Table III-1-6 Progress of Liberalization of Foreign Investment into Japan

Time of Liberalization	Accumulated No. of Industrial Fields in Group 1	Accumulated No. of Industrial Fields in Group 2
July 1967 (the First Round)	33	17
March 1969 (the Second Round)	160	44
September 1970 (the Third Round)	447	77
April 1971 (Automobile Industry)	-	-
August 1971 (the Fourth Round)	shift to a negative system	151
May 1973 (the Fifth Round)	100% free in principle	

Source: R. Komiya, M. Okuno & K. Suzumura ed., Nihon no Sangyoseisaku (Japan's Industrial Policy), (original source: Customs and Tariff Bureau, Ministry of Finance).

Note: Group 1 indicates joint ventures in which foreign share is 50% or less, and Group 2 points to investments with a more than 50% share up to 100%.

1-2-3 Transition Period and Current Period (1970s and 1980s)

In "Vision of MITI Policies in the 1980s", the 1970s was seen as a period of the accumulation of knowledge to adapt to change and the 1980s as the time for Japan to consolidate its economic security and develop its technology.

With the high-growth period of the 1960s achieving average annual GDP growth of more than 10%, the Japanese standard of living became higher than that of prewar period and the long-time goal of "catching up with the West", Japan set for itself since the Meiji Era, became a possible reality. Near the turn of the 1970s, Japan stood along-side the mid-range Western countries in terms of per capita income. But on the other hand, strains and side effects of high economic growth were revealed. The concentration of plant facilities and population in the Pacific-belt-zone advanced and pollution and environmental problems became more serious. In response to the changes in the domestic situation, the Japanese Government began to attribute greater importance to social welfare than to mere quantitative expansion in its long-term economic plan.

In May 1971, the Industrial Structure Council submitted a "Vision of MITI Policies in the 1970s" to the Minister of International Trade and Industry, advocating the need for knowledge-intensive industries, namely research and development, sophisticated assembly, fashion and knowledge-intensive industries. This "Vision" stated that industrial

policies intended for high economic growth principally through development of heavy and chemical industries had reached their peak but, at the same time, had brought environmental problems and other negative outcomes. As for the external environments, the factors for Japanese economic success in the 1960s has changed in the 1970s, beginning with the August 1971 "Nixon Shock", in which the United States executed a new economic policy featuring a halt to dollar-gold exchanges and a 10% surcharge on imports. The drastic measure was intended to forestall further deterioration of U.S. leadership in the world economy, and demand greater contributions of other industrial countries in maintenance of the world's free economic system. Consequently the IMF system was compelled to change, with the Japanese yen exchange with the U.S. dollar soaring rapidly. In the face of these developments, the course of the Japanese economy was shifted from long-held policies of export promoting to policies of promoting imports and capital liberalization, in view of the importance placed on economic harmony with other countries.

The oil crisis broken out in 1973 had strong impact on the Japanese economy. It was hard hit by spiraling oil prices and, in 1974, registered the first negative economic growth since World War II. The oil crisis marked the end of Japan's high economic growth era, and annual growth of around 5%, or half the pace of the previous growth, became a permanent fact of life. And also, this oil crisis marked a turning point in energy policy. Since then the Japanese Government has promoted energy conservation and alternative energy development. The need for knowledge-intensive industries grew even stronger following the energy crisis.

Because of radical changes in external economic conditions after the first oil crisis, many industries such as petrochemicals and aluminum smelting are in difficulty. Encouraging adjustment in industries facing structural problems became an important task for industrial policy. Along this direction, the Law on Temporary Measures for Specific Depressed Industries and the Law on Temporary Measures for Unemployed of Specific Depressed Industries were enacted in 1978.

The importance placed in the 1970s on industrial policies for knowledge-intensive industries was shared in a similar "Vision of MITI Policies in the 1980s" presented by the Industrial Structure Council in March 1980. Based on the fact that Japan accounted for 10% of GNP of the world and its per capita national income had reached 90% of that of the United States, exceeding the average of the EC countries, and the other hand that the heavy dependence on foreign supplies of energy would cast serious problems on the future its economy, the Council pointed to requirements of the new decade as the promotion of energy conservation, achievement of national economic security, progress in international industrial specialization and replenishment of people's needs, and, called for further efforts to transform industry into a more technology-intensive and intelligent-labor structure. Specifically, the Council stressed the need for developing Japan's own technology in such a way that each industry can increase the added value of its products.

(1) Policy goals and major tasks of current industrial policy

Japan has achieved the national goal set for itself since the Meiji Era, reaching the level of Western industrial nations. As described in the "Vision of MITI Policies in the 1980s", it is time for Japan to establish new national long-term goals. In the Vision the followings are proposed as national long-term policy goals:

(a) Contributing positively to the international community
(b) Overcoming the limitations of national resources and energy
(c) Attaining co-existence of dynamism of the society and the improved quality and comfort of life.

Aiming to reach these national goals, Japanese industrial policy is confronted with two broad tasks described below.

(a) To facilitate the development of high technologies:

Technological innovation can revitalize the economy and expand the frontiers of economic activity. For this reason, great expectations are placed on technological development providing the key to the solution of various problems in the 1980s. In Japan, the main thrust of technological development comes from the private sector (see Figure III-1-2). And the principal role of the Government policy for the development of technology is to encourage private sector's development efforts. But the role of Government is becoming more important, especially in those areas of R&D in which - despite strong social needs - long lead times, high risks and huge funding requirements inhibit private initiative. In response to economic and social necessities in the 1980s, the followings are important areas for technological development efforts:

- Energy: energy-saving technologies, alternative energy technologies, new energy technologies

- Improving the quality of life and community facilities

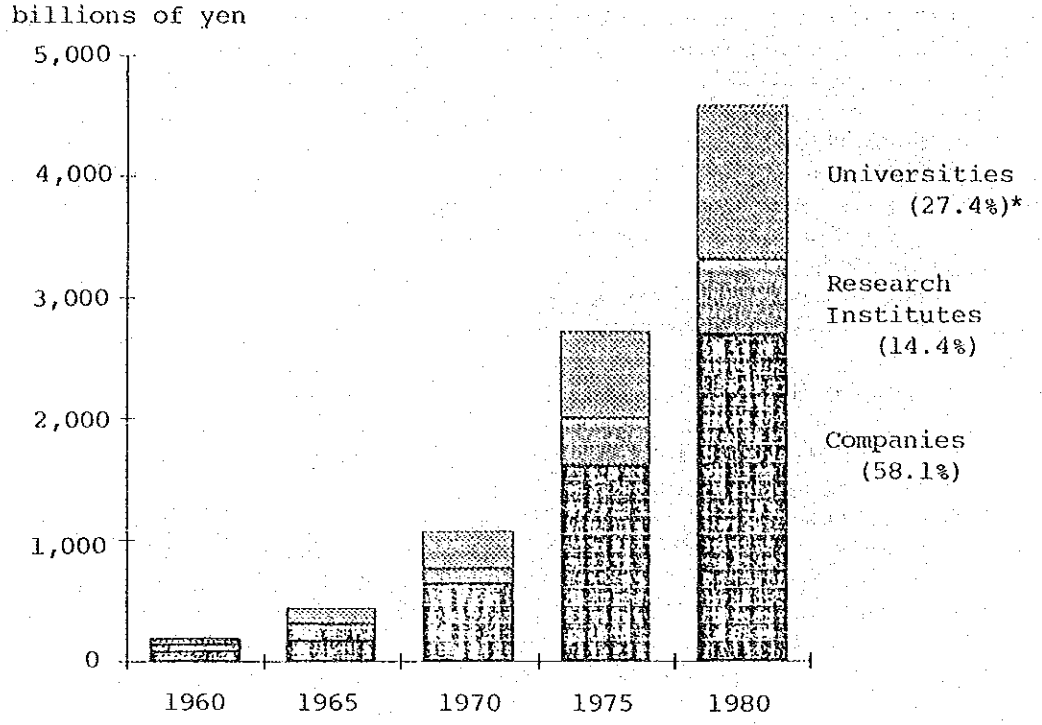
- Knowledge-intensive and innovative technologies: knowledge-intensive production systems equipped with microcomputers and upgraded resource-saving and energy-saving technologies innovative technologies such as new materials, optical communication, VLSI and laser beam technology

- The next-generation technologies

(b) To encourage adjustment in industries facing structural problems:

Due to the changes in the international economic conditions caused by the oil crisis, a number of Japanese industries such as aluminum smelting, synthetic fibers, chemical fertilizer and shipbuilding are facing with difficulty. They suffer from over capacity caused by decrease of demand. The task of industrial policy here is to promote structural adjustment in these industries without

Figure III-1-2 Expenditures on R & D



* ( ) shares in 1980.

Source: Statistics Bureau, Management and Coordination Agency, Report on the Survey of Research and Development, Various issues.

recourse to protectionism. Such adjustment, designed to ensure economic rationality in the medium- and long-term, involves reduction of excess manufacturing capacity, business tie-ups for scale of economy and revitalization investment for technological development and energy conservation. This is consistent with the concept on the Positive Adjustment Policy (PAP) adopted by the OECD in 1978.

In 1978, the Law on Temporary Measures for Stabilization of Specific Depressed Industries, the Law on Temporary Measures for Unemployed of Specific Depressed Industries, and the Law on Temporary Measures for Unemployed of Specific Depressed Areas, were enacted in order to implement policy measures to promote structural adjustment (see Table III-1-7).

(2) Tools of industrial policy

Tools of industrial policy have changed over the years in response to the requirements of the times. As far as Japan's industrial policy is concerned, emphasis has shifted to more soft-

Table III-1-7 List of Industrial Adjustment Measures

Policy Measures \ Relevant Laws	The Law on Temporary Measures for Unemployed of Specific Depressed Industries	The Law on Temporary Measures for Unemployed of Specific Depressed Areas	The Law on Temporary Measures for Stabilization of Specific Depressed Industries	The Law on Temporary Measures for Small and Medium Enterprises Located Together in Specific Depressed Areas
Applicable Period	January, 1978 to End of June, 1983	November, 1978 to End of June, 1983	May, 1978 to End of April, 1983	November, 1978 to End of June, 1983
Method of Information Supply	Job placement by public employment security offices	Job placement by public employment security offices	A basic business stabilization plan is prepared with the opinion of relevant council taken into account for each designated depressed industry.	None
Improvement of Job/Business Switching Potential	Vocational training and employment guidance	Vocational training and employment guidance	Emergency import restrictions frequently put into practice.	Designated small and medium enterprises can get emergency loans or "business-switching" loans at low interest rates. (6.1% to 6.6%)
Promotion of Job Changes	Companies which have employed jobless people who fulfill the specified requirements and who have Job Seeking Pass-Books, are paid a "Subsidy for Accelerating Employment of Specified Job Seekers."	Companies which have employed those who left jobs in specified depressed areas and are between the ages of 45 and 65 are paid a "Subsidy for Accelerating Employment of Specified Job Seekers."	The business stabilization plan includes employment securing measures.	Measures directly relating to the "Law on Temporary Measures for Unemployed Specific Depressed Areas," which falls under the jurisdiction of the Ministry of Labor, are put into practice
	An Employment Adjusting Subsidy is paid to support the job suspension allowance, training costs and wages for leased employees.	An Employment Adjusting Subsidy is paid to support the job suspension allowance, training costs and wages for leased employees.	If a company belonging to a designated recession-hit industry curtails its operations under the business stabilization plan, the Credit Fund for Designated Recession Hit Industries will guarantee the company's debts.	Extension of the repayment term of loans for equipment, favorable treatment in credit insurance, special treatment of various advance tax refunds on deferred losses and accelerated depreciation are applied.
Stabilization of Regional Life	Promotion of finding work in public sector (application of the requirement that 40% of public employees come from these categories.)	Promotion of finding work in public sector (Application of the requirement that 40% of public employees come from these categories).	If the curtailment of business operations exerts a negative influence upon the regional economy, the prefectural governor may express his concern to the appropriate minister.	The invitation of other businesses to the region is accelerated through the use of the Industrial Relocation Subsidy.
Temporary Income Compensation	Especially prolonged payment of unemployment benefits (90 days for those 40 years old or over and 60 days for those under 40)	Especially prolonged payment of unemployment benefits (90 days for those 40 years old or over and 60 days for those under 40)	None	Measures directly relating to the "Law on Temporary Measures for Unemployed of Specific Depressed Areas," which falls under the jurisdiction of the Ministry of Labor, are put into practice.
Others	This law applies to business categories chosen chiefly from industries for which the national policy against structural recession has been put into practice. The Ministry of Labor is left some room for discretion.	The Minister of Labor chooses the areas to which this law applies from areas designated by government ordinance under the Law on Temporary Measures for Small and Medium Enterprises Located Together in Specific Depressed Areas.	A basic business stabilization plan is prepared to accelerate the intentional curtailment of excess facilities in each specified depressed industries. According to circumstances, the government may give instructions to take joint action without the application of the Anti-Monopoly Law in order to complete the plan.	"Specified Depressed Areas" in blocks of municipalities.

Source: R. Komiya, M. Okuno & K. Suzumura ed., Nihon no Sangyoseisaku (Japan's Industrial Policy).

handed measures. Taxational, financial, budgetary and legislative measures designed to complement the market mechanism serve only as a pump-priming for industrial development and adjustment. Thus their contributory effects are limited.

Following are the principal instruments of current Japanese industrial policy:

(a) Visions

In Japan's industrial policies, the visions are considered as the base for policy measures.

Visions on the overall industrial structure, such as "Vision of MITI Policies in the 1980s", are designed to:

- Analyze changes in the economic society as it relates to industry (such as trends in the needs of the people and the state of technological innovation), and the current conditions of industry and the industrial structure as reflected in such changes, and clarify the problems involved.

- On the basis of such an analysis, clarify emerging trends from such changes in the economic society and the industrial structure, and propose a desirable industrial structure to be aimed for.

- Outline policy tasks for facilitating such an industrial structure and indicate the direction in which such policies will be implemented.

Visions are not formulated by the Government alone. They are formulated through open discussions of councils composed of representatives from various quarters, including not just industries but also financial institutions, academia, journalism, labor, small business, consumers and local public entities. Daily exchange of views with corporate managers, careful analysis of industries and industrial structure, and opinions from the press, form the basis of discussions. Typical one of such councils is the Industrial Structure Council. It should be emphasized that this process of council deliberation guarantees the openness of policy planning.

A vision thus prepared has the following functions:

- Presenting in a well-arranged form useful information pertaining to the industrial structure, and indicating the basic direction of medium- or long-term policy. Thus uncertainties inherent in the market economy can be alleviated so that private enterprises may demonstrate their vitality more fully.

- Providing a source of useful information that may be utilized by businesses in formulating their strategies.

(b) Government financing

It is obvious that the best use must be made of the market mechanism, and that free and creative activity in the private sector forms the foundation of Japan's economic society. Obviously, too, funds for private investment projects are as a rule supplied by private financial institutions through the market mechanism.

In reality, however, private financing is often inadequate for large-scale investments that involve high risks and long lead time. Government financing may be necessary where such projects are deemed essential from the standpoint of the national economy. In other words, the government can supplement private financing and support self-help efforts by private enterprises, in order to ensure an appropriate allocation of resources.

The Japan Development Bank supplies funds for a wide range of projects related not only to industrial development but also to urban development, environmental protection (e.g. pollution control) and energy development.

(c) Tax incentives

Tax preferences for private enterprises, or tax incentives, are kept to a bare minimum. They are granted to achieve certain policy goals, such as securing stable, long-term energy supplies, promoting economic cooperation with the developing countries and encouraging technological development.

Such tax privileges have been curtailed or rationalized in recent years. (During fiscal 1976-82, for instance, about 90% of such incentives were either reduced or abolished.) Pollution control and energy development are the two major areas in which corporate tax privileges are granted. Small business accounts for about one-half of such measures (see Table III-1-8).

(d) Budgetary appropriations

Budgetary appropriations related to industrial policies are kept to the necessary minimum. MITI takes only 1.6% of the initial government budget for FY1983. The Ministry budget gives priority to measures related to small business and energy (shares of total general budget of MITI were 23% and 49% respectively in FY1982). Government share of gross R&D expenditure (excluding defense) in Japan is the lowest (28%) compared with those of the U.K. (32%), the U.S.A. (33%), West Germany (41%) and France (47%).

(e) Organization of MITI

The organization of the Ministry of International Trade and Industry (MITI) is shown in Figure III-1-3. The Ministry was established in May 1949 as a ministry which is responsible for industrial policy. The MITI's organization is grid-like, with cross-sector concerns such as trade, industry, industrial location, environmental protection, and energy policy administered "horizontally" for industry as a whole and sector-specific issues for basic industries (e.g. steel and chemical products), machinery and information industries (e.g. electronic equipment, automobiles, aircraft, daily necessities, and home furnishings) administered "vertically" in the specific sector concerned.

MITI is thus characterized by close coordination between these bureaus in a system that ensures a broad perspective on domestic and international economic policies while maintaining watchful attention to individual industries.

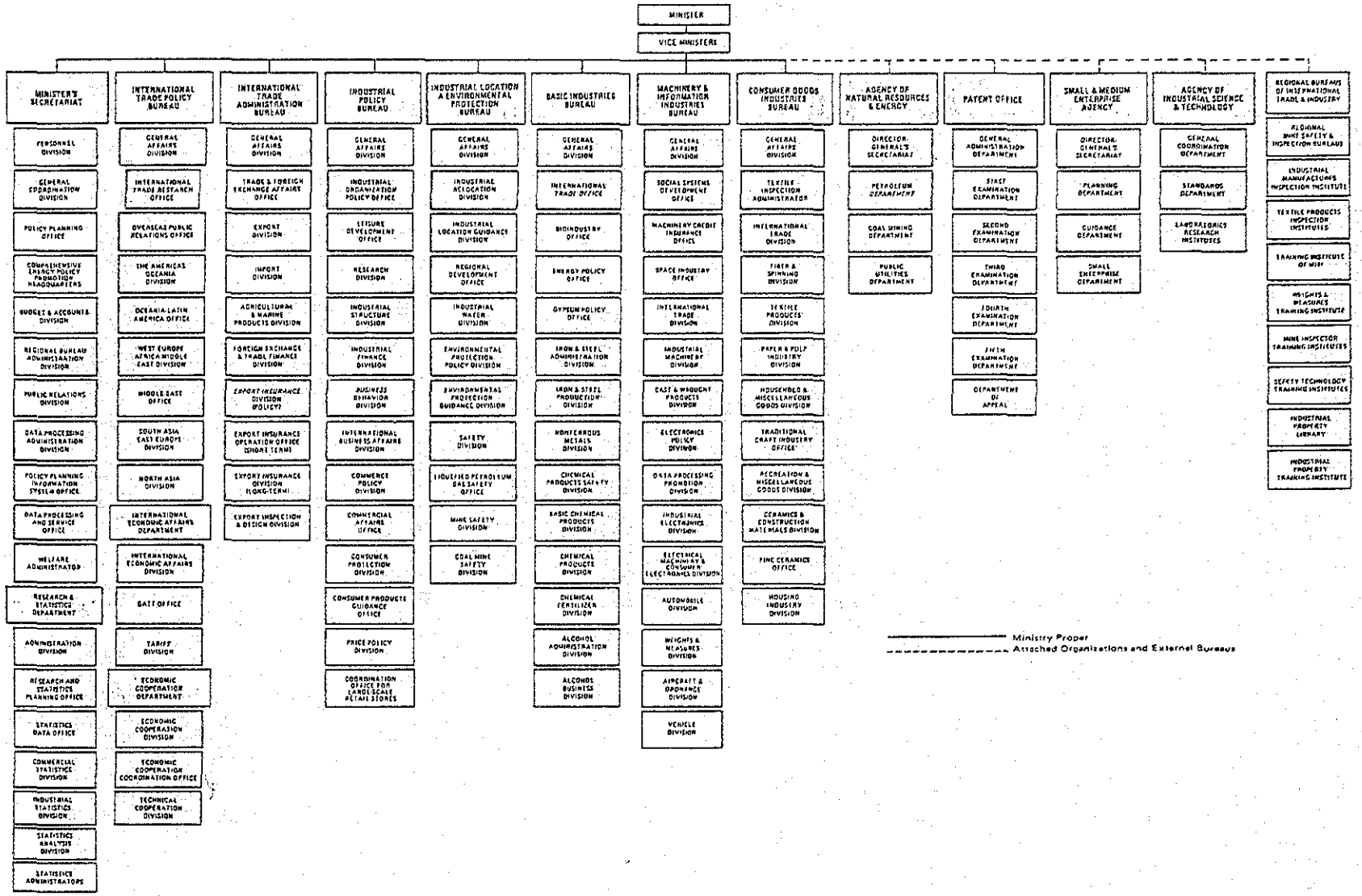
For reference, major postwar industrial policies are shown in the appendix table (Chronology of Japan's Postwar Industrial Policy).

Table III-1-8 Fiscal Incentives under the Specific Law

Fields	Reserve Systems	Special Depreciation or Accelerated Depreciation Arrangements	Income and Tax Exemptions	Others
Environmental Preservation		. Special depreciation on pollution prevention equipment . Special depreciation on pollution-free production facilities		
Natural Resources and Energy	. Reserve for injuries from metal mining . Reserve for planned forestation . Depreciation reserve for nuclear power generation work . Depreciation reserve for gas piping work . Reserve for water shortages . Reserve for exploration . Reserve for overseas exploration	. Special depreciation on a plant for waste recycling treatment . Special depreciation on energy saving equipment and non-oil using equipment . Tax system to encourage alternative energy measures . Special depreciation on mining tunnels . Accelerated depreciation on oil storage facilities . Special depreciation on facilities to be changed to industrial waterworks . Special depreciation on forestation costs	. Special exemption for new mineral deposit exploration costs . Special exemption for new overseas mineral deposit exploration costs . Tax system to encourage alternative energy measures	. Tax deduction for contributions to the Power Reactor and Nuclear Fuel Development Corporation . Exemption of the oil tax on petroleum products when received
Small and Medium Enterprises	. Reserve for overseas markets development by small and medium enterprises . Reserve for the structural improvement of small and medium enterprises . Reserve for extraordinary risks	. Special depreciation on store buildings for small and medium retailers . Special depreciation on machinery owned by small and medium sized enterprises . Special depreciation on machinery for modernization of local small and medium enterprises . Special depreciation on common facilities for small and medium enterprises' structural improvement . Special depreciation on machinery owned by members of commercial and industrial associations which execute small and medium enterprises' structural improvement plans . Special treatment for depreciation on facilities owned by specified small and medium enterprises which are transformed into other businesses. (The Law on Temporary Measures for Small and Medium Enterprise Business Transformation) (The Industrial Relocation Promotion Law) (The Small and Medium Enterprise Modernization Promotion Law)	. Special exemption for the retained incomes of cooperatives	. Special treatment in allowance for bad debts of small and medium enterprises . Special tax treatment for cases in which investment in kind has been approved under the law relating to the organization of small and medium corporations
Research and Development	. Reserve for buyback losses on electronic computers . Reserve for programs	. Special depreciation on contributions to the Industrial Technology Association . Special depreciation on major compound machinery and equipment	. Income exemption for export of technical know-how . Special tax exemption for increases in examination and research expenses	. Reduction of the commodity tax on electric automobiles
Others	. Reserve for price fluctuations . Reserve for commodity trade liabilities . Reserve for investment losses in free trade areas . Reserve for overseas investment losses	. Special depreciation on industrial machinery in industrialized agricultural districts, coal mining areas, and specified depressed areas		. Contributions to testing and research corporations

Source: Tsusho Sangyo Gyosei Kenkyu-kai ed., Tsusho Sangyo I (Industrial Policy I), 1983.

Figure III-I-3 Structure of the Ministry of International Trade and Industry



Source: MITI, MITI Handbook 1984.

