Table III-4-5 Trade of Metal Processing Machine

(Millions of US$)

By Amount	81	82	83	84/1Q	84/2Q
1. Export (By Kinds)	1,538	1,226	1,175	331	356
1-1.NC Machine	1,084	808	769	236	253
1-1-1. NC Turning Machine	554	386	295	89	94
1-1-2. Machining Center	471	362	389	110	123
2. Export (By Destination)					
2-1. Europe	305	241	241	62	65
2-2. North America	784	566	445	150	146
2-3. Others	449	419	490	120	146
3. Imports	191	216	161	32	34

By Unit	81	82	83	84/1Q	84/2Q
1. Export (By Kinds)					
1-1.NC Machine	11,452	7,899	7,868	2,439	2,590
1-1-1. NC Turning Machine	6,613	4,382	3,705	1,212	1,285
1-1-2. Machining Center	4,129	3,083	3,483	1,002	1,089

Source: MOF, Customs and Tariff Bureau, and others
Note: The US$ amounts are converted from Yen with the exchange rate of US$1=202 Yen (The end of Nov. 1985, IFS)

(4) International position and reputation of Japanese NC machine tools

According to "American Machinist" magazine, Japan has been the largest producer of machine tools since 1981. Tables III-4-6 and III-4-7 show the comparison of Western nations to Japan in the production of NC machine tools. Compared to the Federal Republic of Germany, which is in second place, Japan produced about 4 times as many machines, and Japan's production was 7.4 times that of the U.S.A. In the field of general purpose NC machine tools, Japan's position is overwhelming.

As observed so far, Japanese NC machine tools are beginning to be used internationally, and their reputation is quite high. Figure III-4-14 shows the rating of the technical level of Japanese machining centers used in Western nations. There is no question that the technical level is increasing even more. Figure III-4-15 shows that support devices are favorably rated in Japan. The high technical level displayed by the accuracy of these devices may be a supporting factor in Japan's ability to compete in this field.

(5) Current state of NC machine tool manufacturers

At present, out of 112 companies the Japan Machine Tool Builders Association (JMTBA), 94 companies have records of NC machine tool production. Classified by the type of machine produced, NC turning machines and NC machining centers were at the top of the list. In 1984, NC turning machines were produced by 40 companies, and NC machining cen-

Table III-4-6 International Comparison of NC Machine Tool Production (1984)

(No. of machine produced)

	F.R. Germany	France	U.K.	Italy	Japan	U.S.A.
NC Boring Machines	194	-	-	90	215	119
NC Drilling Machines	189	9	-		631	
NC Gear Cutting Machines	296	-	-	-	10	
NC Grinding Machines	1,924	48	-	-	671	546
NC Turning machines	2,356	616	816	830	16,555	1,524
NC Milling Machines	3,769	334		600	2,775	1,434
Other NC Machine Tools	1,265	187	1,814	-	17,189 *	1,528
Total	9,966	1,294	2,630	-	38,036	5,151

Source: Comité Européen de coopération des Industries de la Machine-Outil (CECIMO)

