medium (27 percent)	790	210	250 (119) (note b)
21 others (15 percent)	400	60	50 (83) (note b)

a/The capacities reduced are based on the facilities disposed of in terms of the number of docks or berths and corrected by compensating for reductions in individual capacities, installation of new less-than-5,000-gross ton class facilities and disposals by groups.

b/Figures in parantheses take into account disposals by the nine companies whose surplus facilities were purchased by the Designated Shipbuilding Enterprises Stabilization Association.

Source: Based on information from the Ministry of Transport and the Shipbuilders' Association of Japan.

The Stabilization Association was responsible not only for purchasing facilities and equipment from shipbuilders, but also for selling these items. The money received through the resale of land and equipment is to be used to help pay back the loans. The remainder of the repayment will be provided by all of the companies involved in the cutbacks, including the seven major companies. To ensure repayment, the shipbuilders are required to place 1.3 percent of the contract price of each new vessel into a fund administered by the Stabilization Association.

In addition to implementing the above system, the government established the Depressed Industries Credit Fund in July 1978. The Fund, whose creation was authorized under the Structurally Depressed Industries Law, has been used to guarantee private loans to depressed industries. These guarantees were considered necessary because long-term loans normally require plant and

equipment as collateral, which would hinder the companies' scrapping efforts. Of the 23 billion yen in guarantees made by the latter part of 1981, 14.2 billion yen, or almost 62 percent, had reportedly been used by the shipbuilding industry alone.

Demand creation efforts

The restructuring plan developed by the Ministry of Transport called for increasing the demand for Japanese vessels as well as reducing existing production capacity. Consequently, the government established a goal of constructing 3 million gross tons of new commercial shipping under a 3-year shipbuilding program beginning in fiscal year 1979. To meet that goal, the government agreed to finance a portion of the construction cost of each new vessel with long-term loans at low interest rates. Moreover, for certain types of vessels, the government subsidized a portion of the interest payments on such loans. To further boost demand, the government accelerated the replacement schedule for government-owned vessels. Shipbuilders also benefitted from the extension of Japan's territorial limits to 200 nautical miles, which increased government demand for patrol vessels. The value of ship orders placed by the Defense Agency and the Maritime Safety Agency totaled about 104 billion yen in fiscal year 1977, and reached roughly 137 billion yen in fiscal year 1978.

The government also introduced a program to encourage the scrapping of existing ships. The Ship Disposal and Scrapping Promotion Association was set up in December 1978 to provide subsidies for the disposal of ships at 2,500 gross tons or above; subsidies granted by the Association (for example, approximately 1,700 yen per gross ton for ocean-going vessels) are financed by the government and the private sector.

More needed to be done: forming a recession cartel

The above measures proved insufficient to close the supply demand gap. As a result, the Ministry of Transport recommended that a number of the shipbuilding companies involved in the scrapping program adjust operating levels downward in fiscal year 1979 and 1980 to an average 39 percent of each company's peak year output. Because of concern that such cooperative efforts by the industry would constitute a violation of the Antimonopoly Law, the companies involved formed a recession cartel (permissible under the Antimonopoly Law) in August 1979 to carry out the reductions. Japan's Fair Trade Commission formally approved an extension of the cartel through fiscal year 1981, with operating levels raised from 39 percent to 51 percent as shown in table 10.

Adjusting employment in the industry

The contraction of shipbuilding demand in the latter half of the 1970s produced a corresponding need to make adjustments in the

Table 10

Shipbuilders' Recession Cartels

	1979 (Fiscal Year)	1980 (Fiscal Year)	1981 (Fiscal Year)
Participants	(A) 7 Majors	(A) 7 Majors	
	(B) 16 Upper Middle Class	(B) 17 Upper Middle Class (including one new participant)	
	(C) 16 Lower Middle Class	(C) 11 Lower Middle Class (5 dropped as a result of facilities cutback)	
Total Participants	39 Companies	35 Companies	
Percent (Average) of Annual Output in Peak Year	39%	39%	51%
Duration of Cartel	Recession Cartel of FY 1979~80 (Approved on Aug. 1, 1979)	Existing Cartel (Approved on Apr. 1, 1980)	Mar. 31, 1981 Recession Cartel of FY 1981 Apr. 1, 1981 Mar. 31, 1982

Source: Shipbuilders' Association of Japan

labor force. In fact, shipbuilding industry employment declined rapidly in a relatively short timeframe. As shown in table 11, total workers, including subcontractors and allied industry employees, declined from 361,000 workers in 1974 to 228,000 in 1979, a decrease of 36.8 percent over this 6-year period.

One fairly recent study on adjustment in the Japanese shipbuilding industry 1/ ascribes this relatively rapid decrease at least in part to the flexibility of the workforce due to the widespread use of subcontractors; between 1974-79 this group experienced a 53 percent reduction compared with 35 percent for regular employees and 24 percent for workers in allied industries. The study also notes that the industry's labor mobility may also be explained by the fact that shipbuilding workers have been losing comparative advantage in wage rates relative to their counterparts in other industries.