Appendix Table: Chronology of Japan's Postwar Industrial Policy

1946	Emergency Measures for Surmounting the Economic Crisis (anti-inflation program) Establishment of the Reconstruction Finance Corporation
1947	the Anti-Monopoly Law
1948	Establishment of the Small and Medium Enterprise Agency Nine Principles of Economic Stability (the Dodge Line : an economic stabilization program)
1949	Fixed Exchange Rate at 360 yen to the U.S. dollar Establishment of the Ministry of International Trade and Industry (MITI) The Industrial Standardizing Law Decision on the Basic Policy for Industrial Modernization (at the Cabinet Meeting) Establishment of the People's Finance Corporation The Law on Cooperatives of Small and Medium Enterprises and Other Parties The Foreign Exchange and Foreign Trade Control Law Establishment of the Industrial Modernization Council
1950	The Export Insurance Law The Law Concerning Foreign Investment Establishment of the Export Bank of Japan (Export-Import Bank of Japan since 1952)
1951	Operation of the Japan Development Bank Establishment of the Japan Export Trade Research Organization
1952	The Enterprise Rationalization Promotion Law The Aircraft Manufacturing Industry Law The Electric Power Development Law Agency of Industrial Science and Technology (renamed , established in 1948) Membership of the World Bank (IBRD) Membership of the International Monetary Fund (IMF) The Export and Import Transaction Law Establishment of the Long-Term Credit Bank of Japan
1953	Establishment of the Small Business Finance Corporation The Law on Temporary Measures for Stabilization of the Small and Medium Enterprises
1954	Consolidation into the Japan External Trade Research Organization (Reorganization into Japan External Trade Organization - JETRO - in 1958)
1955	Establishment of the Japan Productivity Center Membership of the General Agreement on Tariffs and Trade (article XII) The Law on Temporary Measures for Coal Mining Industry Rationalization
1956	The Law on Financial and Other Support for Small and Medium Enterprise The Industrial Water Law The Law on Temporary Measures for Machinery Industries (-1971) The Law on the Prevention of Delay in Payment of Subcontracting Charges and Related Matters The Law on Financial and Other Assistance for Small Business Modernization
1957	The Export Inspection Law The Law on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors The Law on Temporary Measures for Electronic Industries (-1971) The Medium and Small Enterprise Organization Law
1958	The Aircraft Industry Promotion Law The Industrial Water Supply Business Law
1959	The Utility Model Law The Design Law

1960 Abolishment of the Foreign Exchange Budget (1950 - 1960)
Announcement of the Foreign Exchange and Trade Liberalization Plan
'Income Doubling Plan'

1961 The Law on Temporary Measures for the Coal-Mining Area Development
The Industrial Technology Association Law

1962 The Petroleum Law
The Computer Technology Association (FONTAC Project)

1963 The Small and Medium Enterprises Modernization Promotion Law
The Basic Law on Small and Medium Enterprises
The Small and Medium Enterprise Guidance Law
The Vision of MITI Policies in the 1960s (the Industrial Structure Council , Heavy and Chemical Industries)
Joined to the Group of GATT Article 11 Nations

1964 Membership of OECD
Joined to the Group of IMF Article 8 Nations
Establishment of the Industrial Structure Council

1965 The Subcontracting Small and Medium Enterprises Promotion Law

1966 National Research and Development Program (Large-Scale Projects)

1967 The First Round towards the Implementation of Liberalization
The Basic Law for Environmental Pollution Control
The Law on Temporary Measures for Structural Improvement of Specific Textile Industries

1968 The Air Pollution Contral Law
The Noise Control Law

1969 The Second Round towards the Implementation of Liberalization

1970 The Law on Unified Trademarks for Export-Oriented Products by Small and Medium Enterprises
The Third Round towards the Implementation of Liberalization

1971 Liberalization of Foreign Investment in Automobile Industries
The Vision of MITI Policies in the 1970s (the Industrial Structure Council , Knowlege-Intensive Industries)
The Industrial Relocation Promotion Law
The Law Concerning Improvement of Pollution Prevention System in Specified Factories
The Fourth Round towards the Implementation of Liberalization
The Law on Temporary Measures for Promotion of Specific Electronic and Machinery Industries

1973 The Fifth Round towards the Implementation of Liberalization (100% liberalization in principle)
Establishment of the Agency of Natural Resources and Energy
The Pollution-related Health Damage Compensation Law
The Law on Ensuring Propriety in Petroleum Supply and Demand
The Law on Temporary Measures for National Life Stabilization

1974 The Sunshine Project (New Energy Development)

1975 The Petroleum Stockpiling Law

1976 Establishment of VLSI Technology Association (1976-1979)

1978 The Law on Temporary Measures for Unemployed of Specific Depressed Industries (1978-1983)
The Law on International Applications and Other Matters in Pursuance of the Patent Cooperation Treaty
The Law on Temporary Measures for Unemployed of Specific Depressed Areas (1978-1983)
The Law on Temporary Measures for Coping with Small and Medium Enterprises in Areas Related to Specific Industries (1978-1983)
The Law on Temporary Measures for Stabilization of Specific Depressed Industries

The Law on Temporary Measures for Promotion and Development of Specified Machinery and Information Industries
The Moonlight Project (Energy Conservation Technology Development)

1979 The Law on Temporary Measures for Small and Medium Enterprises Located together in Specific Areas
The Law Concerning the Rational Use of Energy

1980 The Vision of MITI Policies in the 1980s (the Industrial Structure Council , High-technology Industries)
The Law Concerning the Promotion of Development and Introduction of Alternative Energy

1981 Research and Development for Next-Generation Industry Program (Information processing, biotechnology, etc.)

1982 Establishment of Institute for New Generation Computer Technology (Fifth-generation Computers)

1983 The Law on Temporary Measures for the Structural Adjustment of Specific Industries
The Law for Accelerating Regional Development Based upon High-Technology Industrial Complex

2. SMALL AND MEDIUM INDUSTRY IN JAPAN

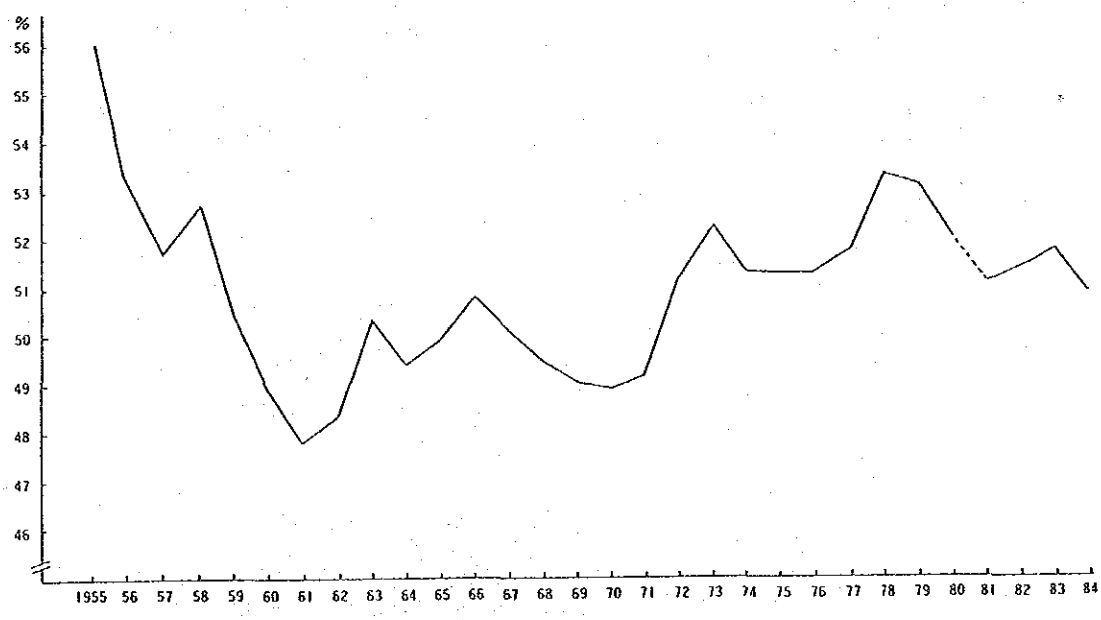
2-1 Small and Medium Enterprises in Japan

2-1-1 Position of small and Medium Enterprises in Manufacturing Industry

In Japan's manufacturing industry, small and medium enterprises occupy an important position. According to 1984 Census of Manufactures compiled by the Ministry of International Trade and Industry (MITI), small and medium establishments employing less than 300 workers account for 99.1% of total manufacturing establishments, 71.8% of employed workers, 50.9% of shipments and 54.9% of value-added (see Table III-2-1).

Although these figures had shown a downword trend in the latter half of the 1950s, they leveled off during the 1960s and have been more or less constant during the 1970s and the 1980s after the small rise in the early 1970s (see Figure III-2-1).

Figure III-2-1 Trend in Share of Small and Medium Manufacturers in Terms of Value of Shipments



Source: MITI, Census of Manufactures.

Notes :
1. Share of small and medium manufacturers is the ratio of shipment values by establishment employing less than 300 workers to the total shipment values.
2. The Census are conducted on an establishment basis.
3. Figures for 1984 are provisional.
4. Figures for 1981-84 are the figures for the establishments employing 4 workers or more.

Table III-2-1 Size Structure of Japanese Manufacturing Sector

(1) Persons and Value

Number of Employees	1955	1960	1965	1970	1975	1980	1983	1984
< No of Establishments >								
1 - 9	331,201	345,673	404,971	479,376	560,688	558,456	262,348*	243,219*
10 - 19	55,961	71,079	74,451	88,761	90,764	83,038	87,088	86,459
20 - 99	39,469	59,882	65,535	69,007	70,142	79,104	83,023	84,345
100 -299	4,333	7,588	9,566	11,457	10,528	10,514	10,919	11,357
300 -999	1,354	2,210	2,853	3,436	3,076	2,864	2,909	2,993
1000 or more	376	618	730	894	772	647	650	669
1 -299	430,964	484,222	554,523	648,601	732,122	731,112	443,383*	425,380*
300 or more	1,730	2,828	3,583	4,330	3,848	3,511	3,559	3,662
Total	432,694	487,050	558,106	652,931	735,970	734,623	446,942*	429,042*
< No of Employees > 1,000 persons								
1 - 9	1,102	1,194	1,599	1,910	2,153	2,143	1,552*	1,458*
10 - 19	750	960	1,050	1,262	1,282	1,145	1,196	1,188
20 - 99	1,463	2,295	2,630	2,850	2,848	3,044	3,184	3,240
100 -299	709	1,231	1,551	1,859	1,704	1,697	1,762	1,822
300 -999	681	1,115	1,446	1,751	1,549	1,437	1,463	1,493
1000 or more	805	1,374	1,645	2,047	1,761	1,465	1,495	1,531
1 -299	4,024	5,680	6,830	7,882	7,986	8,029	7,694*	7,708*
300 or more	1,486	2,489	3,091	3,798	3,310	2,902	2,957	3,024
Total	5,510	8,169	9,921	11,680	11,296	10,931	10,651*	10,733*
< Value of Shipments > billions of yen								
1 - 9	538	785	1,696	3,987	8,788	14,000	12,911*	12,767*
10 - 19	576	987	1,798	4,487	8,906	13,173	14,547	15,007
20 - 99	1,539	3,264	6,182	13,587	26,423	47,155	52,708	56,226
100 -299	1,141	2,576	5,051	11,671	21,299	37,321	41,813	44,730
300 -999	1,382	3,206	6,400	14,561	28,263	49,824	53,394	57,033
1000 or more	1,593	4,760	8,371	20,742	33,842	53,227	60,153	67,254
1 -299	3,794	7,613	14,726	33,732	65,416	111,649	121,979*	128,730*
300 or more	2,975	7,966	14,771	35,303	62,104	103,051	113,548	124,287
Total	6,769	15,579	29,497	69,035	127,521	214,700	235,527*	253,017*
< Value-Added > billions of yen								
1 - 9	109	177	765	1,933	4,314	6,811	6,241*	6,199*
10 - 19	177	324	723	1,836	3,635	5,338	5,970	6,193
20 - 99	459	1,022	2,095	4,844	9,145	16,029	18,383	19,779
100 -299	341	766	1,565	3,960	7,063	12,204	13,787	15,004
300 -999	440	942	1,831	4,766	8,036	14,161	15,572	17,346
1000 or more	574	1,605	2,687	7,232	10,240	16,704	19,151	21,427
1 -299	1,086	2,290	5,148	12,574	24,157	40,382	44,381*	47,176*
300 or more	1,014	2,547	4,518	11,998	18,276	30,865	34,724*	38,773*
Total	2,100	4,837	9,665	24,572	42,433	71,247	79,105	85,949

Table III-2-1 (cont.)

(2) Share (%)

Number of Employees	1955	1960	1965	1970	1975	1980	1983	1984
< No of Establishments >								
1 - 9	76.5	71.0	72.6	73.4	76.2	76.0	58.7*	56.7*
10 - 19	12.9	14.6	13.3	13.6	12.3	11.3	19.5	20.2
20 - 99	9.1	12.3	11.7	10.6	9.5	10.8	18.6	19.7
100 -299	1.0	1.6	1.7	1.8	1.4	1.4	2.4	2.6
300 -999	0.3	0.5	0.5	0.5	0.4	0.4	0.7	0.7
1000 or more	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
1 -299	99.6	99.4	99.4	99.3	99.5	99.5	99.2*	99.1*
300 or more	0.4	0.6	0.6	0.7	0.5	0.5	0.8	0.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0*	100.0*
< No of Employees >								
1 - 9	20.0	14.6	16.1	16.4	19.1	19.6	14.6*	13.6*
10 - 19	13.6	11.8	10.6	10.8	11.3	10.5	11.2	11.1
20 - 99	26.6	28.1	26.5	24.4	25.2	27.8	29.9	30.2
100 -299	12.9	15.1	15.6	15.9	15.1	15.5	16.5	17.0
300 -999	12.4	13.6	14.6	15.0	13.7	13.1	13.7	13.9
1000 or more	14.6	16.8	16.6	17.5	15.6	13.4	14.0	14.3
1 -299	73.0	69.5	68.8	67.5	70.7	73.5	72.2*	71.8*
300 or more	27.0	30.5	31.2	32.5	29.3	26.5	27.8	28.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0*	100.0*
< Value of Shipments >								
1 - 9	7.9	5.0	5.7	5.8	6.9	6.5	5.5*	5.0*
10 - 19	8.5	6.3	6.1	6.5	7.0	6.1	6.2	5.9
20 - 99	22.7	21.0	21.0	19.7	20.7	22.0	22.4	22.2
100 -299	16.9	16.5	17.1	16.9	16.7	17.4	17.8	17.7
300 -999	20.4	20.6	21.7	21.1	22.2	23.2	22.7	22.5
1000 or more	23.5	30.6	28.4	30.0	26.5	24.8	25.5	26.6
1 -299	56.0	48.9	49.9	48.9	51.3	52.0	51.8*	50.9*
300 or more	44.0	51.1	50.1	51.1	48.7	48.0	48.2	49.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0*	100.0*
< Value-Added >								
1 - 9	5.2	3.7	7.9	7.9	10.2	9.6	7.9*	7.2*
10 - 19	8.4	6.7	7.5	7.5	8.6	7.5	7.5	7.2
20 - 99	21.9	21.1	21.7	19.7	21.6	22.5	23.2	23.0
100 -299	16.2	15.8	16.2	16.1	16.6	17.1	17.4	17.5
300 -999	21.0	19.5	18.9	19.4	18.9	19.9	19.7	20.2
1000 or more	27.3	33.2	27.8	29.4	24.1	23.4	24.2	24.9
1 -299	51.7	47.3	53.3	51.2	56.9	56.7	56.1*	54.9*
300 or more	48.3	52.7	46.7	48.8	43.1	43.3	43.9	45.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0*	100.0*

Source: MITI, Census of Manufactures.

Notes: 1. The Census are conducted on an establishment basis.
2. Figures for 1984 are provisional.
3. * indicates that the figures are for the establishments employing 4 workers or more.

The sectors in which small and medium manufacturers have the comparatively large share are the followings (see Table III-2-2):

(a) Light industries, including foodstuffs, textiles, lumber and furniture.

(b) Segments producing the intermediate goods of the processing and assembling industries. (Many of the small and medium manufacturers in these fields are supplying large corporations with parts and components as their subcontractors.)

Generally speaking, the fields in which many small and medium enterprises exist are charaterized by demand which is so small in quantity and varied in specifications that mass production through product standardization would be difficult. On the contrary, the fields which support large corporations are those where mass production is effective.

2-1-2 Position and Role of Subcontractors

Japan's small and medium subcontractng enterprises have formed a basis for major industries which made large contribution to the development of nation's economy. They have played a vital role in the structure of division of labor and are an important factor in the high performance of the Japanese economy.

Subcontracting small and medium enterprises, which are engaged in subcontracting transactions to varying extent, account for 65.5% of Japan's small and medium manufacturing enterprises in 1981. Although subcontractors exist throughout a wide range of Japan's industrial field, they especially center around the machinery, textile and metal industries (see Table III-2-3).

Table III-2-4 shows the ratio of subcontractors to the total small and medium manufacturing enterprises. The ratio steadily increased from 60.7% in 1976 to 65.5% in 1981. This upward trend was observed in every classification of the size of enterprises.

The ratio of subcontractors is particularly high in the transportation, electric and other machinery industries and in the textile industry. The characteristics which is common among these industries is that the number of parts and components or processing steps is large.

The make-up of the subcontracting structure differs from one industry to another. It would be appropriate to classify the forms of Japanese subcontracting structure into two types. One is the form in which wholesalers and trading companies, which have the good ability of product planning and sales, organize many small and medium manufactures as their subcontractors. In the other form, manufacturers of finished goods organize small and medium parts manufacturing and processing enterprises as their subcontractors at various stage of production process.

Table III-2-2 Number of Establishments and Value of Shipments of Small and Medium Manufacturing Establishments by Subsector (1983)

	Number of Establishments		Value of Shipments	
		share (%)	¥ billion	share (%)
Food and tobacco	53,384	99.4	21,387	84.1
Textile	37,716	99.5	6,695	83.0
Apparel & related products	31,001	99.9	3,204	86.8
Lumber & wood products	24,461	99.9	3,899	93.1
Furniture & fixtures	18,676	99.9	2,643	92.2
Pulp,paper	12,285	99.4	4,723	66.9
Publishing,printing	30,313	99.6	5,439	66.5
Chemical products	5,143	95.0	8,644	45.0
Petroleum & coal products	962	96.0	2,474	17.3
Rubber products	5,566	98.6	1,216	44.6
Leather products	5,782	99.9	921	95.1
Ceramic,stone & clay products	21,955	99.5	6,568	76.2
Iron & steel	6,888	97.7	5,845	36.4
Non-ferrous metal products	4,238	97.4	3,021	43.6
Metal products	51,145	99.7	9,345	83.3
Ordinary machinery	41,914	99.1	10,598	52.3
Electrical m. & equipment	31,549	97.5	9,767	30.9
Transport equipment	15,123	97.3	5,498	18.6
Precision instruments	7,944	98.4	1,784	47.3
Others	37,322	99.7	8,309	80.3
Total	443,383	99.2	121,979	51.8

Source: MITI, Census of Manufactures.

Notes: 1. The Census is conducted on an establishment basis.
2. Above figures are for the establishments employing 4 - 299 workers.
3. "Share" means the share of establishments with 4 - 299 workers among establishments with 4 or more workers.
4. Exchange rate in 1983 is $1 = ¥237.75.

Table III-2-3 Ratio of Subcontractors by Subsector

(%)

Industry	1971	1976	1981
Food and tobacco	30.2	14.5	17.5
Textile	75.9	84.5	84.9
Apparel & related products	71.4	83.9	86.5
Lumber & wood products	43.8	42.9	48.0
Furniture & fixtures	49.4	41.2	51.6
Pulp,paper	43.9	44.8	51.6
Publishing,printing	51.0	50.8	59.0
Chemical products	38.7	37.1	38.5
Petroleum & coal products	30.7	27.0	38.9
Rubber products	54.3	61.1	71.8
Leather products	64.5	62.5	68.8
Ceramic,stone & clay products	34.0	29.4	36.6
Iron & steel	66.0	70.4	72.0
Non-ferrous metal products	69.7	68.7	73.6
Metal products	71.7	74.8	78.6
Ordinary machinery	75.8	82.7	84.2
Electrical m. & equipment	78.9	82.3	85.3
Transport equipment	77.9	86.2	87.7
Precision instruments	70.7	72.4	80.9
Others	58.7	56.5	62.2
Total	58.7	60.7	65.5

Source: MITI, Kogyo Jittai Kihon Chosa (Basic Survey on State of Industry).

Note: $\text{Ratio of Subcontractors} = \frac{\text{Number of Subcontractors}}{\text{Number of Enterprises employing less than 300 workers}} \times 100$

Table III-2-4 Ratio of Subcontractors by Size of Enterprise

(%)

Number of Employees	1971	1976	1981
1 - 3	62.1	66.8	71.1
5 - 9	57.5	57.7	62.8
10 - 19	55.0	54.4	57.2
20 - 29	56.5	50.6	54.7
30 - 49	57.2	50.2	55.6
50 - 99	47.4	51.7	57.6
100 - 199	47.2	51.8	54.8
200 - 299	42.3	48.4	51.1
Total	58.7	60.7	65.5

Source: MITI, Kogyo Jittai Kihon Chosa (Basic Survey on State of Industry).

Note: $\text{Ratio of Subcontractors} = \frac{\text{Number of Subcontractors}}{\text{Number of Enterprises}} \times 100$

The former type is observed mainly in textile and furniture industries. In the subcontracting system of this type, the role of the subcontractors can be expressed as the factories of trading companies. The latter type is often seen in machinery industries and the subcontracting enterprises play the role of branch factories which undertake a part of the parent company's production procedure.

Concerning the Japanese subcontracting system, several problems such as the followings are pointed out: (a) subcontractors lag behind in technology and production facilities as compared with parent companies, (b) they are easily forced to endure unfavorable terms of transaction.

However, the subcontracting system also has efficiencies stated below, which have played important roles in the strong competitiveness and the fast development of the assembling and processing type of industries in Japan.

First, as the whole production procedure is divided into many steps and these production steps are shared by many subcontractors, each firm can concentrate their effort of technology strengthening upon their specific field. Furthermore, the relationship between the parent enterprises and their subcontractors is relatively stable, although the amount of order varies owing to the business fluctuation. The stability in the subcontracting relationship has made the risk of equipment investment smaller to some extent and has promoted the installation of new equipment in the subcontractors.

Secondly, technological guidance provided by the parent enterprises to the subcontractors has assisted them in improving technological standard.

2-2 Policies for Small and Medium Enterprises in Postwar Japan

2-2-1 Reconstruction Period after World War II (from late 1940s through 1950s)

(1) Establishment of Small and Medium Enterprise Agency

The first significant event in the postwar history of small and medium enterprise policies was the establishment of the Small and Medium Enterprise Agency.

During the reconstruction period after World War II, the Japanese Government stimulated the reconstruction of basic industries, such as coal, steel, fertilizer, etc., by the preferential allocation of industrial funds and materials to those industries (as described in III-1-2). While big corporations started the recovery with the help of these measures, small and medium enterprises were confronted with the serious shortage of business funds and materials. This intensified the necessity of policy measures for small and medium enterprises and the administrative organization to take charge of those matters exclusively.

Under those circumstances, the Small and Medium Enterprise Agency was established as a part of the Ministry of Trade and Industry in August 1948. The purpose of the Agency is "to nurture and develop small and medium enterprises and to establish adequate conditions to improve their management" (Article 1 of the Small and Medium Enterprise Agency Establishment Law). The establishment of the Agency laid the foundation of the comprehensive and systematic development of small and medium enterprise policies in the years after.

(2) Establishment and strengthening of government financial institutions for small and medium enterprises

Immediately after the War small and medium enterprises were suffering serious financial difficulties under the severe by restrictive policies to control the wild inflation. The financial difficulties of small and medium enterprises arose basically from the reluctance in the private financial institutions' lending attitude to them. In order to improve their financing situations, the following government financial institutions for small and medium enterprises were established or strengthened in the period from the late 1940s to the early 1950s.

(a) Establishment of the National Finance Corporation

The National Finance Corporation (NFC) was established in June 1949 in succession to the People's Bank (established in July 1938 and dissolved in June 1949) and the Pension Bank (established in June 1938 and dissolved in June 1949). The purpose of NFC is to "make small loans of business funds to those persons who are not in a position to obtain credit from banks or other private financial institutions" (Articles 1 & 18 of the National Finance Corporation Law).

(b) Strengthening of Shoko Chukin Bank

Shoko Chukin Bank is a semi-governmental organization established in December 1936 in order to promote the structural organization of small and medium enterprises by supplying funds with cooperatives. As the promotion of structural organization has been an important target in the small and medium enterprises policies, the government adopted various measures for strengthening the function of the Bank during the reconstruction period after the War: appointment as the agency for the small and medium enterprise agency loan of the Reconstruction Finance Corporation (established in January 1947 and dissolved in January 1952), increase in the capital subscription by the government, increase in the undertaking of the Bank's commercial and industrial debentures by the government, expansion of the scope of customers to individual members of cooperatives, etc.

(c) Establishment of the Small Business Finance Corporation

The Small Business Finance Corporation (SBFC) was established in August 1953. The purpose of SBFC is "to supply long term funds

necessary for the promotion of small and medium enterprises which would be difficult for them to obtain through ordinary private financial institutions" (Article 1 of the Small Business Finance Corporation Law). The establishment of SBFC was intended to cover the small and medium enterprises which existed between the customers of NFC and Japan Development Bank (JDB: established in April 1951 as a government financial institution to supply long-term funds for the promotion of industrial and social-economic development). NFC's customers are very small enterprises and the major purpose of JDB is to make loans to key industries, and thus there exist a large number of small and medium enterprises which cannot borrow necessary funds from both organizations. The purpose of SBFC establishment is to fill up the empty space in the system of supplying government funds to small and medium enterprises.

(d) Establishment of credit supplementation system for small and medium enterprises

In addition to the government financial institutions stated above, the system to supplement the poor credibility of small and medium enterprises has also been set up during the same period (see 2-3-1 (2)). This system of credit supplementation was consisted of two parts. One was the Small and Medium Enterprise Credit Insurance and the other was the Credit Guarantee Associations. In Small and Medium Enterprise Credit Insurance System, the national government's Small and Medium Enterprise Credit Insurance Special Account based on the Small and Medium Enterprise Credit Insurance Law (1950) underwrote the long-term loans which small and medium enterprises obtained from financial institutions as well as the guarantee liabilities of credit guarantee associations. Credit guarantee associations were established pursuant to the Credit Guarantee Association Law and guaranteed the short-term loans which small and medium enterprises obtained from financial institutions.

In July 1958, the credit supplementation system has been reformed to the present system by the establishment of the Small Business Credit Insurance Corporation and the abolishment of Small and Medium Enterprise Credit Insurance Special Account.

2-2-2 Period of Rapid Economic Growth (from late 1950s through 1960s)

(1) Enactment of Small and Medium Enterprise Basic Law

From the late 1950s through the 1960s, the Japanese economy sustained a long and fast expansion although interrupted by relatively short recessions. Small and medium enterprises also developed significantly in this period. However, the economic environment surrounding small and medium enterprises have become more and more severe as labor shortage and increase in wages became serious and Japan took steps toward open economy in the course of rapid economic growth.

Under these circumstances, the Small and Medium Enterprise Basic Law was enacted in July 1963 to make the new direction which small and medium enterprises must proceed clear and to illustrate the objectives of the policies on small and medium enterprises.

According to the Law, the objectives of the small and medium enterprise policies are to ensure the development of small and medium enterprises along with the overall national economic development and, at the same time, to help elevate the economic and social status of the people working in small and medium enterprises (Article 1 of the Law). In order to attain the objectives, the Law provides that the government takes necessary measures for the following specific matters (Article 3 of the Law):

- modernization of facilities
- improvement of technology
- rationalization of management and administration
- structual strengthening of small and medium enterprises (appropriateness of enterprise scale, joint operation of business, collectivization of factories, stores, etc., conversion of line of business, etc.)
- correction of unfair terms of transaction
- promotion of demand
- securing the proper level of business opportunities
- adjustment of labor relations, as well as improving the workers' welfare and securing the necessary labor force

In order to secure clearness and consistency in the enforcement of policies, the Law prescribed the scope of small and medium enterprises as follows (see 2-2-3 (1)):

1) in manufacturing, mining, transportation, etc., a company whose amount of capital or total subscription is not more than ¥50 million or a company or individual enterprise whose number of regular workers is not more than 300,

2) in commerce and service business, a company whose amount of capital or total subscription is not more than ¥10 million or a company or individual enterprise whose number of regular workers is not more than 50.