Note: * Including 10,252 Machining Centers

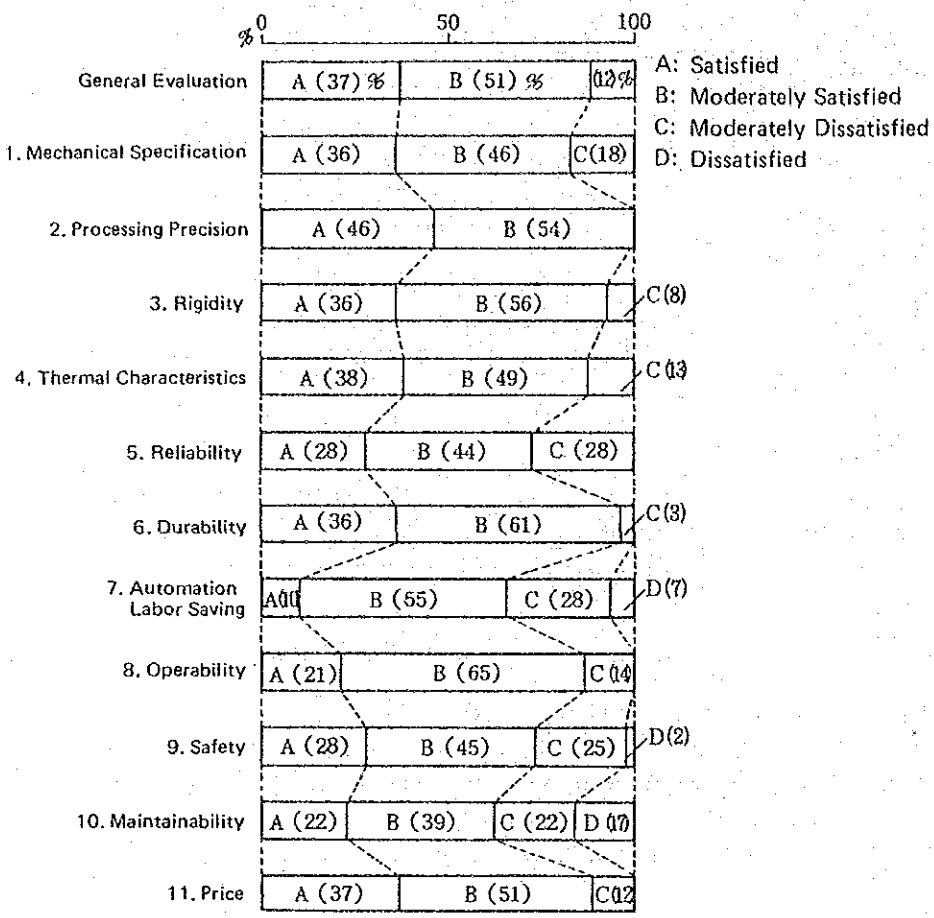
Table III-4-7 International Comparison of Machining Center Production

(No. of machines produced)

	F.R. Germany	France	U.K.	Italy	Japan	U.S.A.
1980	242	61	215	410	5,231	2,132
81	307	119	201	541	7,394	2,081
82	436	123	184	455	6,942	1,396
83	539	121	148	498	7,791	1,005
84	821	167	338	530	10,252	1,237

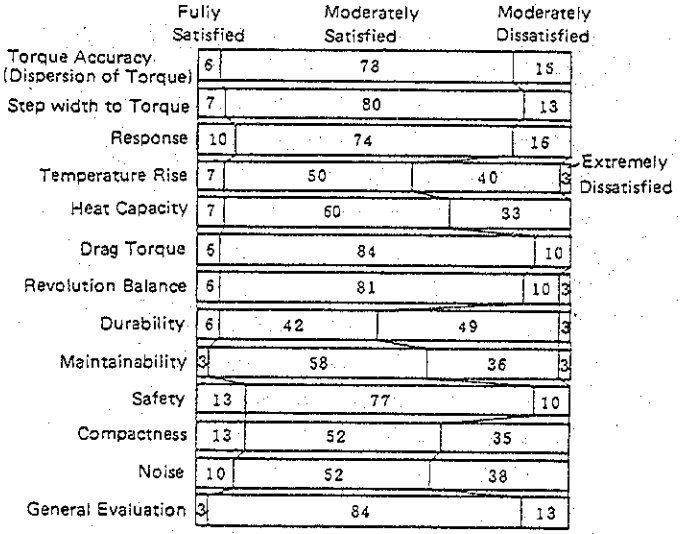
Source: CECIMO

Figure III-4-14 Reputation of Japanese-made Machining Centers in Western Nations (General Table)

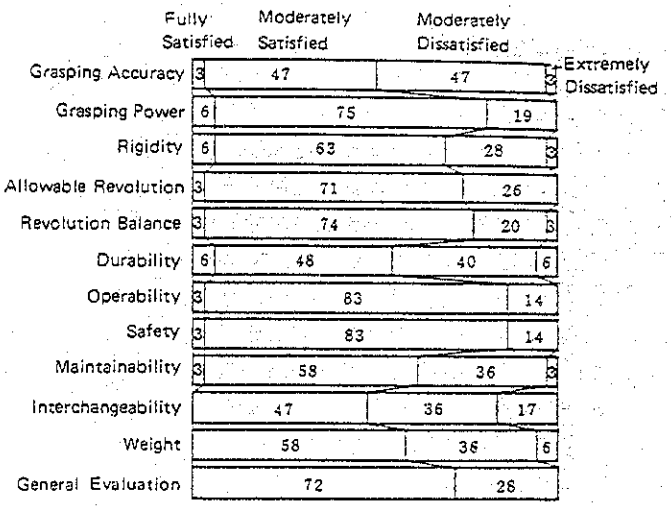


Source: Survey by Japan Machine Tool Builders Association (1981)