Both the private sector and government took action to ease the adjustment process. The firms made efforts to retrain and relocate workers; the government instituted employment adjustment programs to aid workers from depressed industries.

1/ Yoshie Yonezawa, Adjustment in Japanese Shipbuilding Industry and Government Shipbuilding Policy (Japan Economic Research Center, 1980).

Table 11

Shipbuilding, Subcontractor, and Allied Industries Workforce

Classification	Time					
	1974	1975	1976	1977	1978	1979
	(Year-end)					
Shipbuilding Industry	184,000	183,000	175,000	164,000	137,000	120,000
Subcontractors	90,000	74,000	69,000	52,000	39,000	42,000
Allied Industries	87,000	83,000	81,000	80,000	71,000	66,000
Total	361,000	340,000	325,000	296,000	247,000	228,000

Source: Japan Confederation of Shipbuilding & Engineering Workers' Unions (Zosen Juki Roren)

Private sector assists displaced workers

According to one Japanese economist we spoke with, it is Japanese firms, not the government, that take primary responsibility for shifting their workers into other industrial activities when necessary. Larger firms have tried either to shift workers into other lines of work within their companies or to place their excess workers in other firms.

The IHI case illustrates the number of measures used by the company to adjust to declining employment needs in its shipbuilding facilities. IHI

--instituted a mandatory early retirement program for workers aged 55 to 59;

--developed plans for shifting workers into other groups within the company;

--retrained some workers to build jet engines;

--shifted others to the nuclear power division; and

--arranged temporary transfers to an auto plant during the height of the recession (1977-79).

Ministry of Labor employment adjustment programs

To provide employment adjustment to workers in industries for which the government recommended production capacity cutbacks, the

Law for Temporary Measures for the Unemployed in the Designated Depressed Industries was enacted. A second law--the Law for Temporary Measures for Unemployed in Designated Depressed Districts--was passed to ease the impact in areas where depressed industries such as shipbuilding, were important regional employers. These two laws provide the framework for government assistance to displaced workers in depressed industries and are administered by the Ministry of Labor. These laws in essence provide workers with more extensive coverage of those benefits provided to unemployed workers in general--e.g., unemployment insurance, retraining and job-hunting allowances.

According to labor union representatives, workers in the shipbuilding industry were given priority over workers in other depressed industries because the decline came more rapidly and was more severe than in other industries such as textiles. In the words of one labor union official, the shipbuilding industry was "caught by surprise" when demand plummeted in the mid-1970s.

The severity of the unemployment problem in the shipbuilding industry as compared with other industries is illustrated by job application cards from 1977 to 1979. The cards are issued to workers in the designated depressed industries who had been continually employed by the industry for at least a year prior to being laid off. Displaced workers in the shipbuilding industry accounted for 62 percent of the cards issued in fiscal year 1979, as shown below.

Job Application Cards Issued

Industry	Fiscal year 1977		1978		1979	
Shipbuilding	6,741	(52%)	25,300	(54%)	11,839	(62%)
Others	6,163	(48%)	21,412	(46%)	7,297	(38%)
Total	12,904		46,712		19,136	

Source: Zosen Magazine

INDUSTRY ASSESSMENT

Views of observers of the Japanese shipbuilding industry vary both with respect to the appropriateness and the success of measures designed to aid the industry and the industry's future prospects. The industry has in fact recovered somewhat from its 1979 low; ship completions increased 29.7 percent in 1980. At the same time, however, there is concern over the industry's ability to withstand the growing competition from newly industrializing countries, such as Korea.

Various government officials and industry representatives we spoke with believe the government assistance provided to the shipbuilding industry was appropriate and necessary. Not surprisingly, the Ministry of Transport believes that the shipbuilding industry would not have survived without this assistance and that the consequences of the shipbuilding recession would have been much more severe had the government not intervened. According to the Ministry, all 61 firms involved in the scrapping program benefitted in one way or another from at least one government measure. Industry representatives we spoke with also felt this government assistance was necessary. Representatives from one industry association noted that, because the Ministry of Transport had the power to enforce its rationalization plan, companies were willing to comply. Another industry representative felt the government's restructuring program helped to prevent the major companies from competing among themselves and depressing prices.

The Ministry of Transport appears optimistic about the future of the Japanese shipbuilding industry; according to a Ministry spokesman, the industry's competitive position is not declining and it will be removed from designation as a structurally depressed industry some time in 1982.

Some industry representatives we spoke with, however, are more guarded in presenting industry outlooks. They expressed concern over the increasing competition from Korea and Taiwan. Korean shipbuilding capacity in particular is expected to increase rapidly in the 1980s. As far as these representatives were concerned, the Japanese Government has done nothing to help the shipbuilding industry in the face of this growing competition.

The rationalization plan implemented by government and industry was designed to cope with the sudden worldwide drop in demand in the mid-1970s. It remains to be seen whether these measures, which may well have been an appropriate response to a short-term problem, will be enough to enable the industry to remain competitive during the 1980s without assistance.

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