(2) Policies for modernization of small and medium enterprises

In conformity with the directions of policies expressed in the Small and Medium Enterprise Basic Law, several laws were enacted to carry out policy measures for small and medium enterprises. The followings are the laws which were enacted at this time in order to promote modernization of small and medium enterprises.

(a) Enactment of the Small and Medium Enterprise Modernization Promotion Law

The Small and Medium Enterprise Modernization Law was enacted in March 1963 to promote modernization of small and medium enterpri-

ses for advancement of industrial structure and strengthening of international competitiveness. In order to attain the purpose the government took the following measures pursuant to the Law:

1) When one industry was deemed to require modernization, the government designated the industry by a cabinet ordinance and drew up a modernization basic plan which contained the targets of modernization (the performance and quality of products, cost of production, scale of production, etc. in the target year) and types of machinery and amount of funds required to achieve the target.

2) The government made modernization executing plans annually to carry out the modernization basic plan.

3) In order to carry out the plan smoothly, comprehensive measures such as securing necessary amount of funds, special taxation measures to promote mergers and joint subscription, accelerated depreciation for equipment modernization, guidance for conversion of business, etc., were prepared.

After playing a major role in modernization of small and medium enterprises, the Law has been revised extensively in July 1975 to cope with the changing economic environment (see 2-2-3 (3)).

(b) Enactment of the Small and Medium Enterprise Modernization Fund Assistance Law

The Small and Medium Enterprise Modernization Fund Assistance Law was enacted in March 1963 by revising and expanding Small and Medium Enterprise Promotion Fund etc. Assistance Law (enacted in May 1956). By the revision of the Law, Special Account for Small and Medium Enterprise Structural Strengthening Fund was set up in order to extend interest-free loans to prefectures to promote structural strengthening of small and medium enterprises. The Special Account was abolished in August 1967 when Small Business Promotion Corporation (renamed as Japan Small Business Corporation in October 1980, merging Small Business Mutual Aid Corporation) was established and taken over by the Corporation.

(c) Enactment of the Small Business Investment Company Limited Law

The Small Business Investment Company Limited Law was enacted in June 1963 in order to promote the completion of equity capital of small and medium enterprises by subscribing stocks and convertible debentures of small and medium enterprises. In November 1963 three small business investment companies were established in Tokyo, Nagoya and Osaka pursuant to the Law.

(d) Enactment of the Small and Medium Enterprise Guidance Law

The Small and Medium Enterprise Guidance Law was enacted in July 1963 in order to deliberately and effectively carry out the small and medium enterprise guidance business of the State, prefec-

tures and the Japan Small and Medium Enterprise Guidance Center (an incorporated foundation established in June 1967) which is indispensable for the rationalization of management and the elevation of technology of small and medium enterprises. The main purposes of the Center were to conduct education and training of persons in charge of guidance activity and to make research on management and technology of small and medium enterprise. It was abolished in August 1967 and its whole business activities has been taken over by the Small Business Promotion Corporation which was established at the same time.

2-2-3 Period of Changing Economic Environment (from early 1970s to present)

After enjoying a long prosperity in the latter half of 1960s, the Japanese economy has entered into the period of intense changes of economic environment in the years after 1971. What shook the Japanese economy furiously in this period were international monetary crisis triggered by Nixon Announcement in August 1971 (so-called "Nixon Shock") and the oil crisis started from the 4th Middle East War in October 1973, as well as domestic economic problems such as the serious industrial pollution which resulted from past rapid industrialization of the economy.

The drastic changes in and out of the Japanese economy have transformed the basic conditions which supported rapid expansion of the economy and brought Japanese rapid economic growth era to an end. Under these circumstances small and medium enterprises have been faced with the problems such as development of internationalization, demand for saving energy and natural resources, serious environmental pollution, etc.

(1) Extension of scope of small and medium enterprises

The scope of small and medium enterprises which are eligible for policy measures for small and medium enterprises was prescribed in the Small and Medium Enterprise Basic Law of 1963. After a lapse of 10 years, the definition became unappropriate because of largement of scale of the economy during the period. As a result, the scope of small and medium enterprise was extended as follows by revising the Small and Medium Enterprise Basic Law in October 1973:

1) in manufacturing, mining, transportation, etc., a company whose amount of capital or total subscription is not more than ¥100 million (¥50 million before revised), or a company or individual enterprise whose number of regular workers is not more than 300,

2) in wholesale trade, a company whose amount of capital or total subscription is not more than ¥30 million (¥10 million before revised) or a company or individual enterprise whose number of regular workers is not more than 100 (50 before revised),

3) in retail trade and service business, a company whose amount of capital or total subscription is not more than ¥10 million, or a company or individual enterprise whose number of regular workers is not more than 50.

(2) Emergency measures for international economic adjustment

Small and medium enterprises have been faced with very severe problems of international economy such as rapid appreciation of yen, catch-up of developing countries, decreasing export and increasing import of light industry goods, etc. However, they have actively coped with the problems by diversification of export market, switch to domestic market, upgrading quality of products, conversion of business, etc. In order to support and stabilize management of small and medium enterprises and to help their efforts to be adapted to the changing environment, the government took the following measures:

(a) "Urgent Measures for Small and Medium Enterprises pertaining to the Implementation of Import Surcharge of U.S., etc." were decided by cabinet in September 1971 after the 'Nixon Shock'. It contained financial measures, credit supplementation measures, foreign exchange transaction stabilization measures, taxation measures and business conversion promotion measures.

(b) "The Law on Temporary Measures for Small and Medium Enterprises pertaining to the Implementation of Adjustment Measures on International Economy" enacted in December 1971. It contained measures as follows: rescheduling of Small and Medium Enterprise Equipment Modernization Fund, exceptional measures for credit insurance of exporting small and medium enterprises, implementation of Loans for Business Conversion by SBFC, NFC and Small Business Promotion Corporation, creation of accelerated depreciation for the equipment concerning business conversion, implementation of vocational training and mediation of finding employment for workers who had been employed by the enterprise which carried out business conversion, etc.

(c) "Urgent Measures for Small and Medium Enterprises pertaining to the Change in International Monetary Situation" were decided by cabinet in March 1973 after yen moved to floating system in February 1973. It contained implementation of emergency loans by government financial institutions for small and medium enterprises (SBFC, NFC and Shoko Chukin Bank), rescheduling of emergency loans made after the "Nixon Shock," smoothing of forward exchange contract, etc.

(d) "The Law on Temporary Measures for Small and Medium Enterprises related with Appreciation of Exchange Rate of Yen" enacted in February 1978 in order to stabilize the management of small and medium enterprises who were in difficulties owing to the appreciation of yen after mid 1977. The Law provided that government financial institutions for small and medium enterprises (SBFC, NFC and Shoko Chukin Bank) made emergency loans to small and medium enterprises which were confirmed as damaged

firms by prefectural governors or mayors.

(3) Measures to promote adaptation to changing environment

(a) Revision of the Small and Medium Enterprise Modernization Promotion Law

The Small and Medium Enterprise Modernization Promotion Law was revised extensively in July 1975 in order to improve adaptability of small and medium enterprises to the changing environment. Major points of the revision are as follows:

1) Necessary conditions to be designated as modernization promotion business were "advancement of industrial structure" or "strengthening of international competitiveness." "Industries which are supplying goods and services having a close relationship with the national life" was added by the revision.

2) Modernization plan drawn up by the government consisted of basic plan and executing plan. They were unified as small and medium enterprise modernization plan in order to make the planning more flexible. Concerning the content of plan, "elevation of welfare of employees, increase in interest of consumers, preservation of environment" were added as matters to be mentioned.

3) Small and Medium Enterprise New Field Launching Plan was established in order to assist small and medium enterprises who suffer from stagnant demand resulting from change in demand structure etc. and enter into new business field.

(b) Enactment of the Law on Temporary Measures for Small and Medium Enterprise Business Conversion

The Law on Temporary Measures for Small and Medium Enterprise Business Conversion was enacted in November 1976 for the promotion of the business conversion of small and medium enterprises to cope with the drastic changes in economic conditions (decrease in export or increase in import owing to the remarkable changes in trade structure, decrease in demand owing to technological innovation, difficulties in securing materials owing to the remarkable changes in supply-demand situation of the materials, difficulties in supplying goods and services owing to the strengthening of regulations concerning preservation of environment or prevention of danger). The Law provides that the government takes the measures of financing, credit supplementation, etc., for small and medium enterprises who perform business conversion based on the conversion plan recognized by prefectural governors.

2-3 Outline of Present Small and Medium Enterprise Policies in Japan

2-3-1 Financial Measures

(1) Government financial institutions for small and medium enterprises

There are four government financial institutions for small and medium enterprises: Small Business Finance Corporation (SBFC), National Finance Corporation (NFC), Shoko Chukin Bank, and Environmental Sanitation Business Finance Corporation (ESBFC). In line with government industrial policies, they have played a significant role in supplementing private financial funds for small and medium enterprises.

They extend loans to small and medium enterprises using government funds which are raised through the postal saving system and others such sources as government-run pensions, postal life insurance and government-guaranteed bonds. The funds are funneled through what is known as the Fiscal Investment and Loan Program (FILP). In FY1983 the FILP was expected to have ¥24.2 trillion ($102 billion at current exchange rates) in receipts, with ¥20.3 trillion ($84 billion) to be disbursed in policy loans of which 19% to be lent to smaller financial institutions aimed at small business.

The total loan outstanding of the four government financial institutions extended to small and medium enterprises is ¥18.4 trillion ($71 billion) as of March 1985, which accounts for 11.2% of the total loan outstanding to small and medium enterprises by all kinds of financial institutions including private banks.

As well as providing general-purpose loans for general business activities of small and medium enterprises, SBFC and NFC make special-purpose loans to them when they need funds for business activities in line with the specific government policies such as promotion of modernization, structural improvement, prevention of industrial pollution, conservation of energy, etc. Special-purpose loans carry more favorable loan terms such as lower interest rates, longer repayment periods and larger maximum amount of loans than general-purpose loans.

(a) Small Business Finance Corporation (SBFC)

SBFC provides plant and equipment funds and long-term operating funds to small and medium enterprises which find it difficult to obtain necessary funds from private financial institutions.

SBFC funds are available to small and medium enterprises through either direct loans or agency loans. In direct loans, the whole loan procedure is managed by SBFC's head and branch offices directly. On the other hand, agency loans are managed by private financial intitutions which have been designated as agencies of SBFC. The purpose of agency loan system is to make relatively small amount of loans to small and medium enterprises in remote areas by simple and quick procedures.

(b) National Finance Corporation (NFC)

NFC provides small amount of business funds to very small enterprises. NFC funds are also available through either direct loans and agency loans.

(c) Shoko Chukin Bank

Shoko Chukin Bank is a semi-governmental financial institution whose capital is subscribed by the government, cooperative associations of small and medium enterprises, commerce-industry trade associations, etc., and is endowed with full financing functions such as making loans, receiving deposits, handling of bonds, dealing of foreign exchanges, etc. The Bank provides loans to such organizations as cooperative associations and their members.

(d) Environmental Sanitation Business Finance Corporation (ESBFC)

ESBFC was established in September 1967 in order to provide loans to small and medium enterprises engaging in environmental sanitation business (restaurants, barber shops, beauty parlors, laundries, etc.) for the elevation of sanitation standards and modernization. Most of the ESBFC loans are made through agency loan system.

(2) Credit supplementation system

In view of the difficulty small and medium enterprises experience in raising funds from financial institutions, often due to insufficient collaterals, the credit supplementation system has been set up. In this system, credit guarantee associations, established in each prefecture and several major cities, guarantee the loans which small and medium enterprises obtain from private financial institutions. Guarantees of these associations are insured by the Small Business Credit Insurance Corporation, a governmental institution established in July 1958. Borrowings of small and medium enterprises from private financial institutions are made easier by this system.

(3) Small Business Investment Companies (SBICs)

SBICs were established in November 1963 in Tokyo, Nagoya and Osaka with subscriptions from SBFC, prefectural governments and private organizations. The purpose of SBICs is to supply equity capital to small and medium enterprises (corporations whose amount of paid-in capital is not more than ¥100 million) by underwriting new stocks or convertible bonds. SBICs also extend guidance services for management and technology to their customers.

2-3-2 Taxation Measures

Various taxation measures are implemented for the development of small and medium enterprises. Small and medium enterprises are given such tax privileges as basic taxation measures of personal income tax

and corporate income tax. In personal income tax, system for taxation on deemed corporations, system of tax allowances for the remuneration of family employees, etc., are implemented. In corporate income tax, lower tax rate for smaller corporations, deduction of retained income for family corporation, etc. are implemented.

Special taxation measures are given in line with industrial policies by Special Taxation Measures Law. These special taxation measures are implemented as reduction and exemption of taxes or deferment of taxes. Special depreciation and reserve funds are the examples of deferment measures of taxes, provided by the Law in order to promote modernization, research and development, cooperative activities, structural improvement, etc. Most of the special taxation measures are given only to taxpayers filling blue form returns whom the tax offices approve that they equip and keep adequate books prescribed by tax laws.

Various taxation measures implemented now for the promotion of small and medium enterprise development are discribed below.

(1) General measures for individual proprietors

(a) Various deductions on income tax and residents tax

1) basic deduction, spouse deduction, dependents deduction, etc.
2) deduction for blue form return (report of corporation income to the tax office)
3) deduction of family workers' payroll
4) proprietors allowance

(b) System for Taxation on Deemed Corporations: when a taxpayer filling a blue form return selects this system, deduction of proprietor's remuneration is approved.

(2) General measures for corporations

1) reduced rate of corporate income taxes for small and medium corporations
2) reduction of taxes on retained income for family corporations
3) additional transfer to reserve for doubtful accounts for small and medium corporations
4) graduated tax rates for corporate enterprise tax

(3) Measures for succession of business for small and medium enterprises

Inheritance tax system was revised in the following points for the purpose of promoting smooth succession of small and medium enterprises:

1) improvement of method of appraisal of stock value of family corporations,
2) special treatment in appraisal of value of land for business use for individual proprietors.

(4) Measures for cooperatives

1) reduced rate of corporate income taxes for cooperative associations, etc.
2) deduction of dividend paid to members in proportion to their degree of utilization of cooperative activities
3) treatment of entry fee from new members as tax exempt income
4) deduction of retained income
5) deduction of reserve for extraordinary danger for mutual fire insurance cooperatives and their federations
6) exemption of stamp duties (certificates of investment, passbook of deposit, etc.)
7) reduction and exemption of establishment tax
8) exemption of real estate acquisition tax on hospitals and clinics of cooperatives, etc.
9) exemption of real estate tax on offices, warehouses, hospitals and clinics of cooperatives, etc.

(5) Measures for modernization and structural improvement of small and medium enterprises

(a) Special depreciation of machinery for small and medium enterprises: when small and medium enterprises acquire new machinery and use it, special depreciation is approved in the first year.

(b) Taxation system for small and medium enterprises to promote investment in new technology: when small and medium enterprises acquire or lease numerical control (NC) machine tools, industrial robots, computers, etc., special depreciation or tax credit is approved in the first year.

(c) Taxation system for small and medium enterprises to strengthen technological foundation: concerning the research and development expenditure of small and medium enterprises for improvement of technology, invension, etc., tax credit is approved.

(d) Taxation system for cooperatives based on the Law on Temporary Measures for Small and Medium Enterprise Technology Development Promotion: the following taxation measures are approved to cooperatives and their members who carry out technology development activities based on the Law

1) special depreciation of machinery for technology development
2) reduction of taxes for research and development expenditure charged to members by cooperatives
3) exemption and reduction of special land holding tax and establishment tax for land and facilities used for technology development activities

(e) Tax credit of increased research and development expenditure: when blue form return taxpayers spend research and development expenditure in one year more than in any years after 1966, tax credit is approved.

(f) Taxation system to promote research and development of basic technology: when blue form return taxpayers acquire assets for research and development of new materials, biotechnology, high-tech electronics, high-performance robots, etc., tax credit is approved.

(g) Reserves for structural improvement, promotion of subcontractors and promotion of traditional craftworks: when cooperatives, etc. accumulate payments from members in above-mentioned reserves as funds required for joint activities, special taxation treatment is approved for cooperatives and members.

(h) Measures for structural strengthening projects of small and medium enterprises

1) special deduction of transfer income concerning transfer of lands for construction of industrial and commercial estate based on the Japan Small Business Corporation Law

2) deferment of income tax concerning replacement of business assets for collectivization such as industrial estate

3) reduction of registration and license tax for land and building of industrial estate constructed pursuant to the Japan Small Business Corporation Law

4) special depreciation of joint facilities, etc. in the first year of acquisition for structural strengthening activities carried out pursuant to the Small and Medium Retail Business Promotion Law

5) reduction of real estate acquisition tax of joint facilities which cooperatives, etc. acquire pursuant to the Japan Small Business Corporation Law

6) exemption of real estate acquisition tax of industrial estate, etc. if cooperatives resell the real estate to their members in five years

7) reduction of property tax of machinery for joint use which cooperatives acquire pursuant to the Japan Small Business Corporation Law

8) exemption of special land holding tax and establishment tax of assets which cooperatives, etc. use for structural strengthening projects, etc. pursuant to the Laws

(i) Measures concerning the Small and Medium Enterprise Modernization Promotion Law

1) extra depreciation of machinery, etc., for five years for members of commercial and industrial cooperatives who carry out structural improvement plan authorized by competent minister

2) voluntary depreciation of research and development expenditure which cooperatives, etc. charge to their members based on structural improvement plan, etc.

3) tax credit of increased research and development expenditure for new products or new technology development activities which cooperatives carry out based on structural improvement plan, etc.

4) deferment of income tax concerning research and development assets which cooperatives, etc. acquire based on structural improvement plan, etc.

5) reduction of registration and license tax concerning establishment, capital increase and merger of corporations with the approval of competent minister pursuant to the Small and Medium Enterprise Modernization Promotion Law

6) exemption of special land holding tax and establishment tax of assets used for launching new field based on structural improvement plan, etc.

(j) Measures for business conversion of small and medium enterprises

1) exemption of special land holding tax of land which small and medium enterprises use for the business after conversion pursuant to the Law on Temporary Small and Medium Enterprise Business Conversion

2) reduction and exemption of establishment tax

(k) Measures to promote small and medium enterprises in specific depressed regions

1) voluntary depreciation of research and development expenditure which cooperatives, etc. charge to their members pursuant to the Law on Temporary Measures for Small and Medium Enterprises in Areas Related to Specific Industries

2) tax credit of increased research and development expenditure for new field development activities which cooperatives, etc., carry out pursuant to executing plan based on the Law

3) deferment of income tax concerning research and development assets which cooperatives, etc. acquire pursuant to executing plan based on the Law

4) exemption of special land holding tax and establishment tax of land and facilities used for new field development activities pursuant to executing plan based on the Law

(l) Other measures

1) reserve for overseas market development for small and medium

enterprises, etc.

2) taxation system to promote investment for energy efficiency improvement (special depreciation or tax credit)

3) measures for prevention of environmental pollution (special depreciation of pollution prevention equipment, reduction and exemption of registration and license tax, real estate acquisition tax, property tax and special land holding tax)

4) deduction of mutual aid premiums to prevent chain bankruptcy of small and medium enterprises

2-3-3 Measures for Consultation, Guidance and Training

For the promotion of modernization and rationalization of small and medium enterprises, their voluntary efforts are very important. The government is taking various measures for consultation, guidance and training to help their voluntary efforts.

(1) Consultation and guidance of management by prefectures and 10 major cities

The purpose of consultation and guidance activities is to investigate and analyze the situations of management and administration of small and medium enterprises on their requests, point out problems thereof and advise concrete methods for improvement in order to encourage their voluntary efforts toward rationalization of management.

The consultation and guidance activities are managed by Small and Medium Enterprise Comprehensive Guidance Centers in every prefecture and 10 major cities (Sapporo, Yokohama, Kawasaki, Nagoya, Kyoto, Osaka, Kobe, Hiroshima, Fukuoka and Kitakyushu), staffed by personnel who specialize in consulting and guidance projects. The Center entrusts Registered Small Business Management Consultants in private sector with the activities if necessary.

(2) Consultation and guidance of management by the Japan Small Business Corporation

The Japan Small Business Corporation sends their staffs to help in consulting for structural strengthening projects, etc., of prefectures and 10 major cities.

(3) Registered Small Business Management Consultant System

In order to expand and strengthen the consultation and guidance activities, it is indispensable to secure consultants and improve their capability. For this reason, MITI has managed Registered Small Business Management Consultant System since 1963 pursuant to the Small and Medium Enterprise Guidance Law. In this system, MITI authorizes and register eligible persons as Registered Small Business Management

Consultants. As the authorization expires in two years, reauthorization is needed in every two years for keeping the registration.

(4) Training activities

Every prefecture and 10 major cities have basic training projects for the management of small and medium enterprises in order to provide them with the opportunity to learn managerial know-how and skills.

In addition, Institutes of Small and Medium Enterprises (established as a part of Japan Small Business Corporation in Tokyo, Hyogo Prefecture and Fukuoka Prefecture) offers various training projects for owners, successors and management staffs of small and medium enterprises. Their curriculum contains management, overseas investment, automation, industrial design, micro-computer, mechatronics, electric control, hydraulic control, electronic control, etc. The Institute also provides training projects for guidance personnel of prefectural governments.

2-3-4 Measures for Technology Development

Small and medium enterprises must improve their technological abilities in order to adapt themselves effectively to the changing economic environment. The government has been taking various measures to correct their disadvantages in personnel, funds and facilities which impede improvement of their technological abilities.

(1) Enactment of the Law on Temporary Measures for Promotion of Small and Medium Enterprise Technology Development

The Law on Temporary Measures for Promotion of Small and Medium Enterprise Technology Development was enacted in July 1985 in order to cope with the rapid development of technological innovation and significant changes in demand structure in recent years. The Law provides that the government takes the following assisting measures: (a) investment: exceptional treatment of Small Business Investment Company Limited Law, (b) credit supplementation: exceptional treatment of Small and Medium Enterprise Credit Insurance Law, (c) taxation: special depreciation of facilities, etc., (d) financing: special purpose loans by SBFC and NFC, structural strengthening loans by Japan Small Business Corporation.

To get these official assistance, small and medium enterprises and cooperatives have to draw up technology development plan and submit it to prefectural governors to obtain their authorization.

(2) Local System Technology Development Activities

"Local System Technology Development Activities" was created in FY1985 in order to develop large-scale and advanced system technologies which are necessary for development of small and medium enterprises in a local area with the cooperation of national government, prefectures, public laboratories, universities and small and

medium enterprises.

(3) Local Frontier Technology Development Activities

"Local Frontier Technology Development Activities" was begun in FY1983. The purpose of the Activities is to combine the seeds of technology indigenous to a local area with advanced technologies such as electronics, biotechnology, new materials, etc. in order to revitalize the existing small and medium industries and open new frontiers to them. In this project, central and local governments join hands to consolidate the industry, academe and governments to conduct extensive research and development activities.

(4) Assistance for technology development of small and medium enterprises

(a) Loans for the introduction of new technologies

This is one of SBFC's special-purpose loans. SBFC makes long-term and low-interest rate loans when small and medium enterprises begin to produce new technology products on a commercial basis or manufacture trial machinery or products utilizing new technology. SBFC requires recommendation of Bureaus of International Trade and Industry (regional offices of MITI).

(b) Loans for promotion of high-technology

This is one of SBFC's special-purpose loans too. SBFC makes long-term and large-amount loans to small and medium enterprises who manufacture products using high-technologies (micro-electronics, biotechnology, new materials, etc.), parts or materials for high-technology products, or manufacturing and inspection machinery for high-technology products.

(c) Insurance for commercial production of new technology products

When credit guarantee associations guarantee the loans which small and medium enterprise obtained from private financial institutions as funds required for beginning commercial production of new technology products, special measures are taken concerning the maximum amount of insurance and rate of insurance premium.

(d) Technology improvement expentidure subsidy

The subsidy is granted to small and medium enterprises who carry out technological research or trial manufacturing for the purpose of strengthening of competitiveness, improvement of production efficiency, improvement of welfare and safety, conservation of resources and energy, prevention of pollution, etc.

(5) Technological guidance

About 190 public experimental and research institutes provide technological guidance to small and medium enterprises. In addition,

small and medium enterprises can conduct their own experiments in open laboratories attached to all public experimental and research institutes.

Furthermore, the technical advisor system is managed by prefectures. In this system, technical specialists in the private sector are registered with the prefectural governments as technical advisors so their services may be utilized by small and medium enterprises on their request.

2-3-5 Measures for Construction of Industrial Estate

Measures for construction of industrial estate for small and medium enterprises are managed by the Japan Small Business Corporation as a part of structural strengthening activities. In the structural strengthening activities, the Japan Small Business Corporation and prefectural governments provide funds jointly to make long-term and low-interest rate loans to small and medium enterprises who carry out the structural strengthening activities. Structural strengthening activities are prescribed by laws (Japan Small Business Corporation Law and Enforcement Ordinance of the Law) as follows (* shows industrial estate project):

1) collectivization activities
   a) construction of industrial estate *
   b) construction of wholesale estate
   c) construction of retail estate
   d) construction of truck terminal
   e) construction of warehouse estate
2) shopping district modernization activities
   a) remodelling of shopping district
   b) remodelling of wholesaler district
3) joint retail store
4) joint facilities
5) common facilities utilization
6) special structural strengthening activities in broader region
7) structural strengthening activities for structural improvement
8) construction of joint factories for smaller enterprises
9) joint activities for increasing knowledge-intensiveness
10) joint disposal of equipment
11) structural strengthening for natural disaster relief
12) structural improvement of textile industry
13) prior acquisition
14) joint utilization of local industries
15) loans for computer software

"Construction of industrial estate" as a part of structural strengthening activities is intended to relocate small and medium manufacturers who are situated in urban areas and cannot advance modernization because of difficulties in acquiring land, environmental pollution, traffic jam, etc. to the appropriate factory site collectively in order to become free from such obstacles. Furthermore, "the Activities" is intended to improve their efficiency and competitiveness

drastically by the construction of well-designed industrial estates where joint business activities of small and medium enterprises are conducted.