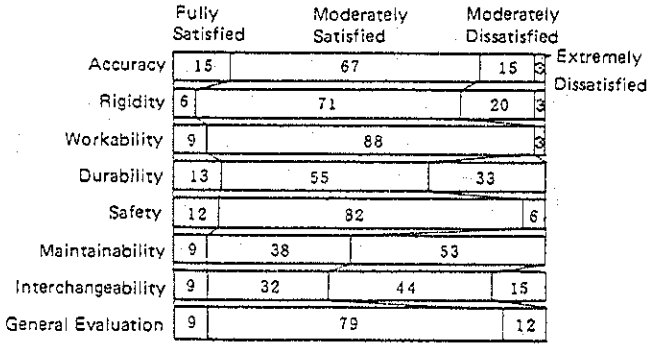
Figure III-4-15 Technical Evaluation of Equipment & Devices by Users (percentage share)



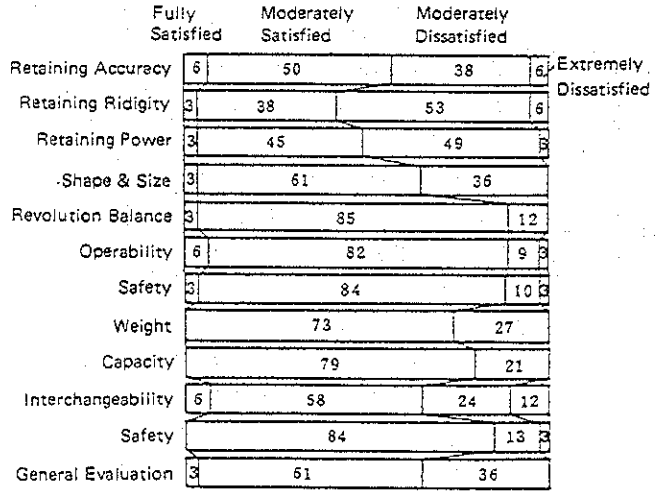
(A) Electro Magnetic Clutch & Brake



(C) Chuck for Turning Machine



(B) Drilling Screw



(D) Tooling

Source: Survey by Japan Machine Tool Builders Association (1982)

ters were produced by 45 companies, as shown in Table III-4-8. Table III-4-9 lists the manufacturers of NC machine tools. Those who manufacture almost all types are such large enterprises as Hitachi Seiki Co., Ltd., Mitsubishi Heavy Industries, Ltd., Okuma Machinery Works Ltd., Shin Nippon Koki Co., Ltd., and Toshiba Machine Co., Ltd. In general, however, with the exception of large enterprises for whom this field is a side line, machine tool manufacturers are relatively small in scale, and their business foundations are not strong (Tables III-4-10 and III-4-11). This tendency is common both in Japan and Western nations.

(6) Current state of NC units manufacturers

At present in Japan, FANUC is the leading NC units manufacturer. Production of other manufacturers is quite small. Recently, NEC started production of these items which they had previously discontinued. Yasukawa Electric Mfg. Co., Ltd., Mitsubishi Electric Corporation, and others are also increasing their production. Okuma Machinery Works Ltd., among others, is a major manufacturer of built-in type NC units. They are emphasizing their advantages by differentiating their products from FANUC NC units which most NC machines are equipped with in Japan. The most common type of unit shipped is the profile control type. The data in Tables III-4-12 and III-4-13 is somewhat dated but is shown for reference.

Though these tables list members of the Japan Machine Tool Builders Association only, FANUC has been leading the domestic market. With the epoch-making development of electrohydraulic pulse motors, FANUC retained over 70% of the market until the early 1970s. After the first oil crisis, however, less competition was noticed due to the high energy consumption of the pulse motor, so the switch to DC motors was made under a licensing contract with Getty. FANUC has securely retained a market share of approximately 60% even in the 1980s.

At present, FANUC has firmly established its ability to produce 2000 NC devices per month. The recent sudden rise in sales by Mitsubishi Electric Corporation and the withdrawal of Oki Electric Industries Co., Ltd. from this market in the spring of 1980, depict the ferocity of the competition. There are also several machine tool manufacturers specializing in built-in type NC units. Of these, Okuma Machinery Works Ltd. maintains a high position, second only to FANUC in the entire NC machine tool market. Since built-in NC units are of the integrated type with machines, they have advantage to fit to the specific needs of each user. On the other hand, there is the disadvantage of making mass-production difficult. New entries to this market are expected to be few in number because of the requirements of hiring engineers and investing large amounts of capital.

(7) Direction of the Japanese machine tool industry in the future

The machine tool industry, and especially machine tool technology in Japan, is expected to develop gradually in two different directions. One direction is toward systemization with NC machine tools forming the core. This would encourage sophistication of production systems by

Table III-4-8 Number of Manufacturers of NC Machine Tools Classified by Machine Type

(Unit: Number of manufacturers)

	Turning Machines	Drilling Machines	Boring Machines	Milling Machines	Planing Machines	Grinding Machines	Gear Cutting & Finishing Machines	Special Purpose Machine	Machining Centers	Electric Discharge Machine	Other Machiens	Total
1976	25	15	12	17	2	9	0	7	20	--	4	111
1976	25	12	9	16	2	10	1	5	22	--	4	112
1977	25	9	7	13	0	9	0	8	22	--	10	103
1978	25	7	7	12	3	11	1	10	23	5	7	111
1979	26	6	8	19	1	9	1	11	26	5	5	117
1980	29	7	10	21	--	14	1	13	31	5	9	141
1981	31	6	8	19	--	13	0	14	32	7	2	132
1982	34	9	10	27	--	17	3	14	39	7	7	167
1983	37	12	11	26	--	18	6	28	44	7	14	203
1984	40	18	10	26	--	23	7	31	45	7	19	226

Source: Japan Machine Tool Builders Association

Note: "Planning Machines" are included in "Other Machines" from 1980 on.

Table III-4-9 Production of NC Machine Tools Classified by Machine Types and Manufacturers
(Based on 1984 record and schedule for 1985)

Type of Machines / Name of Enterprises	Turning Machines		Drilling Machines	Boring Machines	Milling Machines	Grinding Machines	Gear Cutting Machines	Special Purpose Machines	Machining Centers					Electric Machines Discharge		Other Machine Tools	Total
	Horizontal	Vertical							Horizontal	Vertical	Gate Type	Workpiece Rotating Type	Other Types	Wire Cutting	Shape Carving		
Aichi Tokei Denki			●					●		○	●						3
Ashina Iron Works			●								●						2
Azuma Shimamoto Engineering	●																1
Daido Machinery			○														1
Dainichi Kinzoku Kogyo	●																1
Daiwa Seiki	●																1
Eguro Machinery	●				●			●								●	4
Enshu Limited					●	●		●	●	●							5
Fanuc	●		●		●			●	●	●				●			6
Fuji Machine Manufacturing	●	●						●									3
Fujikoshi	●					●		●								●	4
Fuji Seiki Machine Works			●													●	2
Hamai				●	●					●							3
Hitachi Seiki	●				●	●		●	●	●	●						6
Hitachi Seiko	●				●	●		●	●	●				●	●		8
Hokoku Machinery			●						●	●							3
Homma Machinery		●	●		●			●			○					●	6
Howa Machinery								●	●	○							3
Iida Machinery					●												1
Ikeda Iron Works			●														1
Ikegai	●	●		●				●	●		●						6
Ito Seisakusho			●														1
Japax														●	●		2
Kanzaki Kokyukoki Mfg.			●		●		●	●									4
Karatsu Iron Works	●						●										2
Kashifuji Works						●	●										2
Kataoka Machine Tools Mfg.	●					●										●	3
Keiyo Seiki	●																1
Kiriu Machine Mfg.	●	●	●														3
Kitagawa Kogyo	●	●															2
Kitamura Machinery	●				●				●	●	●						5
Kiwa Iron Works			●		●					●							3
Komatsu	●				●			●				●	●				5
Kondo Machine Works						●											1
Kotobuki Industry					●			●		●	●						4
Kurashiki	●			●	●				●	●							5
Makino Milling Machine					●	△			●	●				●	●		6
Marufuku Machinery Works					●					●						●	3
Mazda Motor						●			●								2
Matsuura Machinery									●	●			●				3
Minakuchi Machinery Works						○											1
Mitsubishi Electric														●	●	●	3
Mitsubishi Heavy Industries	●			●	●	●	●	●	●	●							8
Mitsui Seiki Kogyo				●		●		●	●	●							5
Miyano Machinery	●												●				2
Mori Seiki	●								●	●							3
Motokubo Machine Tool Works					●												1
Murata Machinery	●								○	●							3
Nakamura-Tome Precision Industry	●								●	●							3
Nihon Kikai Seisakusho							●	○									2

Table III-4-9 (cont.)