Plan for the construction of industrial estate is made by cooperatives organized by small and medium manufacturers who are going to relocate their factories to the planned industrial estate. Small and Medium Enterprise Comprehensive Guidance Centers of prefectures (or Guidance Division of the Japan Small Business Corporation) assist small and medium enterprises in making the plan.

The application of loans for structural strengthening activities is received by the prefecture. The staff of prefecture in charge of management guidance, etc. perform consultation of the construction plan and investigate the feasibility of the plan with cooperation of consultants from the Japan Small Business Corporation.

2-3-Appendix Principal Organizations for Small and Medium Enterprise Promotion Policies

(1) Small and Medium Enterprise Agency

The Small and Medium Enterprise Agency is a central government agency established in August 1948 as a part of Ministry of International Trade and Industry pursuant to the Small and Medium Enterprise Agency Establishment Law (1948). The Agency is in charge of comprehensive policy measures for the promotion of small and medium enterprises.

(2) Japan Small Business Corporation

The Japan Small Business Corporation was established in October 1980 as a governmental institution by merging the Small Business Promotion Corporation (established in August 1967) and the Small Business Mutual Aid Corporation (established in December 1965) pursuant to the Japan Small Business Corporation Law (1980).

The scope of business of the Corporation is as follows:

(a) Making loans and providing guidance for structural strengthening activities such as construction of industrial estate, remodelling of shopping district, joint facilities utilization, etc.

(b) Training of management consultants, owners, management, etc. of small and medium enterprises and making research on methods of training and guidance by Institute of Small and Medium Enterprises established as a part of the Corporation.

(c) Collection analyzing and offering various information for small and medium enterprises with the cooperation of other organizations through Small Business Information Center established in the Corporation.

(d) Managing mutual aid system based on Smaller Enterprise Mutual Aid Law (1965) and Small and Medium Enterprise Bankruptcy Prevention Mutual Aid Law (1977).

(3) Small Business Finance Corporation (SBFC)

SBFC was established in August 1953 as a government financial institution for small and medium enterprises pursuant to the Small Business Finance Corporation Law (1953). The scope of business of the Corporation is to make long-term loans to small and medium enterprises which find it difficult to obtain necessary funds from ordinary private institutions.

(4) National Finance Corporation (NFC)

NFC was established in June 1949 as a government financial institution for very small enterprises pursuant to National Financial Corporation Law (1949). The scope of business of the Corporation is to make small loans of business funds to those persons who find it difficult to obtain credit from banks or other private financial institutions. In addition, the Corporation makes small loans of education funds necessary for entering high schools, universities, etc.

(5) Shoko Chukin Bank

Shoko Chukin Bank was established in December 1936 as a semi-governmental financial institution for cooperatives of small and medium enterprises pursuant to Shoko Chukin Bank Law (1936). The Bank has full financing functions and provides loans to cooperatives and their members.

(6) Small Business Credit Insurance Corporation

The Small Business Credit Insurance Corporation was established in July 1958 as a government financial institution pursuant to the Small Business Credit Insurance Corporation Law (1958).

The scope of business of the Corporation is as follows:

(a) Extending insurance coverage to guarantee liabilities of credit guarantee associations of prefectures and major cities for the loans which small and medium enterprises obtain from financial institutions.

(b) Making loans to credit guarantee associations in order to supply funds necessary for increasing their amount of liabilities.

(7) Small Business Investment Companies (SBICs)

SBICs were established in November 1963 in Tokyo, Nagoya and Osaka as semi-governmental corporation pursuant to Small Business Investment Company Limited Law (1963). The scope of business of SBICs is as follows:

(a) Supplying equity capital to small and medium enterprises (corporation whose amount of paid-in capital is not more than ¥100 million) by underwriting new stocks or convertible bonds.

(b) Underwriting new stocks issued by corporations whose shares SBICs have held pursuant to the provision (a).

(c) Extending managerial and technological guidance to the corporations whose shares or convertible bonds SBICs have held pursuant to the above provisions, in response to their request.

3. DEVELOPMENT OF PETROCHEMICAL INDUSTRY IN JAPAN

3-1 Introduction

The chemical industry has several subsectors which may be classified in different ways. Manufactures Census of the Ministry of International Trade and Industry classified this sector into seven subsectors, namely (a) fertilizer, (b) inorganic chemicals, (c) organic chemicals, (d) chemical fibers, (e) oil, fat and soap, (f) drugs and medicines, and (g) others. This paper will describe the development process of the petrochemical industry classified in organic chemicals, which showed rapid growth after World War II (Figure III-3-1).

Successful economic growth in the postwar period is quite often said that it was led by "the development of heavy and chemical industries." In fact it can not be denied the importance of the contribution made by the chemical industry, especially the petrochemical industry to the development of the Japanese economy. The chemical industry played a quite important role as a supplier of high-quality basic materials to various industries which eventually became able to produce very competitive products on the international market. With respect to the investment amount, chemicals sector consistently occupied large share of 8%-10% of all indusries' investment amount together with other leading sectors such as iron and steel, machinery, in the 1960s (Table III-3-1). Along with the development of the economy, the production amount of the chemical industry has been growing and there are existing 17 petrochemical complexes now in Japan (Figure III-3-2). Japanese chemical industry is now ranked second in the world, next only to the U.S.A. (Table III-3-2).

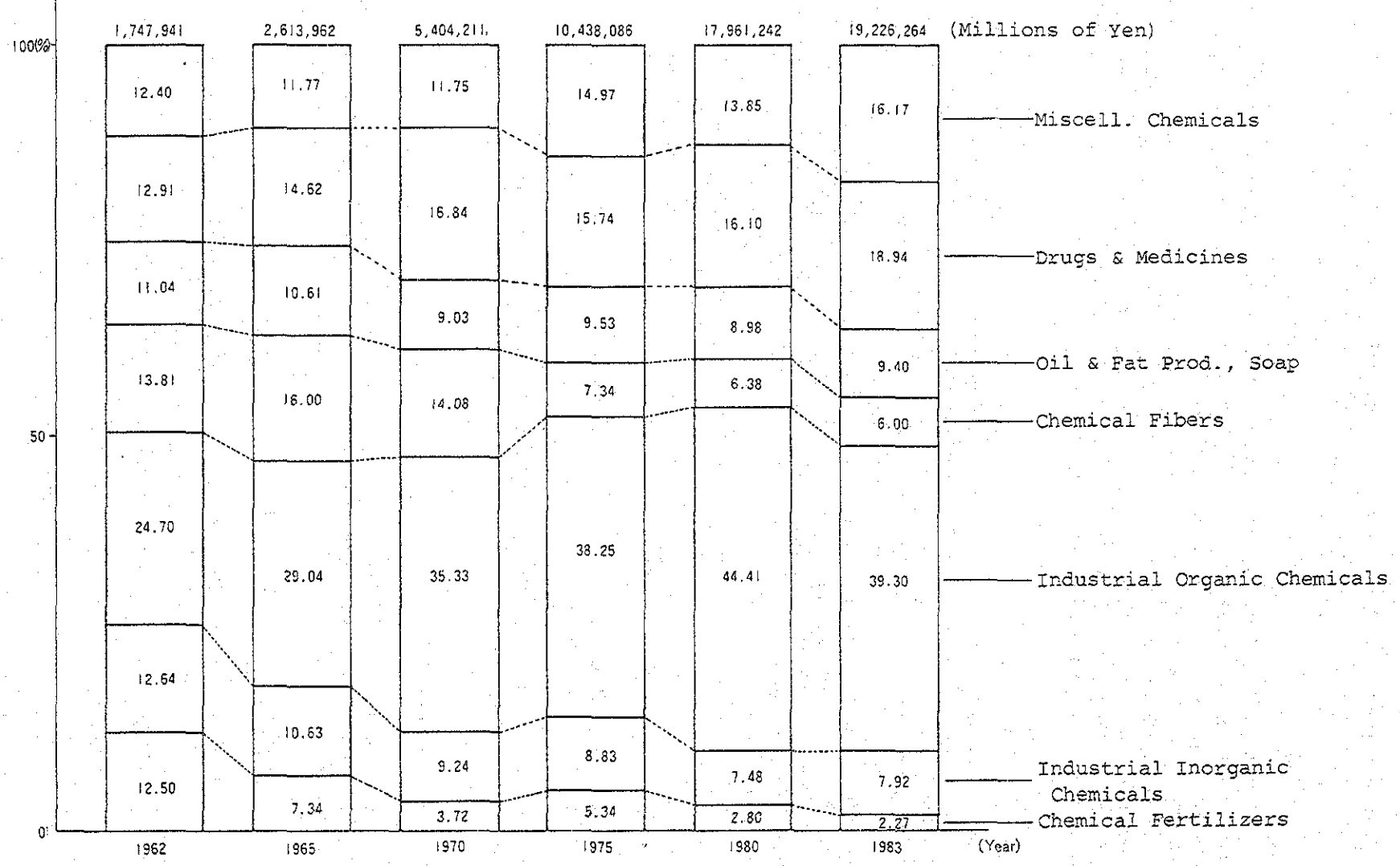
However, after the oil crisis of 1973, structural changes have been undergoing in Japanese industry and petrochemical industry is not an exception. The price hike of oil led to the hike of raw material cost for petrochemicals which hit the profitability of each company quite severely.

3-2 Development Stages

The development of the Japanese chemical industry, focussing on the petrochemical industry, can be classified into six stages as follows (see Table III-3-3).

I	1945-1949	Recovery from the War
II	1950-1954	Initial moves to begin production using organic chemicals
III	1955-1959	Start of the petrochemical industry
IV	1960-1964	Set-up period of the petrochemical industry

Figure III-3-1 Position of the Petrochemical Industry in the Chemical Industry (Shipment Amount)



Source: MITI, Census of Manufactures.

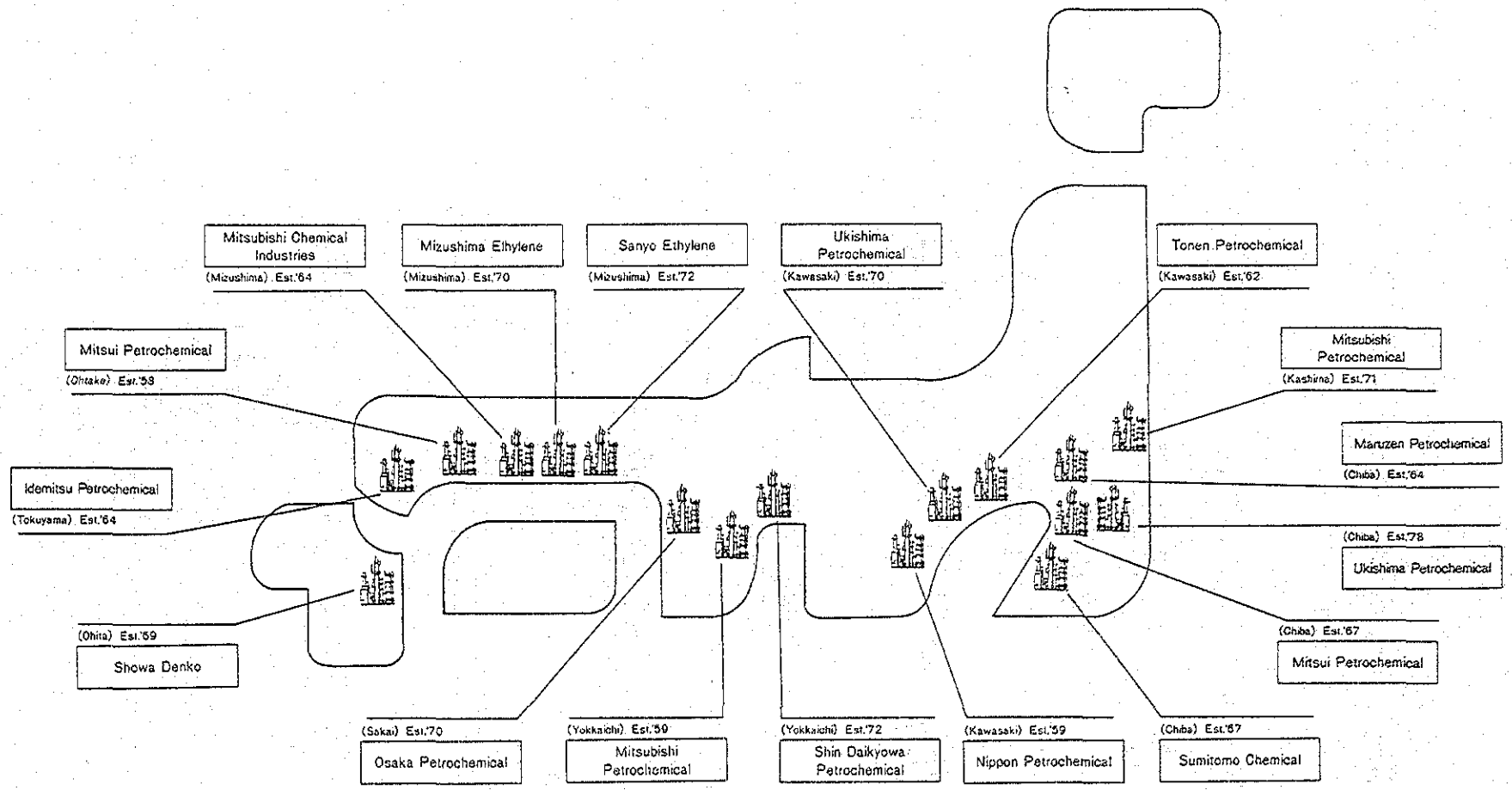
Table III-3-1 Trend of Investment by Industries

(Billions of Yen, %)

		All Industries	All Manufact	Chemicals	Iron & Steel	Machinery	Electric Machi	Transp Machi
By Amount	1960	1,463	921	124	245	26	110	97
	1961	1,916	1,229	160	301	40	161	145
	1962	1,771	1,093	130	275	31	138	134
	1963	1,763	996	150	184	27	104	144
	1964	2,112	1,354	263	213	47	112	248
	1965	1,842	1,047	192	212	29	61	189
	1966	1,876	1,053	166	235	33	83	179
	1967	2,743	1,797	231	454	61	157	341
	1968	3,466	2,315	328	528	88	213	423
	1969	4,257	2,878	404	697	131	346	451
	1970	5,063	3,407	510	890	154	370	465
	1971	5,595	3,316	458	900	142	324	501
	1972	5,512	3,111	318	680	171	345	659
	1973	6,455	3,733	399	713	165	494	686
	1974	6,712	4,248	734	900	142	404	680
	1975	6,220	3,799	632	1,195	128	321	411
	1976	6,790	3,498	334	1,303	101	361	506
	1977	6,150	2,984	405	686	132	437	591
	1978	7,101	2,805	267	557	111	517	698
	1979	7,439	3,496	462	543	132	568	721
	1980	9,364	4,638	566	596	185	761	1,223
	1981	9,765	5,106	551	852	244	775	1,331
	1982	10,340	5,536	658	1,075	250	1,224	1,270
	1983	9,711	4,992	564	897	231	1,157	956
	1984	10,645	6,033	585	778	272	1,837	1,144
Average Annual Increase Rate,% (1960-1984)		8.62	8.14	6.69	4.92	10.20	12.45	10.82
By Shares								
	1960	100.0	63.0	8.4	16.8	1.8	7.5	6.7
	1961	100.0	64.1	8.3	15.7	2.1	8.4	7.6
	1962	100.0	61.7	7.3	15.5	1.8	7.8	7.6
	1963	100.0	56.5	8.5	10.4	1.5	5.9	8.2
	1964	100.0	64.1	12.4	10.1	2.2	5.3	11.8
	1965	100.0	56.8	10.4	11.5	1.6	3.3	10.3
	1966	100.0	56.1	8.9	12.6	1.7	4.4	9.5
	1967	100.0	65.5	8.4	16.5	2.2	5.7	12.4
	1968	100.0	66.8	9.5	15.2	2.5	6.1	12.2
	1969	100.0	67.6	9.5	16.4	3.1	8.1	10.6
	1970	100.0	67.3	10.1	17.6	3.0	7.3	9.2
	1971	100.0	59.3	8.2	16.2	2.5	5.8	9.0
	1972	100.0	56.4	5.8	12.4	3.1	6.3	12.0
	1973	100.0	57.8	6.2	11.1	2.6	7.7	10.6
	1974	100.0	63.3	10.9	13.5	2.1	6.0	10.1
	1975	100.0	61.1	10.2	19.2	2.1	5.2	6.6
	1976	100.0	51.5	4.9	19.2	1.5	5.3	7.5
	1977	100.0	48.5	6.6	11.2	2.1	7.1	9.6
	1978	100.0	40.8	3.8	7.8	1.6	7.3	9.8
	1979	100.0	47.0	6.2	7.3	1.8	7.6	9.7
	1980	100.0	49.5	6.0	6.4	2.0	8.1	13.1
	1981	100.0	52.3	5.6	8.7	2.5	7.9	13.6
	1982	100.0	53.5	6.4	10.4	2.4	11.8	12.3
	1983	100.0	51.4	5.8	9.2	2.4	11.9	9.8
	1984	100.0	56.7	5.5	7.3	2.6	17.3	10.8

Source: Bank of Japan, Shuyo Kigyo Keiei Bunseki (Analysis of Management of Major Companies).
Note: Companies included in this data are those of more than or equal to the capital of one billion yen.

Figure III-3-2 Location of Petrochemical Complexes



Source: Japan Petrochemical Industry Association, Petrochemical Industry of Japan.

Table III-3-2 Production Amount of Petrochemical Products of Major Countries (1980)

	Japan	U. S. A.	U. K.	France	F.R.Germeny	China	Korea	India	Brazil	Mexico	Australia
Production Amount (thousand tons)											
Ethylene	4,175	12,494	1,105	2,073	3,090	498	373	155	714	366	282
Synthetic Resins											
Polyvinyl Chloride (PVC)	1,429	2,481	361	725	1,070		237	40	330	122	119
Polystyrene(PS)	791	1,597	140	366	505		47	10	114	82	47
Low Density Polyethylene (LDPE)	1,179	3,307	323	836	680		112	85	305	91	114
High Density Polyethylene (HDPE)	681	1,998	91	239	690		89	21	129	67	70
Polypropylene	927	1,647	195	211	300		146				57
Total (including Others)	7,518	17,000	2,342	2,916	6,710	900	861	162	850	480	651
Synthetic Fibers	1,357	3,242	288	192	720	270	536	71	231	239	13
Synthetic Rubbers	587	1,408	140	223	243		70	16	195	68	36
Population (million)	116.8	227.7	55.9	53.7	61.6	965.3	38.2	663.6	123.0	71.9	14.6
Per capita Production (kg/person)											
Ethylene	36	55	20	39	50	1	10	0	6	5	19
Synthetic Resins	64	75	42	54	109	1	23	0	7	7	45
Synthetic Fibers	12	14	5	4	12	0	14	0	2	3	1
Synthetic Rubbers	5	6	3	4	4	-	2	0	2	1	2

Source: European Chemical News.

Table III-3-3 Development Process of Japanese Petrochemical Industry

	Period	New Ethylene Center	Scale of Naphtha Cracking Equipment	Ethylene Production	Characteristics	Government Policy
III	'55 → '59	Mitsui Petrochemical (Ohtake) Sumitomo Chemical (Niihama) Nippon Petrochemical (Kawasaki) Mitsubishi Petrochemical (Yokkaichi)	(1,000 T/Y) 12 - 25	(1,000 T) '58 14 '59 44	*Formation of the industry *Entrance by capital-rich companies who belong to industrial groups *Operation centering on production of synthetic resins and synthetic rubbers *Production setups designed mainly for production of ethylene derivatives *Tie-ups with oil refineries	*Measures for fostering the industry (1955 by MITI) Crude oil allocation system Foreign exchange allocation for the import of petrochemical plant and technology Extra depreciation for petrochemical production facilities Loans by the Japan Development Bank *Disposal of the site of former naval facilities for fuel
IV	'60-'64	Tohnen Petrochemical (Kawasaki) Daikyowa Petrochemical (Yokkaichi) Mizushima Chemical Industries (Mizushima) Maruzen Petrochemical (Chiba) Idemitsu Petrochemical (Tokuyama)	40 - 70	'60 78 '61 107 '62 232 '63 346 '64 505	*Establishment as an industry *New entry by oil refiners one after another *Conversion of raw materials (from conventional method to petrochemical method) PVC: Carbide, Acetylene→Ethylene *Efficient use of propylene Appearance of polypropylene	*Plans for commercialization of petrochemical industry (1959 by MITI) Promotion of conversion from existing chemical method to petrochemical method Promotion of utilization of residuals *Settlement of the standard price for naphtha ---¥6,000/kl
V	'65-'67	Sumitomo Chiba Chemical (Chiba) Nisui Petrochemical (Chiba)	100 - 200	'65 777 '66 1,065 '67 1,368	*Rapid expansion of production facilities *Efficient use of aromatics Development of Synthetic fibers *Construction of second centers by pioneer companies *Import of naphtha on a full scale	*Establishment of "Council for Petrochemical Industry Cooperation" jointly by government and private sectors Plant construction approval standard — criteria for investment: annual production capacity more than 100,000t/year *Promotion of construction of Petrochemical Complexes Simplified topper method
	'68-'72	Tsurusaki Petrochemical (Tsurusaki) Ohsaka Petrochemical (Sakai) Ukishima Petrochemical (Kawasaki) Mitsubishi Petrochemical (Kashima) Mizushima Ethylene (Mizushima) Shin Daikyowa Petrochemical (Yokkaichi) Sanyo Ethylene (Mizushima)	(1,000 T/Y) 300 ~	(1,000 T) '68 1,793 '69 2,400 '70 3,097 '71 3,537 '72 3,851	*Became the second largest petrochemical producing country *Establishment of production setups by large-scale plants each of which has production capacity of 300,000t/year *Rapid increase in demand with the background of high economic growth *Establishment of integrated production systems by major chemical companies *Efficient use of all kinds of residuals obtained from cracking of naphtha *Stringent situation in demand and supply of naphtha	*Decision by "Council for Petrochemical Industry Cooperation" Criteria for investment: annual production capacity more than 300,000t/year — for strengthening international competitiveness Promotion of joint investment
VI	'73-'77	Showa Denko (Tsurusaki) Ukishima Petrochemical (Chiba)	300 ~	'73 4,171 '74 4,176 '75 3,399 '76 3,803 '77 3,979	*The first oil shock (1973) Temporarily favorable in business owing to the sharp price hike triggered by shortage of goods in 1973 *Increase in demand for imported naphtha due to price increase of domestic naphtha Price of naphtha — decided under the negotiation by representative companies each in petroleum industry and petrochemical industry	*Policies to prevent the market of petrochemical products from disordered demand and supply Settlement of the standard price of olefins Settlement of the guide lines for demand and supply of major resins *Flexible import of naphtha
	'78-'83			'78 4,387 '79 4,764 '80 4,175 '81 3,655 '82 3,550 '83 3,688	*The second oil shock (1978) Structural changes of the petrochemical industry *Efforts to re-establish a new order of the industry	*"Council for Industrial Structure" (1981-'82) examination on the industrial structure in the future

V 1965-1972 Period of rapid economic growth

VI 1973- Period of slower growth

The first stage was the recovery from the ruins of World War II. The most important target of economic policy at that time was, no doubt, to secure enough food supply to maintain a minimum standard of living by the people. The so-called "Priority Production System" was employed to maximize economic efficiency. Fertilizer production was selected as a targeted sector to back up the food production. In the second stage, the production level generally recovered to the peak of the prewar period, and several companies started the production of polyvinyl chloride and synthetic fiber. In the third stage, the petrochemical industry was born with considerable support by the government, including a loan from the Japan Development Bank and an accelerated depreciation system. The industrial groups such as Mitsui, Mitsubishi, Sumitomo which were forced to dissolve after the war again gathered capital within a group for investment. In the fourth stage, a number of petrochemical complexes were set up along the coast facing the sea connected with oil refineries by pipeline. The fifth stage was the period of rapid expansion with a large-scale plant policy by the government to increase efficiency by economy of scale and to overcome the threat of competitive foreign product. However, ironically, the biggest problem was not brought about by competitive foreign products but by the unexpected price hike of oil in 1973. This really shook the structure of the petrochemical industry. The Japanese economy as a whole has moved to the stage of a lower rate of growth after the two oil crises. Under such circumstances the Japanese petrochemical industry is now facing new problems.

3-3 Recovery Period after the War (1945-1949)

The Japanese Government adopted a "Priority Production System" as basic policy after the war. The aim of the policy was to maximize economic efficiency in a situation where there were only limited amounts of basic materials available. At that time, the principal source of energy was coal since the importation of oil was not allowed by General Headquarters of Allied Forces. Steel was another important basic material in rebuilding the Japanese economy. Chemical fertilizer was indispensable in increasing food production. The Japanese Government nominated industries to produce those important materials and gave them priority in the supply of the limited resources available.

Under this policy, the selected industries enjoyed special treatment by the Government in the form of loans from the Reconstruction Finance Corporation, priority allocation of essential raw materials and compensation for price adjustment. The policy was regarded as effective in quickening the recovery of those basic industries although it also brought an unfavorable side effect - the acceleration of inflation.

In the chemical industry, the chemical fertilizer sector was made a priority industry and was given favorable treatment by the Government. Eventually, production in the chemical industry recovered its prewar

Table III-3-4 Recovery of Chemical Industry after World War II

(Unit: Thousand tons, %)

	Peak level Production during World War II (per year)(A)		Production at the end of the War (per year)(B)	(B) / (A) x 100	The year of recovery and the production amonut of that time		1983 production
	(year)				(year)		
Ammonia	1941	341	99	29.0 %	1950	433	1,881
Caustic Soda	1940	455	62	13.6 %	1954	459	2,863
Sulfuric acid	1940	2,493	371	14.9 %	1951	2,368	6,662
Soda ash	1940	245	53	21.6 %	1953	277	1,103
	1941	397	156	39.3 %	1950	426	170
Ammonium Sulfate	1941	1,374	304	22.1 %	1950	1,502	1,504
Benzoyl	1944	41	17	41.5 %	1953	47	1,938
Methanol	1943	23	9	39.1 %	1950	24	n/a
Carbide	1941	360	143	39.7 %	1949	427	476

Source: The Industrial Bank of Japan, Ltd.

level around 1950 (Table III-3-4).