Type of Machines / Name of Enterprises	Turning Machines		Drilling Machines	Boring Machines	Milling Machines	Grinding Machines	Gear Cutting Machines	Special Purpose Machines	Machining Centers					Electric Discharge Machines		Other Machine Tools	Total
	Horizontal	Vertical							Horizontal	Vertical	Gate Type	Workpiece Rotating Type	Other Types	Wire Cutting	Shape Carving		
Niigata Engineering					●			●	●	●						●	5
Nicco Machine Tool						●		●								●	1
Nippei Toyama						●		●		●						●	4
Nisshinbo Industries								●								●	2
Nomura Automatic Lathe	●																1
Nomura Machine Tool Works				●				●	●								3
Ogawa Iron Works			●														1
Okamoto Machine Tool Works						●			●							△	3
Okamura Iron Works								●								●	2
Okuma & Howa Machinery	●				●				●	●							4
Okuma Machinery Works	●		●	●		●			●	●	●						7
Ohtori Kiko					●												1
O-M		●	●					●	●			●					5
Osaka Kiko					●			●	●	●							4
Riken Seiko	●				●					●							4
Roku-Roku Sangyo			●					●		●			●			●	4
Sakurai			●		●			●	●							●	5
Sankyo Seiki Mfg.								●								●	1
Seibu Electric Mfg.	●													●	●		3
Seiko-Seiki						●											1
Seiwa Precision Machinery						●	●										2
Citizen Watch	●									●							2
Shigiya Machinery Works						●											1
Shin Nippon Koki	●		●	●	●			●	●	●	●					●	9
Shizuoka Machine Tool					●					●							2
Shoun Machine Tool	●	●						●								●	4
Sodick														●	●		2
Suga Machine Tool								●									1
Star Mfg.	●																1
Taiyo Seiki	●																1
Takisawa Machine Tool	●								●	●							3
Teijin Seiki								●									1
Toshiba Machine		●		●		●		●	●	●		●				●	8
Toyoda Machine Works						●		●	●	●	●		●				6
Toyo Seiki Kogyo			●					●									2
Tsugami	●					●			●								3
Tsune Seiki																●	1
Urawa Machine Tools Mfg.											●						1
Waida Mfg.						●											1
Wasino Machine	●					●											2
Yamazaki Machinery Works	●	●				●			●	●	●					●	7
Yasuda Industry				●					●	△							3
Yoneda Tekkosho					●												1
Yutaka Seimitsu Kogyo							●										1
	37	9	19	10	26	25	7	32	32	35	11	3	5	7	6	20	284

Table III-4-10 Number of Companies, Amount of Sales, and Number of Employees of Machine Tool Manufacturers as Classified by Number of Employees

Calssification by No. of Employees	49 and below	50 - 99	100 - 299	300 - 499	500 - 999	1,000 - 2,300	Total
No. of Companies	16	20	43	13	14	7	113
Output of Machine Tools (million yen)	5,700	33,800	130,300	115,000	202,300	202,100	689,700
No. of Employees in Machine Tool Manufacture	349	1,456	7,440	4,628	9,360	10,548	33,781

Source: Japan Machine Tool Builders Association, Survey of Members, as of the End of 1983.

Table III-4-11 Number of Employees of Machine Tools Manufacturers of Leading Nations

	F.R. Germany	France	Italy	U.K.	Belgium	U.S.A.
No. of Companies	440	163	1,233	982	36	917
No. of Employees	99,000	18,984	46,400	55,200	3,138	59,400
No. of Employees per Company	225	116	38	56	87	65
Proportion of Companies with 500 or more employees (%)						
No. of Enterprises	11.6	4.9	0.6	1.9	2.8	0.3
No. of Employees	49.1	33.7	21.1	49.7	17.3	-
No. of Temporary Employees	50.0	34.7	-	49.9	-	-

Source: Europe: National Surveys (1981).
U.S.A.: NMTBA, Economic Handbook (U.S. Bureau of the Census-1977).