3-4 Initial Moves to Begin Production using Organic Chemicals (1950-1954)

During this period Japan was able to calm down the postwar inflation by implementing a deflationary budget in 1949 on the recommendation of the Dodge mission. Meanwhile, the Korean War (1950-1953), which provided huge demand to Japanese industries, triggered for the development of its economy. Reflecting these environment, the aim of Government policy shifted from mere recovery to such diverse objectives as an increase of efficiency of each company's operation and the setting-up of instruments for industrial policy including governmental supportive system aiming at the further development of industries. The chemical industry itself diversified out of the recovery stage in this period by regaining the prewar level of production.

The following is a partial list of the measures introduced by the Government aiming at the above said objectives.

1949	Rationalization of industries (Cabinet decision)
1950	Foreign Investment Law
	Start of the Special Tax Arrangement Law to accelerate the development industries
	Establishment of the Japan Development Bank
1951	Establishment of the Export Bank of Japan
1952	The Enterprise Rationalization Promotion Law

A notable event in the chemical industry was the start of business related to organic chemicals such as the production of synthetic fiber and polyvinyl chloride. It must be mentioned, however, that raw materials at this stage were not oil-derived products but materials obtained from coal and other sources such as acetylene.

The production level of the fertilizer industry recovered to the prewar level around 1950. The government declared the abolishment of the control of supplies of chemical fertilizer in the same year. This, however, let to an excess of production and the indutry turned to exports as a solution. Unfortunately, export promotion did not result in the hoped for bonanza and government set up two laws to adjust the supply and demand of chemical fertilizer; namely, the Law for the Stabilization of Supply and Demand of Fertilizer and the Law for the Rationalization and Adjustment of the Export of Fertilizer, both enacted in 1954.

When the production of chemical fertilizer recovered to the prewar level and exports could be made, new businesses related to organic chemicals were initiated in several areas. One area undertaken at this stage was the production of synthetic fiber. Research on synthetic fiber was implemented in the prewar period and some companies had resumed their studies in anticipation of starting operations. The government issued a supportive announcement called "Accelerating the Start of the Synthetic Fiber Industry" in 1949 and initiated several

policy measures such as the provision of loans from the Japan Development Bank, accelerated depreciation, and a system of special tax allowance.

Around 1950, the production of polyvinyl chloride was started. The technique for the use of acetylene had already been developed to a considerable level. Also, the efficient use of chloride as a by-product of caustic soda was also desired at that time. From the technical viewpoint, the basic theory had already been in existence during the war and intensive study after the war resulted in the commercially feasible production of polyvinyl chloride. Quite a number of companies planned to enter this business at that time. Since then, polyvinyl chloride was going to become one of the major plastics in Japan.

3-5 Start of the Petrochemical Industry (1955-1959)

After the embryonic stage of organic chemicals, the government clarified the direction for the petrochemical industry by issuing "The Measures for the Development of the Petrochemical Industry" in 1955. The background of this declaration is as follows.

(a) General Headquarters of the Allied Forces allowed the import of oil and the operation of oil refineries from 1949.

(b) There was a relatively large demand for heavy oil by mainly from electric power generating companies reflecing the rapid increase of electricity demand by industrial sector. Meanwhile, demand for the light oil was small and seemed to be continued to be small for a considerable period because the progress of rapid motorization was not expected at that time. An efficient use for the excess of light oil (Naphtha) was desired by setting up the petrochemical sector.

(c) Without the development of a domestic petrochemical indutry, huge amounts of imports would have been unavoidable to support the development of other industries so that import substitution was an urgent policy target of the government.

The actual measures to support this policy were as follows:

(a) The arrangement of loans from the Japan Development Bank for investments recognized as being of high priority
(b) An accelerated depreciation system
(c) The import of technical know-how
(d) Special tax allowances for corporations in the petrochemical industry
(e) Special permission to import equipment for the petrochemical industry

Another supportive declaration called "the use of oil storage facilities of the former Japanese Navy" was announced in 1955 by the Cabinet to provide the basis for petrochemical complexes.

Under these circumstances, in 1958 the Mitsui industrial group established the first petrochemical company, Mitsui Petrochemical Company, and entered the petrochemical business with the ethylene production capacity of 20,000 tons per year. In the same year, Sumitomo followed Mitsui by starting 12,000 tons per year ethylene production facilities. In 1959, newly established company by Mitsubishi group, called Mitsubishi Petrochemical Company started the production of 22,000 tons per year production facilities. These investment movement are called Phase I investments (see Table III-3-3).

The Phase I projects are epoch-making ones which contained following characteristics:

(a) With respect to location, those companies were set up at the advantageous location facing seaport where oil refinery were located. Meanwhile, most of the past chemical companies had been located in inland area where raw materials such as coal and limestone could be obtained.

(b) With respect to raw materials, naphtha was used as same as European companies. Since petrochemical companies in U.S.A. were using natural gas as raw material, Japanese companies were thought to be less competitive against products from U.S.A. However, supply of naphtha continued to be in surplus situation and price of naphtha was controlled at favorable level for petrochemical companies. The problem of naphtha as being raw material was not revealed in this period.

(c) With respect to production system, in order to realize efficient use of every components of naphtha, the petrochemical complex system was chosen by connecting each residual processing companies by pipelines.

These forerunners of Phase I made a good start, supported by a favorable increasing demand for their products.

3-6 Set up Period of the Petrochemical Industry (1960-1964)

Expecting a continuous upward trend for the industry, a number of other companies rushed to set up petrochemical businesses. To keep the situation under control, the government issued "Plans for the Commercialization of the Petrochemical Industry" in 1959, calling for (a) the efficient use of other residual products such as propylene and butylene and (b) the conversion of raw materials from conventional ones to naphtha. New investment and expansion plan approved under this guideline formulated Phase II of petrochemical investment movement.

When the petrochemical business started being able to expect a brilliant future, "The Doubling National Income Plan" was announced by the government in 1960 and the Japanese economy entered a period of high economic growth. In this rapid upward trend of the Japanese economy, the demand sector of petrochemicals, such as synthetic fiber, automobiles, and electric home appliances, experienced quite a high rate of

increase in production, which in turn sustained an increase in demand for petrochemical products. From 1960 to 1970 the demand for synthetic resin and other petrochemical products showed a continuous upward trend in parallel with the popularization of automobiles and electric home appliances (Figure III-3-3).

One of the important objectives of the encouragement of the petrochemical industry in Japan was to realize high rate of economic growth without huge inflow of importing chemical products. As Figure III-3-4 shows, in 1965 the export amount of chemical products exceeded the import amount for the first time. It can thus be said that this objective of the policy was accomplished in 1965.

From the viewpoint of the procurement of raw materials, an event occurred which clearly showed the fragility of the Japanese petrochemical industry. The consumption of naphtha, an important raw material of the petrochemical industry, increased together with the rapid increase in ethylene production. In 1962, the new Petroleum Law was enacted to regulate the oil industry, after oil imports became basically free from quota controls. Under the old system, oil refineries, which provided naphtha to petrochemical complexes, were granted priority for their oil imports. With the abolishment of this privilege after the introduction of the new law, oil refineries were no longer interested in continuing to supply naphtha in the same way as before and hence declared a price increase of their naphtha to petrochemical companies. This issue was eventually resolved, but the Japanese petrochemical industry was forced to experience another raw material supply problem later when the oil crisis occurred in the following decade.

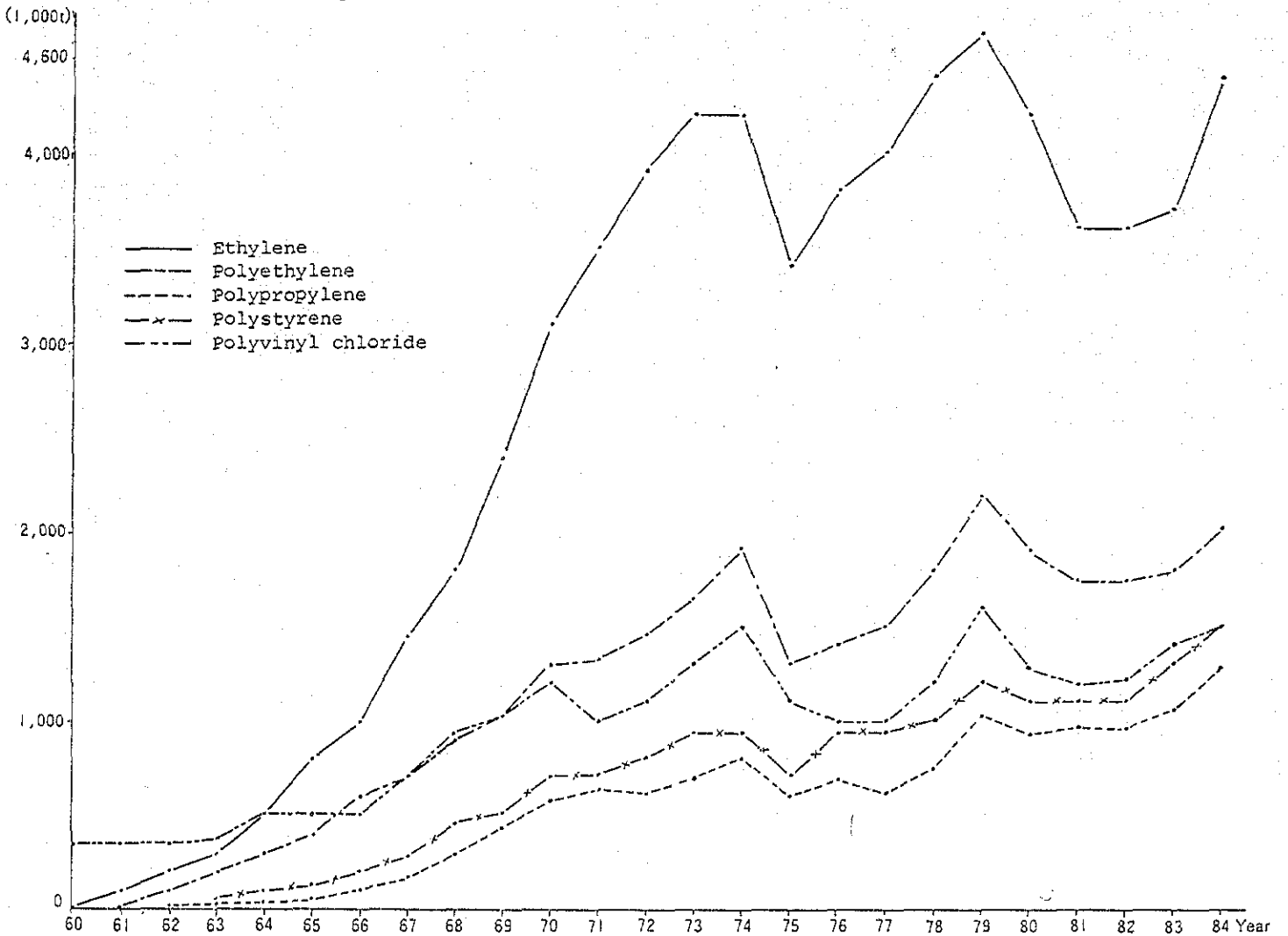
3-7 Period of Rapid Economic Growth (1965-1972)

In this period, the production capacity of petrochemicals continued to grow in generally favorable circumstances. However, the government and the industry began to consider countermeasures to cope with the threat posed by foreign capital. Japan moved to the status of an IMF article 8 country in 1964 and joined the OECD in the same year. The Japanese economy was going to be opened for direct investment by foreign institutions on a step-by-step basis.

The newly borned Japanese petrochemical companies at that time seemed to be less competitive in various aspects such as capabilities of technological development. Their financing were heavily dependent on debt which made the companies vulnerable. In order to avoid the situation where a number of small sized naphtha cracking center would have been established,the government and the petrochemical industry decided to establish an institution to coordinate the activities of the industry known as the Council for the Petrochmical Industry in 1964 aiming at the increase the competitive position of Japan vis-a-vis the threat of foreign capital.

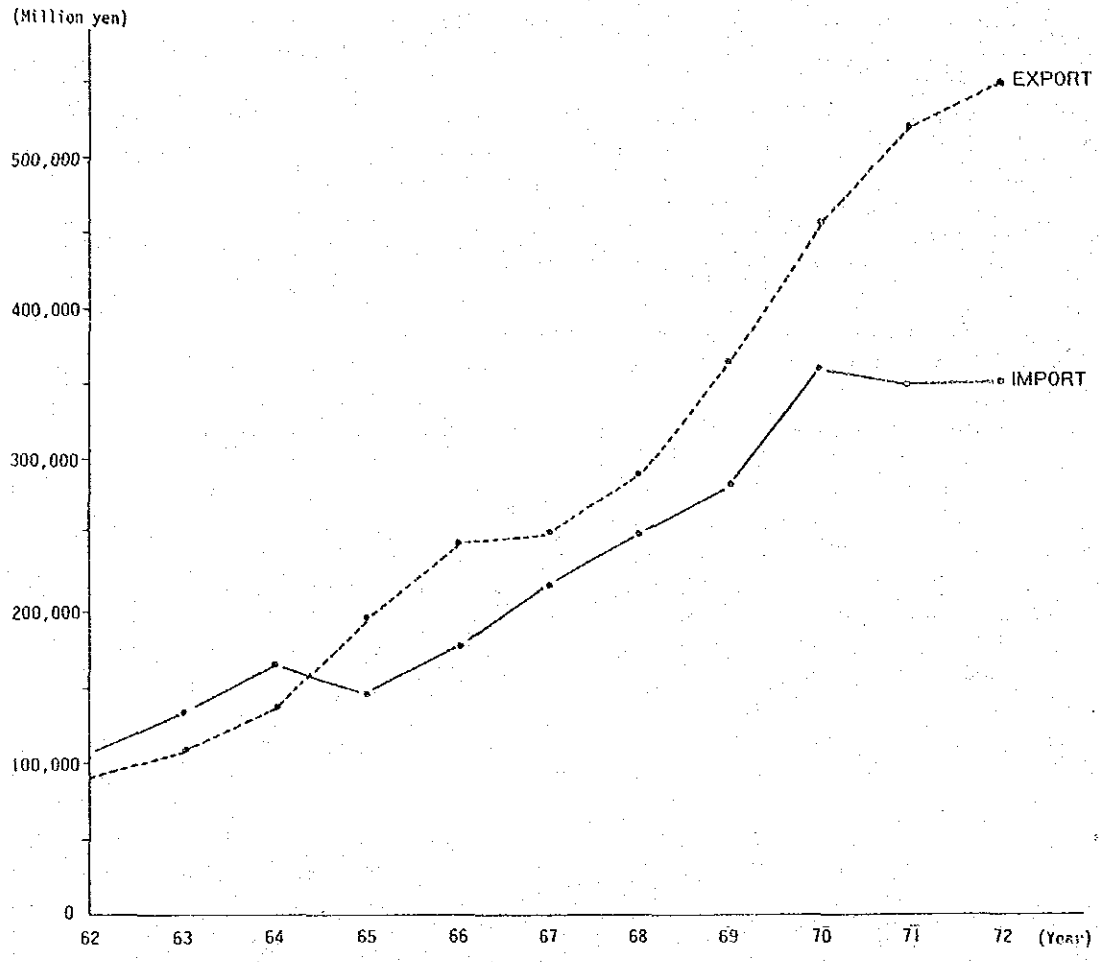
The council's first important guideline to the industry was the establishment of criteria in 1965 for new investment to ensure that annual production capacity of each new naphtha cracking center must be

Figure III-3-3 Annual Production of Petrochemical Products



Source: MITI, Yearbook of Chemical Industries Statistics.

Figure III-3-4 Import and Export of Chemical Products



Source: MITI, Yearbook of Chemical Industries Statistics.

more than 100,000 tons a year. Another quite important guideline, which helped shape today's form of the industry, was announced in 1967. It set forth the criteria for new investment, stipulating that annual production capacity of each new naphtha cracking center must be more than 300,000 tons a year in order to strengthen the international competitiveness of the industry by utilizing economy of scale. It also sought to prevent new entries to the industry to avoid excess competition among domestic companies. Contrary to expectations of the council, however, a number of companies rushed to establish new naphtha cracking centers. As a solution, the council coordinated those new investment plans to encourage to establish joint companies to avoid heavy burdens of large investment.

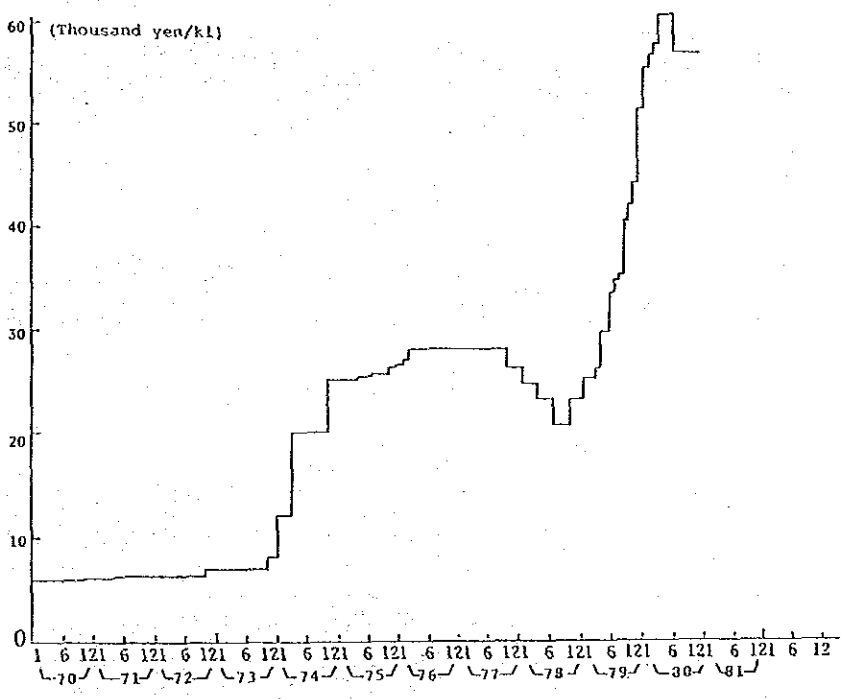
Although the expansion of facilities continued, the demand began to show a slight stagnant tendency (Figure III-3-3). The council issued another guideline, only four years after issuing the 300,000 tons/year figure, stating that no new naphtha-cracking center would be recommended

after 1973. Finally, the first recession cartel for ethylene production was formulated in 1972. This was the first such experience for the industry, which had continued to grow ever since its start.

3-8 Period of Slower Growth (1973-)

The Japanese economy has grown favorably owing to the free trade system of the world after World War II, and the availability of low-cost energy and raw materials played an especially important role. However, a turning point came with the oil crisis in 1973. The price hike of oil had quite a serious impact on the Japanese economy. In the case of the petrochemical industry, it manifested itself in the drastic price hike of naphtha. the price of naphtha increased four times after the first oil crisis, from about 6,000 yen a kiloliter to 25,000 yen a kiloliter (Figure III-3-5). This unexpected price hike of naphtha adversely affected the profit structure of petrochemical companies and the industry has heen having difficulties since then. The influence of oil price hike on manufacturing sector can be seen in Table III-3-5. It shows the ratio of raw materials used to the total shipment. According to the table, petroleum and coal sector which mainly consists of oil refinery companies received the largest influence by oil price hike. This sector increased the ratio by 21 points from 1965 to 1983. Organic chemical ranks next increasing the ratio by 12 points. Meanwhile, transport and electric machinery sectors have not got material influence.

Figure III-3-5 Price of Naphtha after Oil Crisis



Source: Tsusho Sangyo Gyosei Kenkyu Kai (Association for Research of Industry and Trade Policy), Tsusho Sangyo (I), (Trade and Industrial Policy).

Table III-3-5 Ratio of Raw Material Used against Shipment

<Chemical Sector>

Year	Fertilizer	Inorganic Chemi	Organic Chemi	Chemical Fibers	Oil,Fat & Soap	Drugs & Medicines	Chemical Total
65	60.82	56.11	58.25	47.60	65.80	42.15	53.94
66	61.19	55.28	56.74	46.97	66.24	38.94	53.28
67	58.97	54.62	55.18	42.36	66.41	38.43	51.71
68	58.25	54.94	56.28	40.32	65.94	39.07	51.77
69	61.06	55.16	53.81	36.28	64.08	36.51	49.32
70	63.30	54.96	56.01	36.76	62.74	37.49	50.25
71	59.56	54.86	55.50	39.76	59.88	34.40	49.42
72	58.12	52.17	55.21	44.69	60.83	34.06	49.93
73	58.40	51.54	56.28	44.64	59.29	35.48	50.30
74	66.30	59.34	68.72	59.46	60.81	39.42	59.84
75	69.63	59.46	69.84	68.56	58.46	37.78	59.78
76	68.78	60.34	70.59	69.31	60.57	37.85	60.66
77	67.50	58.43	70.19	68.87	61.63	38.02	60.10
78	66.30	57.60	66.28	60.19	58.85	34.11	56.11
79	64.51	57.52	69.93	62.25	59.42	34.16	58.45
80	73.28	67.34	76.60	72.17	62.15	36.18	64.65
81	69.22	65.30	74.99	69.52	63.25	35.45	62.64
82	68.32	61.86	73.58	70.25	62.47	36.02	61.11
83	70.59	63.03	70.00	66.28	60.64	33.83	58.55

<Other Sectors>

Year	Petroleum & Coal	Iron & Steel	Electric Machi	Transport Machi	All Industries
65	62.09	71.93	56.76	64.28	61.73
66	63.66	70.51	57.65	64.75	61.61
67	64.63	69.96	58.34	65.21	61.68
68	63.30	70.83	58.66	64.34	61.27
69	63.70	69.94	59.47	64.47	60.81
70	65.12	71.12	59.92	64.66	61.10
71	68.74	70.47	57.96	66.12	60.11
72	69.53	67.57	56.75	65.11	59.10
73	69.21	64.55	59.71	65.41	60.19
74	85.12	69.66	60.47	69.48	63.59
75	85.34	74.49	55.99	67.92	62.69
76	83.86	72.57	58.59	65.07	62.68
77	83.73	72.30	58.64	65.54	62.76
78	80.16	66.96	56.91	66.79	60.72
79	82.52	64.30	57.24	67.88	61.62
80	85.86	67.93	58.89	70.65	64.74
81	84.33	67.88	60.27	69.98	63.87
82	84.31	68.23	58.22	68.99	62.86
83	83.14	69.43	58.29	67.25	62.01

Source: MITI, Census of Manufactures.
Note: Raw material includes the energy used for production.

The oil crises slowed the growth rate of the Japanese economy as a whole. The demand for ethylene, which had generally showed favorable growth, previously, decreased drastically by 19% in 1975 in comparison with the previous year (Figure III-3-3). The capacity utilization rate decreased to around 60% after the second oil crisis (Table III-3-6). Under these circumstances, in 1983 the government established a law called the Law on Temporary Measures for Structural Adjustment of Specific Industries. Under the Law, the industry, with the support of the government, was to abolish some portion of production facilities to adjust supply capacity to the lower demand. As shown in Table III-3-7, about 30% of production capacity has been decided to be scrapped. Also sales division of vinyl chloride resin and polyolefin were separated from each company and merged to several joint companies to avoid excess competition.

As we have seen, the environment surrounding Japanese petrochemical companies has not been easy or rather they have experienced hard time quite often. Everytime when they faced the problems, they tackled them with well coordinated efforts of the government as well as of themselves. Several problems now existing such as threat of cheaper products from oil and gas producing countries are expected to be solved in the same manner as before. Moreover, we should carefully watch the new movement of this industry changing to involve new materials and engineering plastics.

Table III-3-6 Current Operating Rate of Petrochemical Industry

(Unit; 1,000ton)

1) Etylene

FY	Production	Capacity	Operating Rate (%)
78	4,523	6,070	74.5
79	4,837	6,202	78.0
80	3,872	6,227	62.2
81	3,597	6,247	57.6
82	3,567	6,347	56.2

2) Polyolefin (HOPE, LDPE, PP)

FY	Production	Capacity	Operating Rate (%)
78	2,763	3,291	84.0
79	3,246	3,784	85.8
80	2,619	3,793	69.0
81	2,634	4,001	65.8
82	2,680	4,125	65.0

3) Polyvinyl Chloride

FY	Production	Capacity	Operating Rate (%)
78	1,315	2,000	65.8
79	1,644	2,114	77.8
80	1,321	2,174	60.8
81	1,088	2,139	50.9
82	1,274	2,007	63.5

Source: The Industrial Bank of Japan and Others

Table III-3-7 Industrial Readjustment of Petrochemical Industry

Scrapping of Production Facilities

(Unit: 1,000 ton)

	Production Capacity	Amount of Scrapping of Production Facilities	Scrapping Ratio
Ethylene	6,347	2,070	32.6%
High Pressure Polyethylene	1,667	603	36.2
Middle and Low Pressure Polyethylene	1,007	268	26.6
Vinyl Chloride	2,007	491	24.5
Ethylene Oxide	743	201	27.1

Sales Companies jointly Established by Business Groups

		Capital (¥million)	Participating Companies	Business Groups
Vinyl Chloride Resin	Kyodo Vinyl Chloride Sales	50	5	IBJ Group
	Nippon Vinyl Chloride Sales	80	4	Mitsui Group
	Daiichi Vinyl Chloride Sales	90	4	Nippon Zeon, Kureha Chemical, etc.
	Chuo Vinyl Chloride Sales	90	5	Mitsubishi Group
Polyolefin	Diamond Polymer	100	2	Mitsubishi Group
	Ace Polymer	200	5	Asahi Chemical Industry, Showa Denko, Idemitsu Petrochemical, etc.
	Union Polymer	400	6	Sumitomo Chemical, Ube Industries, IBJ Group
	Mitsui Petrochemical Polymer	900	4	Mitsui, Nisseki Group

Source: The Industrial Bank of Japan and others

4. ELECTRONICS (COMPUTER-RELATED INDUSTRY)

4-1 Development of the Computer-related Industry in Japan

4-1-1 General Overview

(1) Position of the computer industry

The production of the Japanese electronics industry in 1983 was ¥13.5 trillion, which is more than 10% of the total production of Japanese manufacturing industries. Annual growth rate of the computer industry is exceeding 20% in this decade. Computer industry production amounted to ¥2,855 billion, accounting for 20% of all electronics industry production. Production of electron tubes, semiconductors, and integrated circuits also rose, to ¥2 trillion annually, at an average annual rate of 15%. Annual sales of the information industry has become so large as to exceed ¥5 trillion including about ¥1 trillion in information service industry sales.