Table III-4-12 Number of NC Units Shipped by Manufacturer

(Unit: ea.)

	Fujitsu Fanuc	Hitachi	Mitsubishi	NEC	Oki Electric	Toshiba	Yasukawa Electric Mfg.	Machine Tool Manufac-turer	Other Domestic Manufac-turer	Foreign Manufac-turer	Total
1972	1,013	17	43	20	19	32	-	143	36	37	1,360
1973	1,738	25	64	62	82	64	-	347	74	22	2,478
1974	1,739	1	97	78	91	59	-	241	19	31	2,356
1975	1,226	5	112	41	83	54	-	346	5	24	1,896
1976	1,791	0	213	52	119	34	-	853	13	56	3,131
1977	2,803	0	709	90	95	56	15	1,043	27	12	4,850
1978	4,589	0	809	86	107	59	73	1,548	10	22	7,303
1979	7,333	0	1,557	117	209	12	411	2,646	54	25	12,364
1980	11,236	0	2,436	148	89	7	1,143	3,848	100	120	19,127

Table III-4-13 NC Unit Manufacturers' Market Shares

(Unit: %)

	Fujitsu Fanuc	Hitachi	Mitsubishi	NEC	Oki Electric	Toshiba	Yasukawa Electric Mfg.	Machine Tool Manufac-turer	Other Domestic Manufac-turer	Foreign Manufac-turer	Total
1972	74.5	1.2	3.2	1.5	1.4	2.4	-	10.5	2.6	2.7	100
1973	70.1	1.0	2.6	2.5	3.3	2.6	-	14.0	3.0	0.9	100
1974	73.9	-	4.1	3.3	3.9	2.5	-	10.2	0.8	1.3	100
1975	64.6	0.3	5.9	2.2	4.4	2.8	-	18.2	0.3	1.3	100
1976	57.2	0	6.8	1.7	3.8	1.1	-	27.2	0.4	1.8	100
1977	57.8	0	14.6	1.9	2.0	1.1	0.3	21.5	0.6	0.2	100
1978	62.8	0	11.1	1.2	1.5	0.8	1.0	21.2	0.1	0.3	100
1979	59.3	0	12.6	1.0	1.7	0.1	3.3	21.4	0.4	0.2	100
1980	58.8	0	12.7	0.8	0.5	0.0	6.0	20.1	0.5	0.6	100

Source: Japan Machine Tool Builders Association, Survey of Stastical Results in NC Machine Tool Manufacturing.

Notes: 1. Machine tool manufacturers include: Enshu Seisakusho, Japacs, Makino Milling Machine, Mitsuiseiki, Motokubo Industries, Okuma Machinery Works, O-M Mfg., Toshiba Machine, Toyoda Koki, Waida Mfg. Washino Machinery.

2. Fujitsu-FANUC changed the name to FANUC in 1982.

integrating automatic transfer and handling such as CAD/CAM, and the introduction of FA (Factory Automation). The other direction is toward super precision techniques, microscopic dimensions and super high speed.

At present, the introduction of flexible production systems is drawing foremost attention not only in Japan but the whole world. This is regarded as the introduction of a new production strategy. It is a concept that promotes and supports FA. For example, a survey named current state of automation in manufacturing processes in the Japanese mechanical industry made by Japan Society for the promotion of machine industry in 1985 revealed that, in the design and processing stages, 20% of the processes have already been automated, and by 1990, that figure will grow to about 40%. Furthermore, similar ideas regarding the automation of entire systems are being explored (Table III-4-14 and Figure III-4-16). Promotion of the introduction of FA is expected to accelerate in the future. Therefore, development of equipment and devices for this system is regarded as an urgent task.

As shown in Table III-4-15, the progress of the introduction of FA is in the second stage now, and is expected to grow and proceed to the third stage. As for the flow of hardware technology, as shown in Figure III-4-17, the period from 1980 through 1990 can be seen as a period of transition from FMCs (Flexible Manufacturing Cells) and FMSs (Flexible Manufacturing Systems) to CIM (Computer Integrated Manufacturing) or FA. At this stage, progress in software technology is expected to focus on LAN (Local Network) techniques, by connecting conventional FMSs. Incidentally, by the year 2000, the second FA stage, FA II, will have been completed, and unmanned operation techniques will reach a new level. In any event, NC machine tools in Japan are at the stage of FMS introduction, which is regarded as the core of FA formation.