Natural resources are poor in Japan. Thus, Japan has to choose the way for technical development in order to increase national income by the manufacturing of industrial products. The computer industry has become the focus of important national governmental policy.

(2) Initial stage of the computer

It is said that the Japanese computer industry started ten years later than its American counterpart. In the early 1950s, when business-use computers appeared in the United States, some Japanese universities, laboratories, and companies proceeded with very small scale research and development. From the second half of the 1950s to the early 1960s, however, seven Japanese companies developed business-use computers, when computers made in Japan appeared in the market which had previously been fully occupied by imported US systems (IBM, UNIVAC, NCR, and Burroughs).

As the demand increased, some Japanese companies utilized technical assistance from US computer manufacturers to develop new products. Here are some major examples of such tie-ups:

Hitachi - RCA
NEC - Honeywell
Toshiba - GE
Oki - UNIVAC

In this period, the Japanese computer manufacturers could acquire considerable know-how of production and technology as well as sales, system support, software, and maintenance.

The rental of computers, like product development, was regarded as an important issue for computer industry. This system was already employed by IBM at the time, which was beneficial for computer users to reduce required investment costs. Since computer manufacturers were already making huge long-term capital investments for research, development, and business development, the financial burden of the lease system was very heavy for Japanese companies at that time. In order to relieve them, the government and the industry set up JECC (Japan Electronic Computer Co., Ltd.) in 1961, which succeeded in easing the financial strain and aiding the development of the industry.

In 1964, IBM put into the Japanese market a new series, the IBM-360, which had much improved performance. Immediately after this, Japanese manufacturers presented their own new products to compete with IBM's. The Japanese computer market expanded rapidly in the latter half of 1960s. Although the computer industry was considered strategically important, the Japanese manufacturers remained weak in many aspects compared to US manufacturers like IBM, in terms of capital, product development, technical development, and marketing. This situation prompted the Japanese government to implement a strong policy to foster the industry.

In general, product plans and strategies of computer manufacturers have always been made in response to actions by IBM. In this manner, IBM has exhibited considerable influence on trends in the Japanese computer market.

4-1-2 Government Policies

Since the middle of the 1950s, the government has regarded the computer industry as Japan's most important industry and has taken measures to encourage the industry and promote the computer utilization.

From this context, the following policies are expected for implementation.

- Providing support to companies in strengthening their abilities to develop and commercialize new products
- Providing guidance and assistance to spur sophisticated use of computers
- Promoting improvements in software
- Fostering the information service industry

(1) Assistance for development of new products

This was a financial aid policy from 1972 - 1983 toward development of new products which are competitive with IBM machines.

<First Phase> Five years, 1972 - 1976.
Assistance Fund: ¥67 billion, to promote development of new machines which could compete with IBM's.

<Second Phase> Four years, 1976 - 1979.
Assistance Fund: ¥29 billion, to promote technical research and development of VLSIs (Very Large Scale Integrated circuits)

<Third Phase> Five years, 1979 - 1983.
Assistance Fund: ¥22.2 billion, to promote development of fundamental technology for OS (Operating System) and new peripheral equipment.

These programs led Japanese computer manufacturers to accumulate the ability of technological development, and strengthen the foundation of management. Even after 1975, when trade of computer products and capital were fully liberalized, the Japanese computer business has made steady progress. Domestic computer makers are currently holding a share of slightly more than 50% of the domestic market.

(2) Promoting development and spread of computer programs and fostering the information service industry

For the sake of expanding the sophisticated use of computer systems, IPA (Information-Technology Promotion Agency, Japan) was founded in 1970. This agency has acted as the prop for the promotion of development and diffusion of computer programs and general encouragement of the information service industry. Its specific activities are:

(a) Development of automated systems to produce software

This aims at improving the quality of software development in terms of productivity and reliability through automated computer processes. It also sought the solution for the shortage of personnel, due to rapid expansion in software demands.

(b) Development and diffusion of various types of software

It aimed at the development and diffusion of programs necessary for social and industrial growth through encouragement of private sectors.

(c) Development of software maintenance technology

(d) Promotion of technical development of advanced data processing

For this purpose, a technical center will be set up to promote development of technology which will provide a basis for data processing technology.

(e) Establishment of software distribution system

This is intended to set up register system of software and facilitate distribution of those programs which are created in Japan.

(f) Guarantee of bank loans toward development of useful software

(3) Large-scale project

This system, established in 1966, aimed at the development of technologies of national importance which cannot be developed by private companies due to the risks involved and requirements of huge amounts of funds. Under this system, those important projects have been implemented with the cooperation of industry and the universities partially financed by government funds.

Major computer-related projects are:

- Development of pattern data processing systems: This aims at improving the man-machine interface through improvements in computer functions, such as character reading and voice recognition.

- Super computers: For use in the field of science and engineering.

(4) Research and development of the fifth generation computer

This technology is not an extension of conventional computer technology, but based on a revolutionary concept — "knowledge information processing systems" — incorporating new elements and functions (e.g., problem-solving and interfacing, knowledge-based management, intelligent interfacing, and intelligent programming).

Such research and development will be put forward with the prospect of technical advancement and expanded computer applications in the next ten years. The basic schedule includes:

Development of basic technology ..... three years
Development of subsystem technology ... four years
Completion of the total system ..... three years

To implement this policy, ICOT (Institute for New Generation Computer Technology), organized in 1982 by private companies, was entrusted by the government with research and development.

There are also exchanges of opinions with overseas researchers which will provide a variety of possible approaches.

(5) JECC's rental system

Computer manufacturers jointly founded and invested in JECC (Japan Electronic Computer Co., Ltd.) in 1961, in an effort to reduce the heavy burden of rental systems on users. JECC borrows substantial funds from private financial institutions and the government to

purchase computers from each manufacturer, then leases them to users. This system has supported rapid computerization in Japan, and made a great contribution to the reinforcement of the manufacturing base.

(6) Training of data processing engineers

Data processing education has been gradually enriched in universities, colleges, and senior high schools in response to social needs. However, the quantity of engineers has not been keeping pace with the rapid increase in software demands and improvements in quality. The gap between supply and demand continues to widen. Countermeasures against this trend are:

(a) Testing of data processing engineers

The government has continued to conduct a test every year since 1969 for the following purposes:

- To provide an educational guideline for schools and companies in terms of the level and quality of data processing engineers.
- To certify the professional status of such engineers.
- To provide the engineers with information on areas which requires technical improvement.

The applicants exceed 100,000 each year, and the rate of success is around 15%; the total number of successful applicants from the time of initiation of the test from 1969 to 1984 was more than 100,000.

(b) IPA loan guarantees for money borrowed for the in-house training of engineers by information processing companies and software development companies.

(c) JIPDEC (Japan Information Processing Development Center) provides training to senior engineers.

(7) Computer security measures

(a) Determination of computer system security standards
(b) Promotion of a certification system for the security of data processing companies
(c) Promotion of utilization of auditing systems
(d) Perfection of information-related insurance system

(8) Developing medical information systems

Since 1973, the following systems have been developed through the integration of data processing technology and medical-use electronics technology:

(a) Local medical information systems
(b) Hospital automation systems
(c) Medical-use image processing systems
(d) Intrahospital data processing systems

(e) Medical data base language
(f) Health care network systems
(g) Diagnosis support systems

(9) Cooperation for computerization in developing countries

Developing countries recognize the necessity of computerization, and are looking to Japan for assistance. Japan has met their needs for the last ten years, culminating in the foundation of CICC (Center of International Cooperative Computerization) in 1983 as one of the cooperative activities. The government bears part of the expense of such international cooperation activities. The main services of CICC are:

(a) Training of instructors for computerization in the developing countries.
Various training courses are conducted, by receiving trainees.
(b) Dispatching of specialists to these countries
(c) Conducting surveys on needs for computerization, and research and development on necessary systems for each country
(d) Others
- Inviting key overseas personnel to Japan
- Leasing of computers

(10) Promoting computerization in small- and medium-sized companies

The following services are rendered to small- and medium-sized companies which have insufficient funds and personnel for computerization:

(a) Development of computer systems and programs
(b) Financing for computerization
(c) Instruction of employees in the use of computer system

4-1-3 Trends of Manufacturers

The Japanese computer industry began in the late 1950s. At that time, computer research and development were carried out by only a few universities, colleges, laboratories and private companies. Only American business computers were sold, and the demand was very small. At that time, seven Japanese manufacturers of general electrical appliances or communications equipment began the development of computers. In 1958 and 1959, they started production of several types of business-use computers.

These seven companies (one of them later withdrew) became the so-called "mainframers" sharing the market with U.S. manufacturers. They developed and commercialized minicomputers, personal computers, super computers. Since then, these seven companies have constituted the center of the Japanese computer industry.

In addition to these seven companies, manufacturers of household electrical appliances, office equipment, and precision machinery, participated in the production of small office computers, peripheral equipment, and terminals. After 1975, these companies also got involved in the production of personal computers.

(1) Trends of mainframers' business

At the beginning of the 1960s, some Japanese manufacturers formed technical tie-ups with their U.S. counterparts for the sake of early commercialization. These tie-ups were necessary for Japanese manufacturers, which were technologically ten years behind the U.S.A. while they did not have abundant fund and time for development to cope with the expanding market. At this time, the above mentioned seven companies set up JECC in order to reduce the burden of the lease system.

Immediately after IBM presented a new series of IBM 360 in 1964, and other U.S. manufacturers followed, Japanese counterparts strived to present competitive products. For five years after 1966, the computer market in Japan, in terms of units installed and total value, grew at an annual rate of more than 30%. The share of domestic products in Japan rose to slightly more than 50%, which has been maintained to the present. Domestic computer systems come in a wide range of sizes and capacities, from mini to extra-large. In particular, Japanese small office computers are overwhelmingly superior to the products of their foreign competitors.

However, although reaching the same technological level as their U.S. counterparts at that time in terms of hardware, Japanese manufacturers were considerably inferior in terms of development capability and software, and by themselves they could not develop products competitive with the new IBM 370 series, which was under development at the time. At the beginning of the 1970s therefore, six domestic mainframers organized into three groups, combining resources in an effort to develop new types of machines without competing or overlapping with one another. After IBM began selling the new series of IBM 370 in 1971, those three groups presented respective new series superior to those of IBM in performance and cost, which secured their market shares in 1974. Since then, they have competed with IBM by selling progressively more advanced machines based on these initial series.

Moreover, Japanese manufacturers jumped into the development and commercialization of minicomputers as demand rapidly increased during the second half of the 1960s. Japanese manufacturers produced efficient minicomputer systems designed not only for scientific use or process control, but also for incorporation into large-scale on-line computer systems.

(2) Peripheral equipment manufacturers

In early 1970, as computer demand continued to expand, manufacturers of household electrical appliances and precision equipment (watches, cameras, sewing machines, office equipment, etc.) embarked

on the production of peripheral equipment utilizing their advanced technology. Since then, they have supplied peripheral equipment on an OEM (original equipment manufacturing) basis to mainframers as well as to retail customers. Particularly as personal computer sales increased from the end of the 1970s, demand for peripheral equipment increased.

(3) Personal computer manufacturers

The mainframers of the industry recognized the importance of the development of personal computers expecting the field's future growth. Household electrical appliance manufacturers also participated in the development and commercialization of personal computers. As a result, the number of personal computer manufacturers rose to dozens, with annual production exceeding 2 million units and ¥400 billion.

(4) IC makers

In Japan, ICs began to be produced in 1966 mainly for electronic calculators in contrast to the United States where ICs are used mainly for industrial use. Six computer manufacturers (mainframers) and about four household electrical appliance manufacturers produce the highest-quality products in the world, by using their high microprocessor manufacturing technology, as well as having a high-level development capability. IC demand has increased ten fold in these ten years, in line with the application of ICs in various types of equipment and the decline in prices at an annual rate of 12 - 15%. The price decline gave adverse effects on companies' profits, which have already had heavy burden of the substantial investment in plant and equipment.

On the other hand, exports, mainly to the United States, grew to a considerable extent, exceeding 40% of the ¥1 trillion output. (The annual growth rate of exports was 52% in the 1979-1983 period.) At the same time, imports increased at an annual rate of 20%.

(5) The information service industry

As computerization has advanced, the data processing business has gradually grown, playing a more important role in the Japanese society. Since 1970, such services as data processing, data supply, and software development and supply have flourished as profitable businesses. As a result, many enterprises dedicated to such services are established. It may be said, however, that the information service industry has not yet matured in light of the inadequate legal protection of software rights, delayed arrangement of distribution systems, and a low recognition of its value. As of 1983, the scale of this industry was ¥1.1 trillion, and the number of such companies amounted to 1,000, but they are operated on a small to medium scale.

The composition of the information industry is as follows:

Software development and programming:	33%
Data processing service:	29%

Data base service: 7%

Problems of this area are:

(a) In software development, a large portion of production is done on an order basis for hardware producers. Only a few software products are sold separately as it is.

(b) In the case of data bases, there are 916 data bases, of which 20 - 30% are domestic, and the remainder are foreign products. Their annual sales are ¥80 billion, which is very small compared to sales in the United States and advanced European countries.

It is expected, however, that sales will steadily grow due to projections of increased demand, improvement in the business climate, and an increase in the prevalence of on-line networks.

4-1-4 Trends of Computer Business

(1) General-purpose computers

In the period from 1965 to 1970, computer deliveries showed a substantial increase of more than 30% per year in quantity and value. Although the ensuing world recession resulting from the first oil crisis lessened the increase rate in 1974, and caused a slight decrease in 1975, deliveries have continued to steadily rise, registering 37,218 units worth ¥1,468 billion in 1984 (Figure III-4-1).

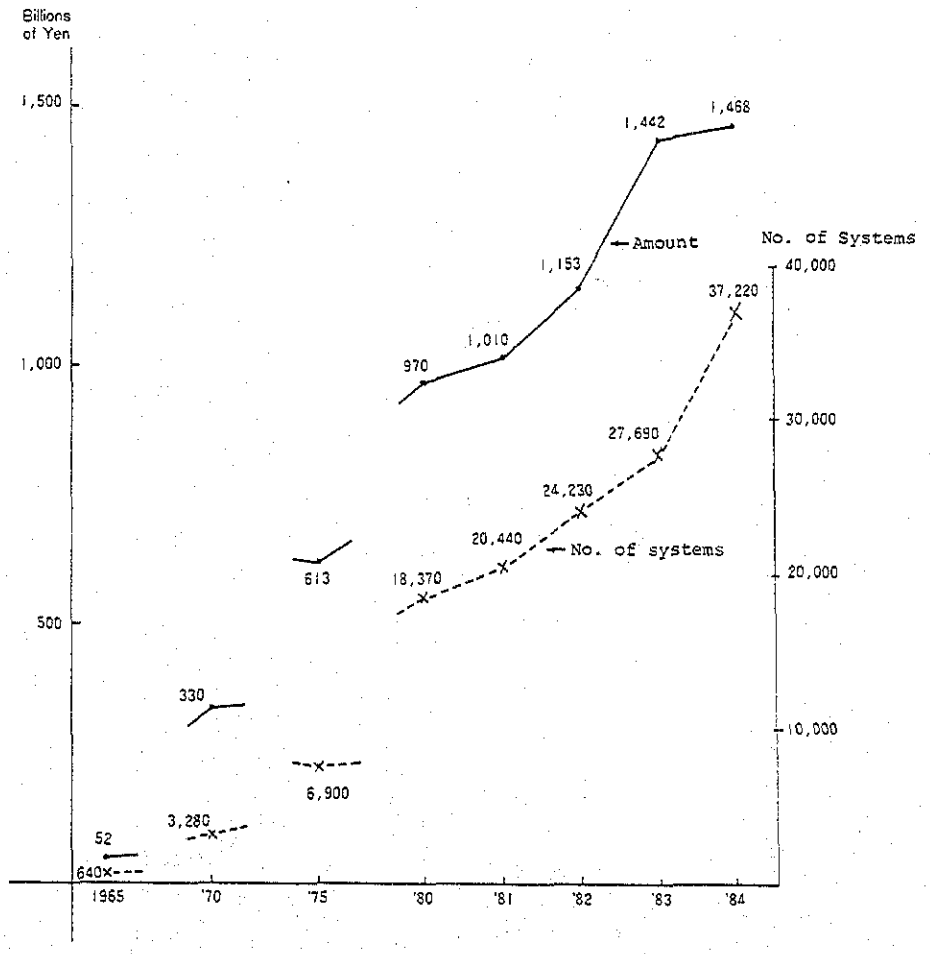
Looking at trends by computer size, it is found that large and micro-computers have shown a sharp increase, while medium ones are sluggish. This is due to an increase in the functional capability of computers, and also to the fact that improvements in communication networks have increased the demand for efficient on-line systems. Units installed amounted to 184,678 worth ¥6,692 billion as of March 1985 (Figure III-4-2).

A breakdown of sales by-customer reveals that largest users is financial business. This sector leads general purpose computer purchasing with annual purchases totalling ¥1.2 trillion, or 18% of total sales. Within this sector, banks occupy the largest share of 13.6% (¥911.8 billion). The distribution industry is second with ¥1 trillion in purchases, 16% of total sales; the electrical machinery manufacturing industry is third, with ¥943 billion in purchases, or 14% of total sales. Government and related organization purchases stand at ¥766 billion (11% of sales) (Tables III-4-1 and III-4-2).

(2) Minicomputers

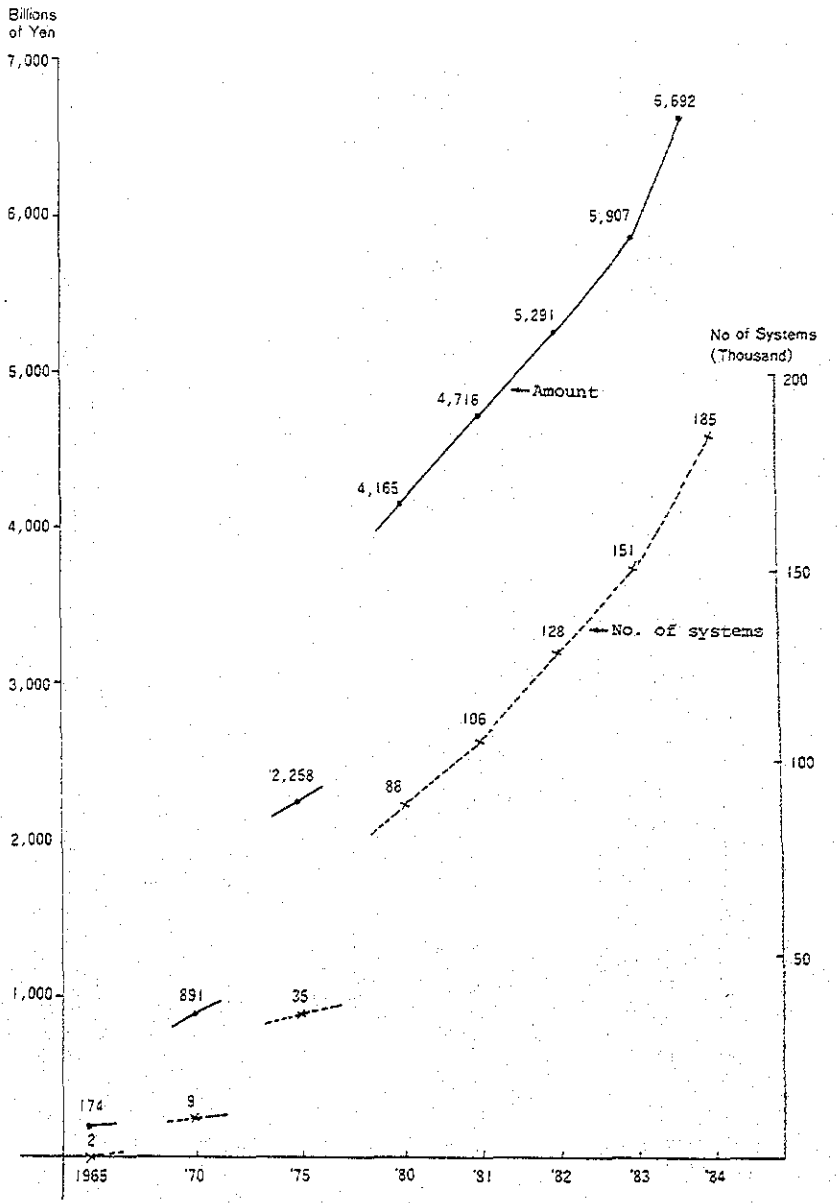
After 1970, the application of minicomputers was expanded to the industrial control devices, as well as processors incorporated into other systems, and demand grew at an annual rate of more than 10% in quantity and value. Minicomputer demand temporarily stagnated due to a decline in investment in plant and equipment, and due to the wait-

Figure III-4-1 Computer Deliveries



Source: JECC, JECC Note.

Figure III-4-2 Computer Installations



Source: JECC, JECC Note.

Table III-4-1 General-Purpose Computer Operation

Size	Computers in Operation as of Mar., 1982		Computers in Operation as of Mar. 1985	
	No. of Systems and Their Value (Millions of yen)	Share (%)	No. of systems and Their Value (Millions of Yen)	Share (%)
Large-scale	3,500	3.3	4,844	2.6
	2,678,120	56.8	3,738,921	56.0
Medium-scale	11,130	10.5	14,968	8.1
	1,095,331	23.2	1,466,470	21.9
Small-scale	32,565	30.6	49,277	26.7
	594,294	12.6	888,844	13.3
Very Small-scale	59,149	55.6	115,589	62.6
	348,675	7.4	597,850	8.9
Total	106,344	100.0	184,678	100.0
	4,716,420	100.0	6,692,085	100.0

Source: JECC, JECC Note.

and-see attitude to anticipate the introduction of a new 32 bit machine in the 1982-1983 period. However, it is expected that demand, mainly for 32 bit machines, will increase again at an annual rate of 10% after 1984. The demand for small-sized and low-priced minicomputers may be, however, eroded by rampant sales of microcomputers, which have been rapidly improved in performance. Sales in 1983 totalled 9,170 units, worth ¥174 billion. As for the breakdown, OEM supply occupied nearly 40% of the units, with industrial control devices occupying 40% of the total value. It is expected that the minicomputer will increase its share in network systems, communication control, and scientific and technical computing (Figure III-4-3).

(3) Personal computer

In Japan, the demand for personal computers has doubled every year since the beginning of the 1980s, but the rate of annual increase has fallen to 50% since 1983. This figure is, however, still considerably high, and a large increase can be expected in the future owing to further sophistication of machine, software accumulation, and improved man-machine interfaces, mainly in the area of business-use machines (Figure III-4-4).

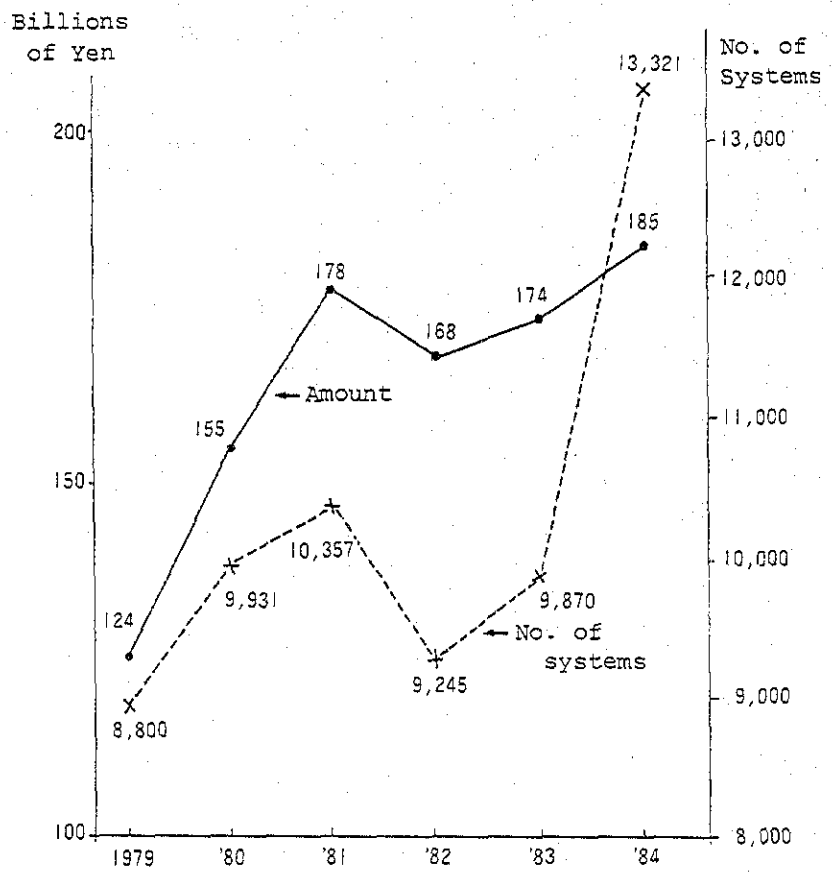
Table III-4-2 General-Purpose Computer Operation by Industry
(March 1985)

Mar. 1985

Industry	No. of System	Value(millions of yen)	Average Value per System	% of Total(Value)
Agriculture	201	5,927	29.5	0.1
Forestry & hunting	80	717	9.0	0.0
Fisheries & related products	258	4,297	16.7	0.1
Mining	228	5,590	24.5	0.1
Construction	4,675	94,702	20.3	1.4
Foodstuffs	5,589	112,311	20.1	1.7
Textiles & textile products	3,197	70,207	22.0	1.0
Pulp, paper & paper products	1,389	25,845	18.6	0.4
Publishing & printing	1,709	61,394	35.9	0.9
Chemicals & petroleum	6,110	217,873	35.7	3.2
Ceramics	1,392	38,350	27.6	0.6
Iron & steel	1,517	167,250	110.3	2.5
Non-ferrous metals	2,918	90,072	30.9	1.4
Machinery	3,555	117,809	33.1	1.8
Electric machinery	7,532	943,200	125.2	14.1
Transportation machinery	2,595	251,399	96.9	3.8
Precision machinery	1,571	64,075	40.8	1.0
Other manufacturing	6,047	105,577	17.5	1.6
Wholesale, retail & trade	81,609	1,047,497	12.8	15.7
Finance	7,564	911,783	120.5	13.6
Securities	390	110,556	283.5	1.7
Insurance	1,188	181,554	152.8	2.7
Real estate	610	7,895	12.9	0.1
Transportation, telecomms.	6,353	186,398	29.3	2.8
Gas and electricity	831	96,221	115.8	1.5
Service				
(Ordinary)	8,466	159,554	18.8	2.4
(Data processing)	10,548	417,788	39.6	6.2
Hospitals	2,108	48,723	23.1	0.7
Universities	1,510	186,060	123.2	2.8
Upper secondary schools	716	14,168	19.8	0.2
Other educational inst.	661	18,307	27.7	0.3
Municipal bodies	2,537	148,123	58.4	2.2
National government	1,278	169,626	132.7	2.5
Government-related org.	1,902	448,182	235.6	6.7
Corporate bodies and co-ops.	5,652	156,442	27.7	2.3
Religious organizations	77	1,740	22.6	0.0
Others	115	4,885	42.5	0.1
Total	184,678	6,692,085	36.2	100.0

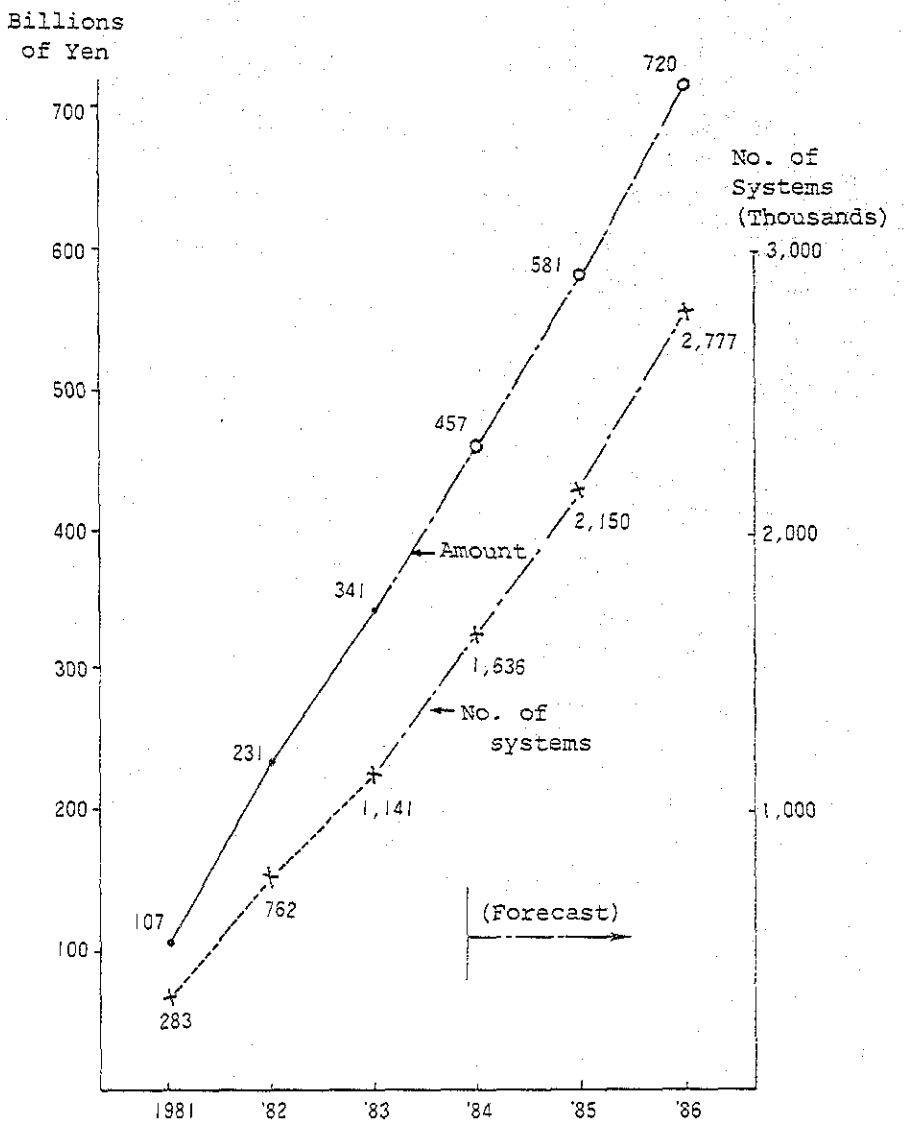
Source: JECC, JECC Note.

Figure III-4-3 Minicomputer Deliveries



Source: Japan Electronic Industry Development Association (JEIDA)

Figure III-4-4 Personal Computer Deliveries



Source: JEIDA

(4) Peripherals and terminals

In order to meet the increased demand for upgraded computer systems (i.e., on-line processing, distributed processing, and network systems), technical progress has been made in the areas of peripherals and terminals. The capacity of external storage devices, for example, has been enlarged and improved. The display unit has been diversified, and the function of terminal has been compounded. Hence, the demand for peripheral and terminal equipment is growing rapidly. In addition to being upgraded in quality, however, prices of such equipment has been falling, intensifying competition for sales. Moreover, it is expected that the growth of demand will be accelerated by the extensive use of word processors and personal computers as terminals (Figures III-4-5 and III-4-6).

(5) Production of computers and related devices

The production of computers and related devices in Japan has shown an average annual increase of 16.5% this decade, and reached ¥2 trillion in total saies in 1983. In particular, the following equipment showed a sharp increase in annual sales of more than 20% (Table III-4-3):

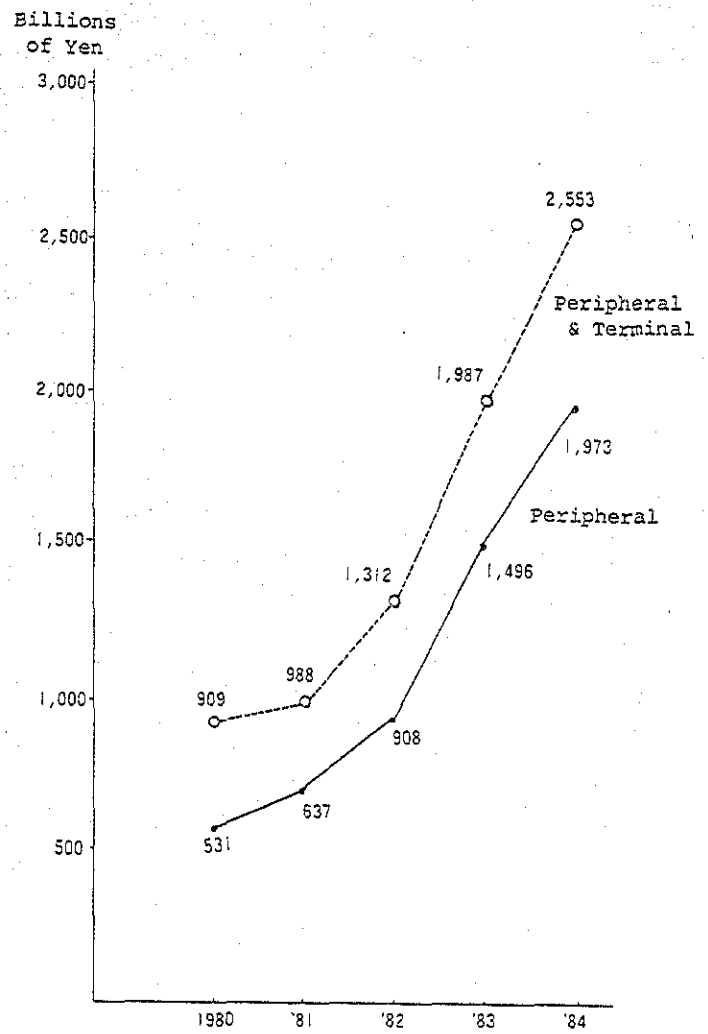
- External storage devices
- I/O devices
- Communication control equipment
- Terminal

4-1-5 Import and Export Trends

Japan's exports of computers and related equipment exceeded ¥100 billion in 1978, after which two-digit growth has been achieved every year. The value of exports stood at ¥1,318 billion in 1984 representing more than 40% of total domestic production. Of that, peripheral equipment accounted for the highest percentage with 67% or ¥893 billion in sales.

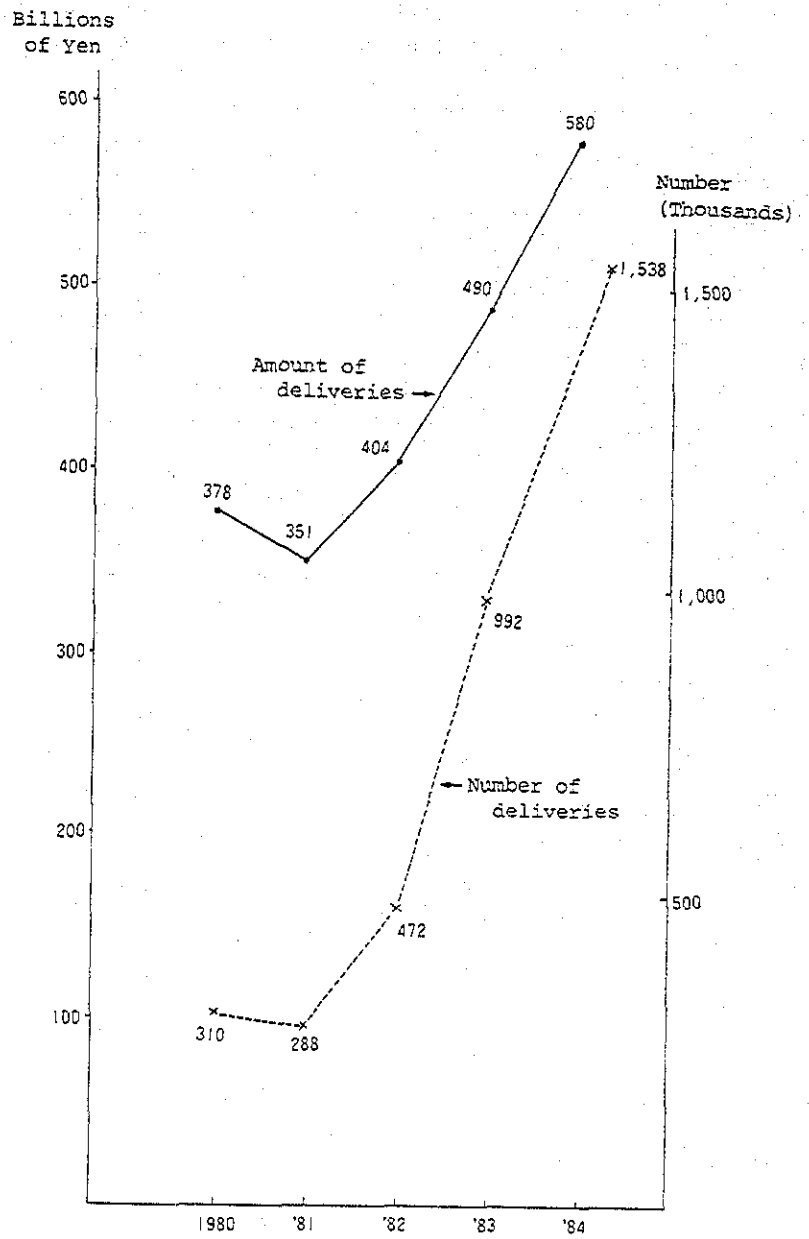
In 1973, imports first exceeded ¥100 billion; in 1980 they broke the ¥200 billion mark. In 1984, imports totalled ¥309 billion, accounting for slightly more than 30% of the domestic demand. Although Japan had a large deficit in trading such equipment for a long time, exports exceeded imports for the first time in 1981, and since 1982, the gap has widened. The main importer of Japanese products in 1984 was the United States, accounting for about 60% of the total, followed by West Germany (9%) and the United Kingdom (6%). The largest exporter to Japan is also the United States, accounting for about 80% of the total. As far as the computer trade with U.S.A. is concerned, exports exceeded imports in 1982. Since then the gap has become even wider (Figures III-4-7 and III-4-8).

Figure III-4-5 Trend of Peripheral Equipment Deliveries



Source: JEIDA

Figure III-4-6 Trend of Terminal Equipment Deliveries



Source: JEIDA

Table III-4-3 Production Trends for Computers and Related Equipment

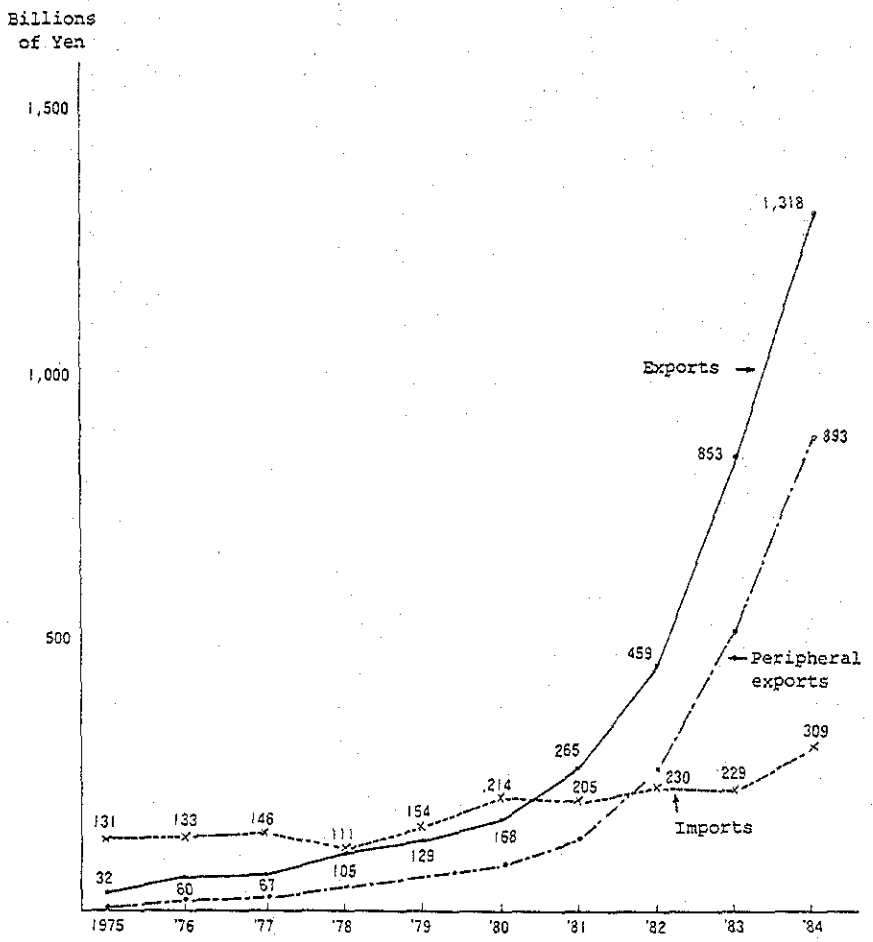
(Billions of Yen)

Item \ Year	1973	1978	1979	1980	1981	1982	1983	* %
General-purpose	203	367	447	462	539	645	700	13.8
		(132)	(122)	(103)	(117)	(120)	(109)	
Control Use	12	13	12	27	28	25	22	10.6
		(83)	(87)	(239)	(103)	(90)	(86)	
Main Units	215	380	459	489	567	670	722	13.7
		(129)	(121)	(107)	(116)	(118)	(108)	
External Storage Devices	99	175	196	231	270	330	433	19.8
		(125)	(112)	(118)	(117)	(122)	(131)	
I/O Devices	78	88	101	120	156	204	290	26.9
		(125)	(114)	(119)	(129)	(131)	(142)	
Peripheral Equipment	178	263	297	351	426	534	723	22.4
		(125)	(113)	(118)	(121)	(125)	(135)	
Comminication Control Equipment		13	15	18	22	27	41	25.0
		(110)	(114)	(119)	(124)	(122)	(150)	
Terminal Equipment	35	164	235	279	300	350	416	20.5
		(116)	(144)	(119)	(108)	(117)	(119)	
Total	428	820	1,006	1,137	1,315	1,581	1,902	18.3
		(125)	(123)	(113)	(116)	(120)	(120)	
Auxiliary Devices	26	38	45	41	37	43	55	7.5
		(152)	(119)	(90)	(90)	(119)	(127)	
Total	454	858	1,051	1,178	1,352	1,624	1,957	16.5
			(123)	(112)	(115)	(120)	(121)	

Source: JECC, JECC Note .

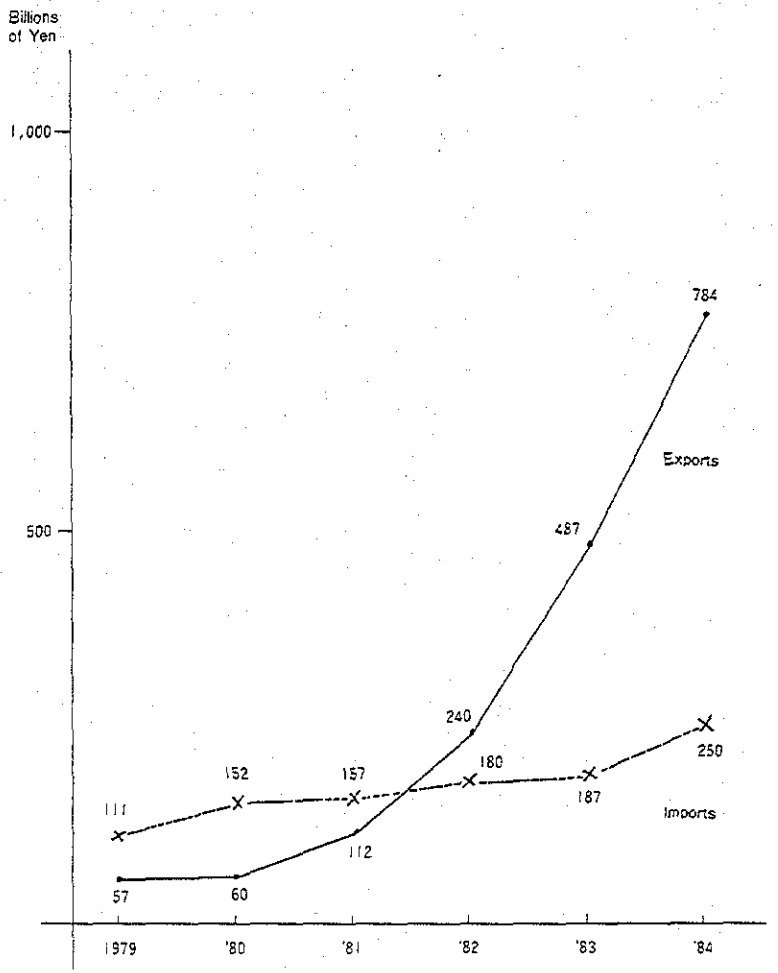
Note: Figures in parentheses denote rate of growth (%) compared to the previous year.
*Figures denote rate of average annual growth (1978 - 1983).

Figure III-4-7 Computer Imports and Exports



Source: JEIDA

Figure III-4-8 Computer Imports/Exports between Japan and USA



Source: JEIDA

4-2 Present State of Mechatronics in Japan: Centering on the Numerical Control (NC) Machine Tool Industry

4-2-1 Meaning and Classification of Mechatronics

(1) What is mechatronics?

The term mechatronics has not been specifically defined up until now. New developments in the mechanical industry brought by a combination of mechanics and electronics are generally called "mechatronics" the newly coined word.

The origin of the word can be traced back to "Mechatronics," a report on mechanical industries published in 1978 by the Japan Society for the Promotion of Mechanical Industries. According to the report, the term is defined as follows: "The word 'mechatronics', coined by combining two words--MECHAnism and elecTRONICS, denotes mechanical devices constructed by combining mechanical elements and electronic elements as appropriate. The tendency to integrate mechanics and electronics which already existed has been intensified with the impact of the development and prevalence of LSI techniques. Thus, a group of high performance machines with versatile functions using microcomputers has developed rapidly. Mechatronics may be interpreted as the new trend of integral unitization of mechanics with electronics, or information-oriented mechanics."

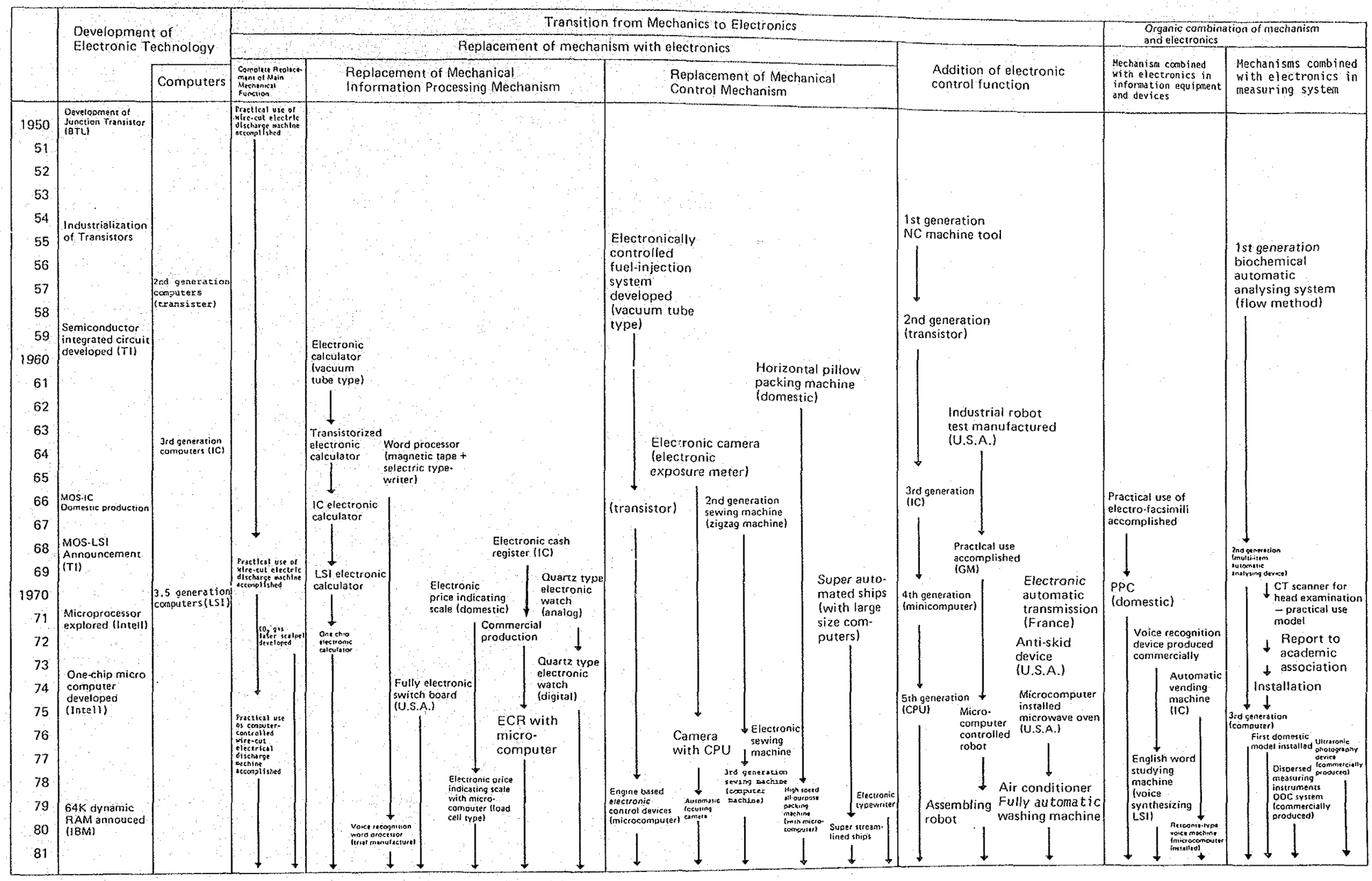
What this means, in short, is that the mechanical industry is becoming electronic. This takes the form of replacement of mechanical parts with electronic parts, and also seeks better cost performance by their organic combination with mechanical parts. Those replacement may be partial or full. Parts with electronic functions as mentioned here include microprocessors, operation amplifiers, AD-DA (analog to digital - digital to analog) converters, etc. In the history of mechanical technology development, today's new functions may be called "mechanisms with a nerve system," or "intelligent machines."

What made it possible to endow machines with intelligence was the introduction of one-chip ICs (integrated circuits) in 1975. The development of mechatronics was further enhanced after this date (refer to Figure III-4-9). Today, technology which supports mechatronics is roughly divided into three categories. The first includes microelectronic techniques (such as LSIs) having thinking and decision-making functions; the second includes sensor techniques for listening and with which input and output of information are performed; and the third includes actuator techniques which represent the kinetic function. The field of mechatronics consists of these three categories.

(2) Mechatronic classifications

Mechatronic devices may be roughly divided into the following four groups using such criteria as replacement of mechanical functions, provision of electronic functions, organic combination of

Figure III-4-9 Progress of Transition from Mechanics to Electronics (Mechatronics)



mechanical and electronic functions, etc.

The first group of mechatronic items are those highly advanced conventional mechanical products using sophisticated control functions employing electronic elements to be integrated into the mechanical equipment for higher performance or more diversified functions. In this group are NC machine tools, industrial robots, electronically controlled engines, anti-skid brakes, etc.

The second group of mechatronic items are those in which their mechanical control mechanisms have been partially replaced with electronic elements resulting in the successful coexistence of mechanics and electronics. One such example is electronic sewing machines using cams and other mechanical parts which have been replaced with electronic elements.

The third group of mechatronic items are those whose mechanisms in most cases dealt largely with information and have been almost completely replaced with electronic elements. Among the examples of this type are digital watches, portable calculators, push button telephones, etc. Of special note is the fact that the items of this group have been provided with new functions which would have been inconceivable with conventional mechanisms.

The fourth group includes miscellaneous items or those which are not included in any of the other groups. Among these are those items using rather simple mechanisms, though electronic elements have been added, such as electric home appliances. Items in which electronic elements play leading roles but coexist with mechanical functions, such as in information equipment and copying machines, also fall in this category.