There have been more than 100 cases observed regarding the introduction of FMS into the production process. FMS is expected to prevail from now on, but at the same time, there are believed to be many problems yet unsolved in improving the functioning of this system. Establishment of FA is thought to require a configuration like that in Figure III-4-18, and accordingly, it is important to solve these problems.

The tasks to be accomplished are as follows:

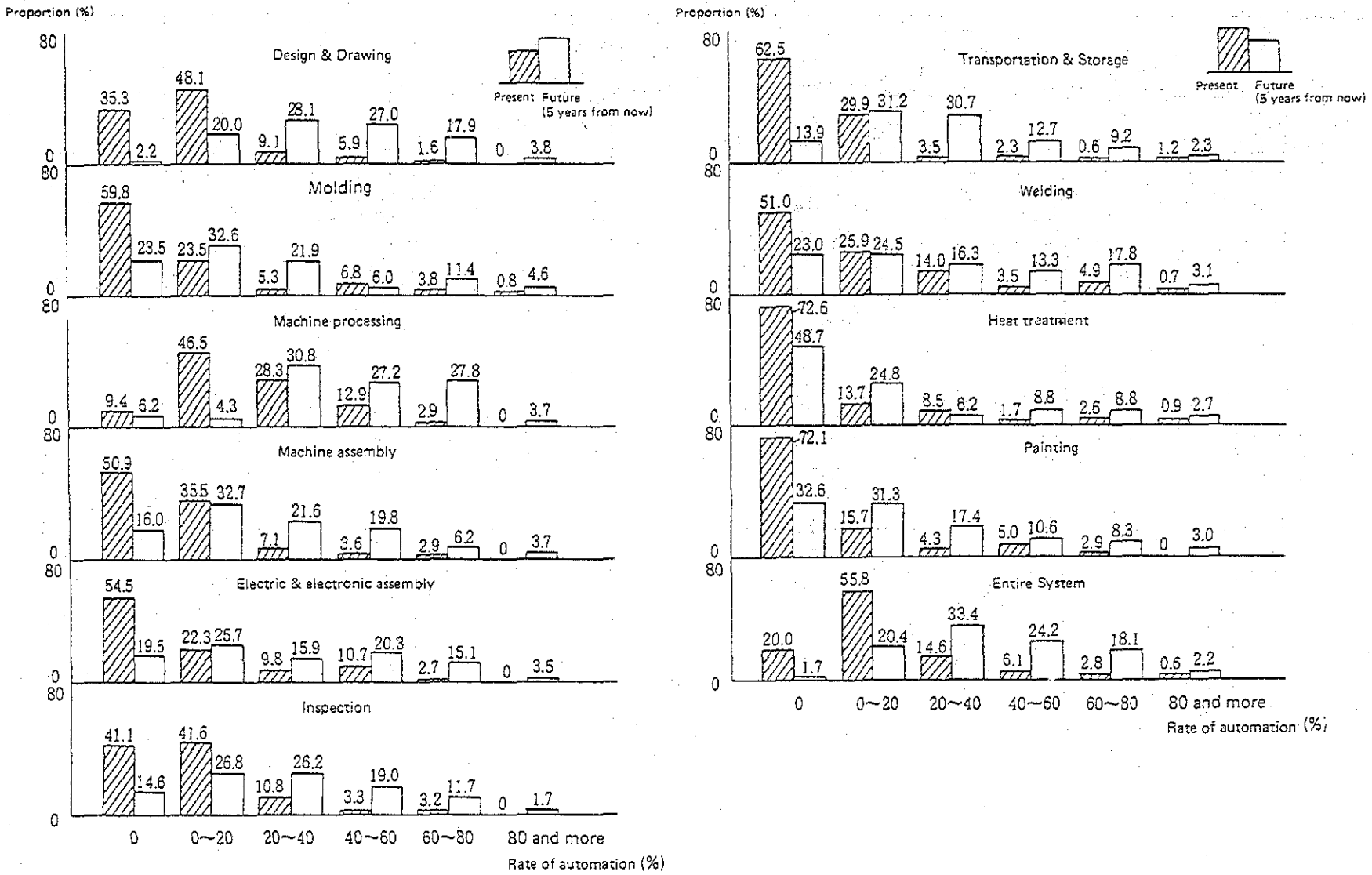
(a) Application of super LSIs

Development of intelligent CNC machines, which use various sensors jointly, is expected to promote reliability and adaptability of an FMS consisting of individual interconnected units.