(3) Technological background

As technological background to support the prevalence of mechatronics, it is sufficient to point to the large accumulation of computer control technology and rapid development of LSI technology which have brought about the current supply of microcomputers and their peripheral devices at extremely low cost. This technology has provided an actual means of knowledge intensification in the mechanisms themselves. It is apparent that LSI elements for microcomputers, peripheral devices, sensors, etc., will keep on developing. Consequently, it is expected that "intelligent" mechatronic products will develop steadily and ripen on the forefront of new mechanical technology.

(4) Characteristics of mechatronic products

(a) With the various advantages electronics provide, mechatronic products are expected to have additional programmability and flexibility compared to purely mechanical products and to become functionally flexible machines.

(b) The introduction of electronics alleviates spatial restrictions, facilitating a freer hand in mechanical design. Also, since electronic parts facilitate the changing of machine functions, model changes of various types may be done easily. Further, machines equipped with memory cells are provided with additional functions and programmability, thus improved mechanical operability is obtained. On the other hand, proper operation of the new products will require thorough knowledge of their functions, and the importance of instruction manuals will increase.

(c) Among mechatronic products, items of higher and more diversified functions are expected to be developed, and with the alleviation of spatial restrictions, freedom in design will increase. Design may well become the decisive factor in the value of such products.

(5) Present state of mechatronic products

Mechatronic products are so numerous that it is impossible to discuss all of them. The followings are observations on 19 items including development history, points of introduction of mechatronic technology and the resulting effect on their development.

(a) Electric discharge machines

Electric discharge machines were put into practical use around 1950. They were used for surface processing in those days. In about 1968, wire-cut electric discharge machines for practical use were developed; then they were further developed into computer controlled wire-cut electric discharge machines by about 1975. Electric discharge processing, being non-contact processing, enables processing of hard-to-cut materials, and thus enlarged the field of shape-processing of complex forms using computer controlled wire-cutting (including taper cutting).

(b) Laser scalpels

Around 1970, CO_2 laser scalpels was developed, and direct cutting with blades was replaced by non-contact type cutting. Application with additional control functions using NC are also possible.

(c) Laser machine tools

As compared with other electronic devices incorporating LCs and LSIs, laser processing features the introduction of NC for the tool's movement. Providing non-contact cutting, it has expanded the range of such processes as welding, cutting and heat processing of hard-to-process materials. The expansion of these abilities is now being attempted using higher powered lasers.

(d) Electronic watches

In 1969, analog watches using quartz oscillators were develop-

ed, and in 1973, digital watches of the same type were introduced. These were made possible by replacing mechanical information processing with electronics and using the added controlling functions of electronic technology to create complex products.

(e) Portable calculators

Electronic calculators were of the vacuum tube type in 1960. They were transistorized in 1964. The transition to the IC and LSI stages took the form of what is called the one-chip electronic calculator in 1971. This item is also making remarkable progress toward smaller and thinner sizes and achieving higher performance. Further development providing a means for printing is expected.

(f) Electronic scales with price displays

The change from the analog to digital type took place in about 1968. A transition again occurred in 1979 with the adoption of load cells and microcomputers, resulting in the elimination of spring mechanisms.

(g) Electronic cash registers

Mechanical information processing was replaced with ICs in 1969, and microcomputers were introduced in 1975. Thus the change to the digital system took place with the introduction of electronics.

(h) Word processor

In 1964, the Japanese-language word processor was developed by incorporating a magnetic tape within a electric typewriter. Japanese word processors, as seen today, appeared in about 1981 or 82, and a rapid development has been undergoing toward higher functions and lower prices.

(i) Full electronic switchboards

In the latter half of the 1970s, it took place a change from the crossbar switchboard to the analog-type semi-electronic switchboard, and then to the digital-type full electronic switchboard.

(j) Injection molding machines

For improvement in accuracy and repeatability, process control (feedback control) is now performed, and even group control has been made possible.

(k) Packing machines

Various types of automatic packing machines have been manufactured since about 1950. The mechanical adjustment of these machines had required great skill before the introduction of automated machine. In 1978, the mechanical control mechanism was replaced with microcomputer control, with the aims of improvement in reliability,

minimization of packing material loss and reduction in time required for adjustment.

(l) Agricultural machines

In 1977, automatic machines with mechanical control mechanisms were replaced with automatic control systems, and in 1978, drying machines equipped with microcomputers were developed. It is said that the introduction of electronics into combines and rice transplanters has nearly reached completion. Introduction of electronics into tractors has accomplished unitization of the engine section and moving parts, and automatic control of speed and power.

(m) Electronic sewing machines

In 1966, zigzag machines, or the so-called second generation sewing machines, were developed. Electronic sewing machines with microcomputers (third generation sewing machines), instead of cam-driving mechanisms, were developed in 1977.

(n) Electronic cameras

In 1964, EE cameras with built-in electronic light meters, came along; then in 1976, cameras equipped with CPUs, and in 1978, cameras with automatic focusing were marketed. The combined replacement of mechanical control with electronic control and the addition of electronic control functions was accomplished. The resulting simplification of operation is well-known, but there was also another effect, that of reducing the number of mechanical parts.

(o) Automobiles

Examples of electronic control in fuel injection systems can be traced as far back as 1957 when vacuum tube type systems were used. They were transistorized in 1966 and microcomputers were added in 1978. Government regulations on exhaust gas emissions are said to have accelerated the adoption of electronic control of fuel injection. The introduction of electronics into the field of automobiles started with the application of ICs for regulators, anti-skid devices, ignition devices, alarm devices, etc. The aforementioned electronic control of engines is still in progress now. Application of electronics to automatic transmissions is expected to follow.

(p) Motorcycles

Motorcycles equipped with microcomputers for electronically controlled fuel injection systems were marketed in 1980. Safety confirmation systems with liquid crystal displays is also mounted on motorcycles.

(q) Copying machines

In the 1950s, diazo process copying machines became popular. In the 1960s, direct electrostatic copiers, and in the 1970s, indirect-

type electrostatic copiers followed it. Copying machines gained complexity and intelligence with the introduction of microcomputers in sequence control circuits, effecting acceleration in operation, stabilization of pictures, reduction in the number of parts, etc.

(r) Electronic typewriters

European-language typewriters equipped with microcomputers were first marketed in 1978.

(s) Electric home appliances

The rate of application of microcomputers to electric home appliances ranges from 10 to 70% aiming at the addition of new functions, achieving optimum energy conservation, minimizing the number of mechanical parts and reinforcing program functions.

(6) Effects of the introduction of mechatronics

The introduction of mechatronics has exerted a strong influence on the Japanese mechanical industry. Those characteristics are; the creation of a larger market, the progress of mechatronics ahead of Western developed nations, the improvements in the export structure and the change in market structure. The details are as follows:

(a) Creation of a larger market

Replacement of mechanical parts with electronical ones, or combination of mechanical parts and electronic ones, has resulted in smaller and lighter, yet more reliable machines and final products. Having more complex functions and higher performance than conventional products, these items have satisfied users' needs and created greater market demand.

(b) Progress of mechatronics ahead of Western developed nations

Such rapid progress from mechanics to electronics has spurred innovation and replacement of equipment and triggered the adoption of flexible production lines and group management of production processes. Electronically automated equipment, such as industrial robots and NC machine tools, have been proven the most effective means of cutting costs, specifically in the areas of streamlining, labor conservation and improvements in quality.

(c) Improvements in the export structure

It is expected that our industry will occupy a position of comparative supremacy in the field of electronically sophisticated machinery. Hopefully, it will grow as a major sector of the country's export industry alongside conventional mass-produced consumer goods.

(d) Change in market structure

Progress in the integration and combination of parts due to the development of semiconductor technology has resulted in a drastic decrease in the number of machine parts. And importance of mechanical adjustments and repair at the retail level using man power has diminished. It triggered the reorganization of sales channels.

In these ways, it can be seen that technical innovation in electronics and the progress in introducing electronics into the mechanical industry have taken effect and solidified in this country ahead of the developed nations. As a result, Japanese industry is entering new period of development.

(7) Current status of the spread of mechatronic equipment and devices

The spread of mechatronics is well represented by the aggressive attitude of small and medium sized companies. According to the research of Small and Medium Enterprise Agency (SMEA), the shipped amount of NC machine tools for small and medium enterprises increased by 26.8 times from 1970 to 1982, and the proportion of the shipped amount to small and medium enterprises to the shipped amount to all sizes enterprises also increased from 17.7% to 59.3%. According to "Research of the Current State of Manufacturers' Management Activities" by the SMEA (Dec. 1983), only 18% of small businesses had introduced mechatronic equipment three years ago, but more than 30% of them have now done so (Figure III-4-10). Also, of the small manufacturers who have not introduced mechatronic equipment and devices so far, 37% want to introduce them within 3 years, so application of mechatronic technology to the production processes of smaller manufacturers is expected to increase even more.

4-2-2 NC Machine Tools as a Representative Case for Mechatronics

(1) Characteristics and development of NC machine tools

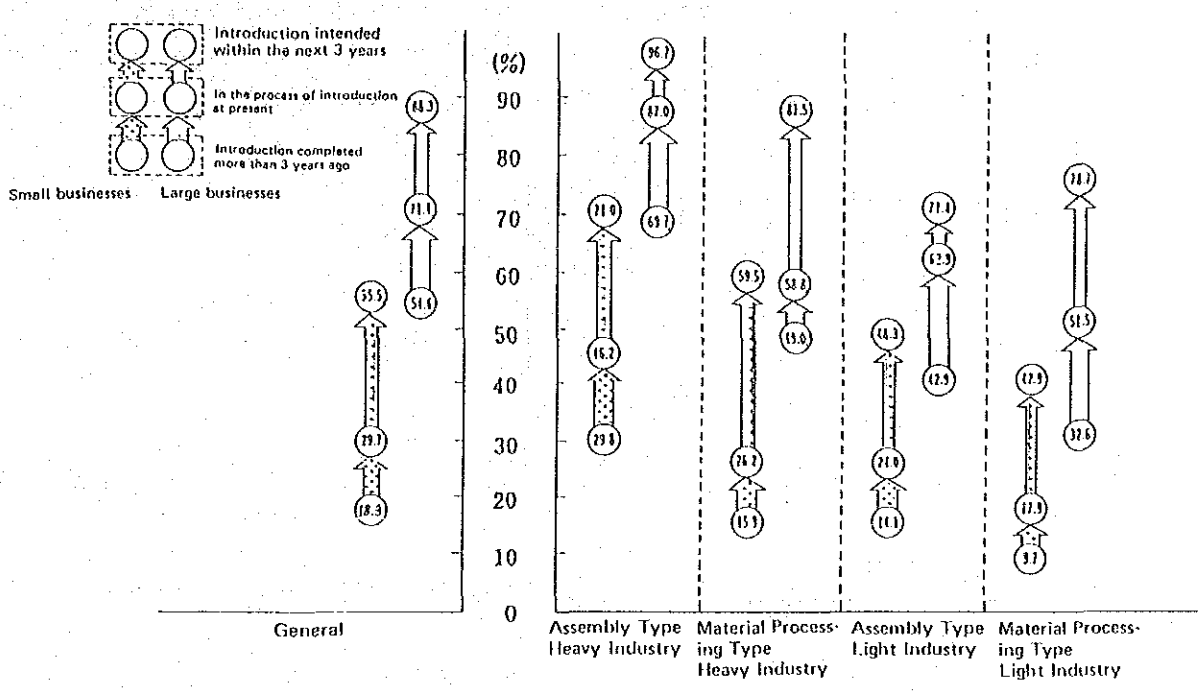
NC machine tools are machines of high performance and diversified functions that perform automatic processing by encoding information, such as dimensions and shapes for cutting.

Their characteristics are:

(a) Ability to cope with a shortage of skilled workers by numerical encoding operation
(b) Improvement in operation consistency and processing accuracy, thus lowering the defect percentage
(c) Simplification of complex processing
(d) Reduction in processing time
(e) Ability to accomodate production of small quantities of many kinds of products

The classifications of NC machine tools are based on conventional ways: turning machines, drilling machines, boring machines, milling

Figure III-4-10 State of Introduction of Equipment and Devices for Mechatronics

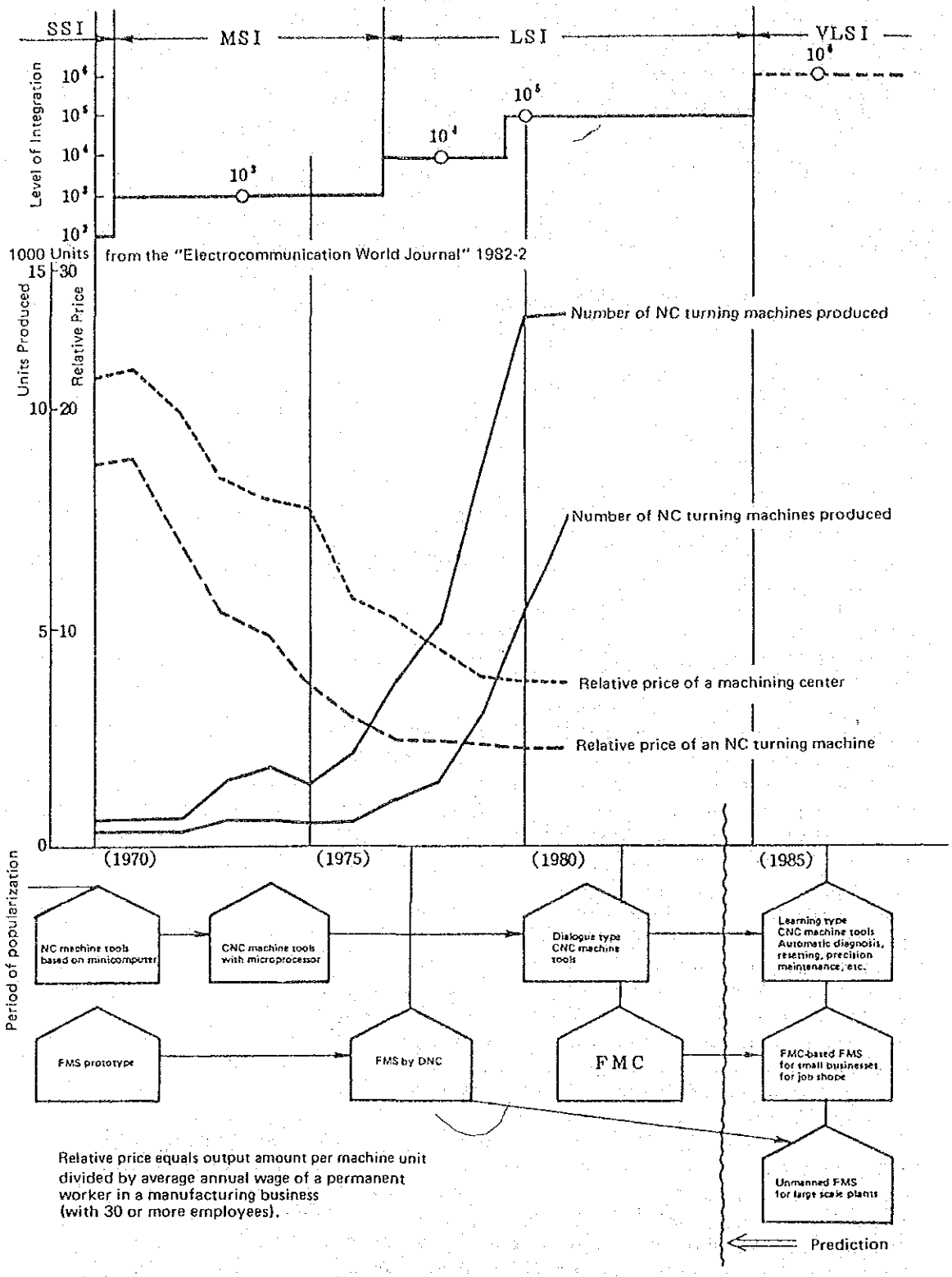


Source: Small and Medium Enterprise Agency, White Paper of Small and Medium Enterprises.

machines, grinding machines and special purpose machines. In addition to the above, new types of machines, such as the NC electron discharge machine which uses electron discharge phenomena, and machining centers which are complex machine tools capable of performing several types of processing (drill, boring, etc.), have appeared. Recently, in response to the demands of machine tool users for higher efficiency and unmanned operation, manufacturers are becoming more system oriented. And machining centers (hereinafter referred to as MCs) are drawing special attention. The latest MCs are provided with automatic tool changing devices (ATCs) and are equipped with more than 40 - 50 tools as well as automatic workpiece supply functions, mounting/dismounting devices (pallet changers) and automatic check devices, which makes possible unmanned operation of the entire unit. Furthermore, unmanned processing systems, using groups of MCs connected by a computer forming automatic processing lines, are being developed now.

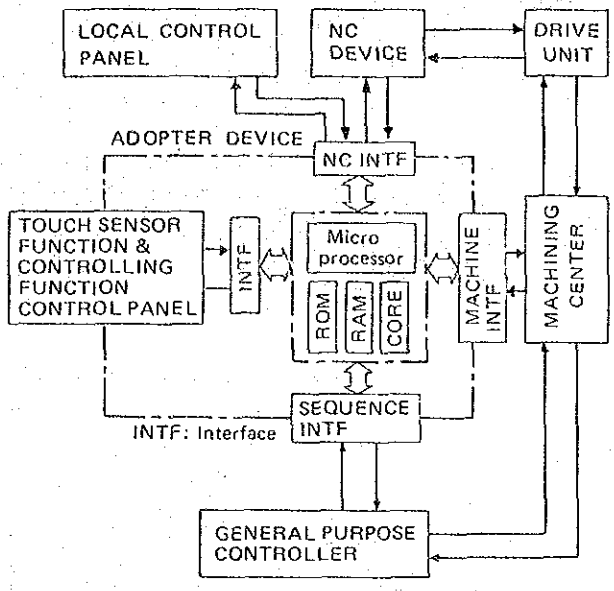
During the past 30 years since NC machine tools first appeared in 1952 in the USA, circuit techniques for NC units developed in accordance with the development of electronics. The present NC units are of the 5th generation, or those equipped with one-chip microprocessors. The first generation, which were with vacuum tubes appeared in 1952, gave way to the development of transistorized units in 1959; the third generation, with the introduction of ICs in 1965 was followed by the fourth generation CNCs (computer NCs) equipped with minicomputers using

Figure III-4-11 Development of NC Machines and Processing System Engineering



Source: Japan Machine Tool Builders Association, Present State and Future Prospects of the Machine Tool Industry, 1984.
MITI, Yearbook of Machinery Statistics.
Ministry of Labor, Yearbook of Labor Statistics.

Figure III-4-12 Example of Mechatronic Application in a Machining Center



Source: The Japan Machinery Federation, Investigative Study of the Sophistication of Production Engineering, 1982.

LSIs, which were regarded as the symbol of the new generation. Finally, fifth generation machines, from 1974 to the present, are CNC's equipped with microprocessors. The period on from the 1970s may be called the period of computer control. Recently, CNC functions have expanded to the dialogue-type programming for practical use. At any rate, NC machines are making further progress in the 1980s. Figure III-4-11 shows the development of NC machine tools and processing system techniques in Japan.

(2) Mechatronics in NC machine tools

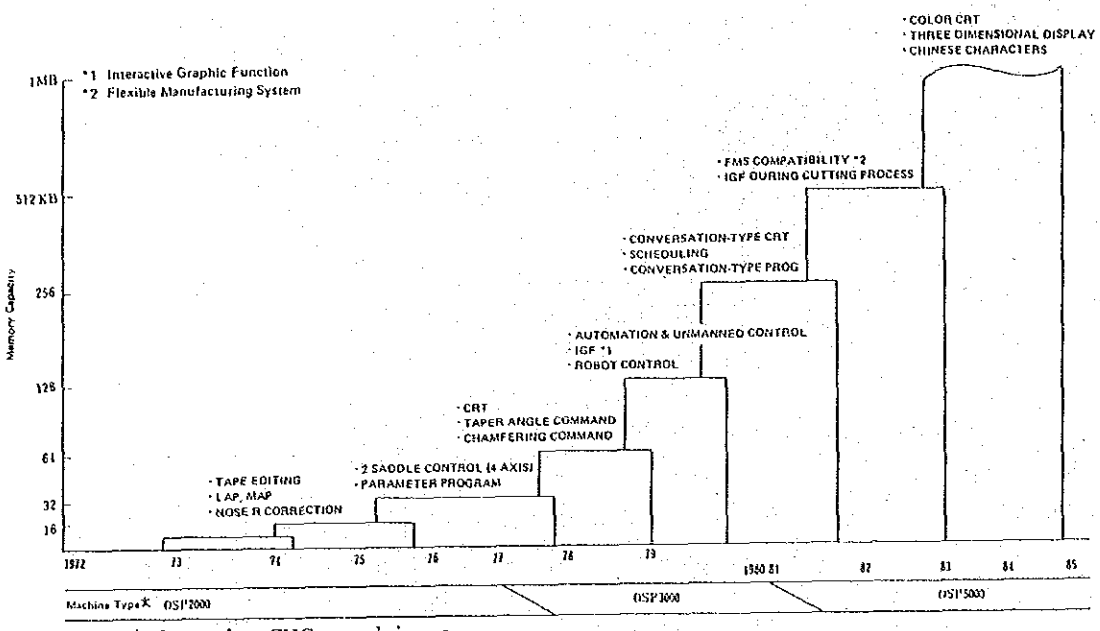
Mechatronics-applied sections of NC machine tools are roughly divided into the NC operating section, servo control section, sequence control section, and measuring and monitoring control section. An example of mechatronics application in a horizontal machining center is shown in Figure III-4-12 (being a 1983 example, it is not the most recent type).

Almost all NC operating sections are of the CNC type using a microprocessor with keyboard and CRT attached. Most of them use 8-bit cells (Intel 8085, Zilog Z 80 or the equivalent), though 16-bit cells (Intel 8086 or equivalent) are also in use now. Progress in the use of 32-bit cells is being made.

Memory cells are mainly core, ROM and RAM, and have capacities of 2K to 64K bytes in total. 4M babbule memories are also in use.

The recent increase in memory capacities of CNC systems is remarkable. This has expanded the range of applicable software, resulting in a drastic broadening of automatic and system functions. Figure III-4-13 shows the recent increase in software and memory capacity at a manufacturing company.

Figure III-4-13 Increase in Memory Capacity and Change in Software



Note: *Okuma's CNC machines
Source: Okuma Machinery Works, Ltd.

(3) Supply and demand structure of NC machine tools

Japan's output of NC machine tools in 1984 amounted to 589.9 billion yen. The number of units produced in the same years was 38,036. Of the total production of machine tools in Japan, those figures amount to 68% and 22% respectively. NC machine tools may be said to occupy about 70% of the machine tool industry of Japan.

NC turning machines and NC machining centers are representative of the NC machine tool industry as a whole. NC turning machines and machining centers occupy 33% and 36% respectively of the total output of all NC machine tools. Production of machine tools progressed favorably, especially in 1984, and recorded a remarkable increase of 38% over the preceding year. This was due to strong demands both in the domestic and overseas markets. A 45% increase in exports over the preceding year is seen as the key factor in this dramatic rise. Exports of NC machine tools in 1984 amounted to 224.8 billion yen.

The background of such a large scale expansion of these machines in this country worth to be considered. During the period of rapid economic growth in the late 1960s, when equipment investment was at its height, the need for such machines as measures to counteract the

increasing shortage of skilled labor grew. Then, during the period following the first oil crisis in 1973, introduction of these machines was promoted as a way of fighting rising costs, specifically as a means for labor-saving and streamlining. After the second oil crisis in 1979, along with severe requirements for cost cuts and improvement in quality, the lowering of prices of these machines accelerated popularization among smaller enterprises. As for the export market, increased sales can be attributed to the advantages previously pointed out:

(a) Ability to cope with a shortage of skilled workers by numerically controlling operation processes
(b) Improvement in processing consistency and lowering of the percentage of defective products
(c) Facilitation of complex processes
(d) Reduction in processing time
(e) Ability to accommodate production of small quantities of various kinds of products.

The demand for NC machine tools in Japan is relatively concentrated on machines for general purposes, while in Western nations the demand for complex specialized processes are emphasized. The general purpose type of machines fit the needs of Western nations for cost reductions after the second oil crisis, which accelerated the export of such machines from Japan. The current trends of Japanese machine tools is shown in Tables III-4-4 and III-4-5.

Table III-4-4 Trends of Production of NC Machines

(Millions of US$)

BY Amount	1980	1981	1982	1983	1984
1. NC Turning Machine	755	798	694	601	955
2. NC Drilling Machine	10	11	9	21	24
3. NC Boring Machine	40	63	56	50	51
4. NC Milling Machine	93	152	168	167	173
5. NC Grinding Machine	17	21	29	29	58
6. NC Special Purpose Machine	32	58	49	74	152
7. NC Electric Discharge Machine (EDM)	162	197	244	302	370
7-1. NC EDM with Wire	0	156	171	200	254
8. NC Machinig Center (MC)	552	819	801	825	1,055
8-1. Vertical MC	256	402	373	386	533
8-2. Horizontal MC	277	385	318	326	378
9. Other NC Machine	20	30	38	44	83
Total	1,680	2,149	2,088	2,112	2,920

BY Units	1980	1981	1982	1983	1984
1. NC Turning Machine	12,007	12,133	10,344	10,020	16,555
2. NC Drilling Machine	249	300	201	501	631
3. NC Boring Machine	103	136	139	140	215
4. NC Milling Machine	1,451	2,381	2,331	2,468	2,775
5. NC Grinding Machine	154	235	294	343	671
6. NC Special Purpose Machine	101	103	137	497	1,193
7. NC Electric Discharge Machine (EDM)	2,566	3,020	3,534	4,233	5,034
7-1. NC EDM with Wire		2,379	2,435	2,659	3,481
8. NC Machinig Center (MC)	5,231	7,394	6,942	7,791	10,252
8-1. Vertical MC	2,937	4,682	4,220	4,722	6,589
8-2. Horizontal MC	1,841	2,368	1,852	2,035	2,567
9. Other NC Machine	190	224	216	415	710
Total	22,052	25,926	24,138	26,408	38,036

Source: MITI, Yearbook of Machinery Statistics.
Note: The US$ amounts are converted from Yen with the exchange rate US$1=202 Yen (the end of Nov. 1985, IFS)