(b) Standardization of FA equipment and devices

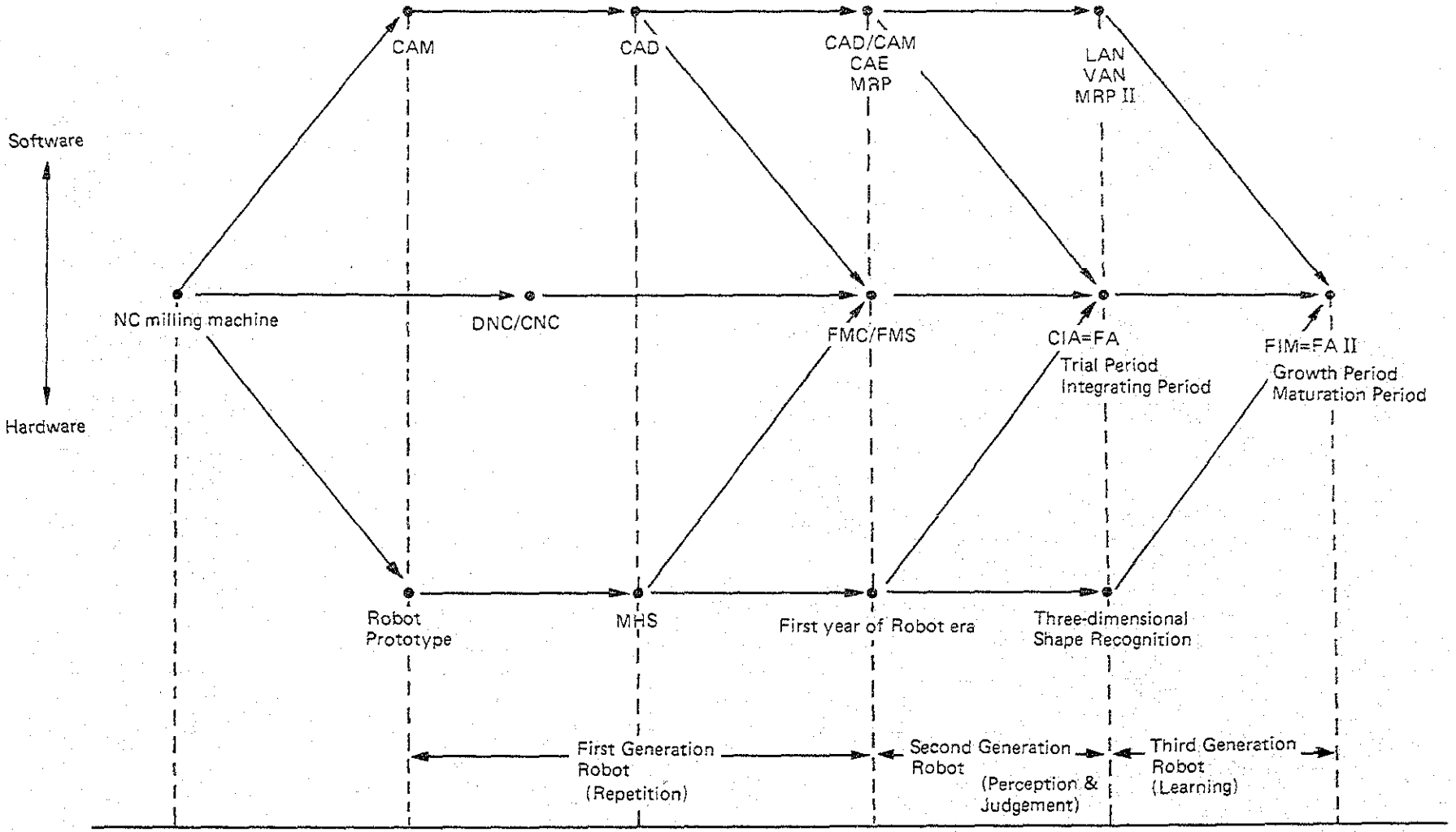
Standardization of sophisticated CNC machines in terms of both hardware and software is important in view of maintenance as well as for international marketing. Interchangeability of parts being made

Figure III-4-16 Present State of Automation through Introduction of ME Equipment and Devices



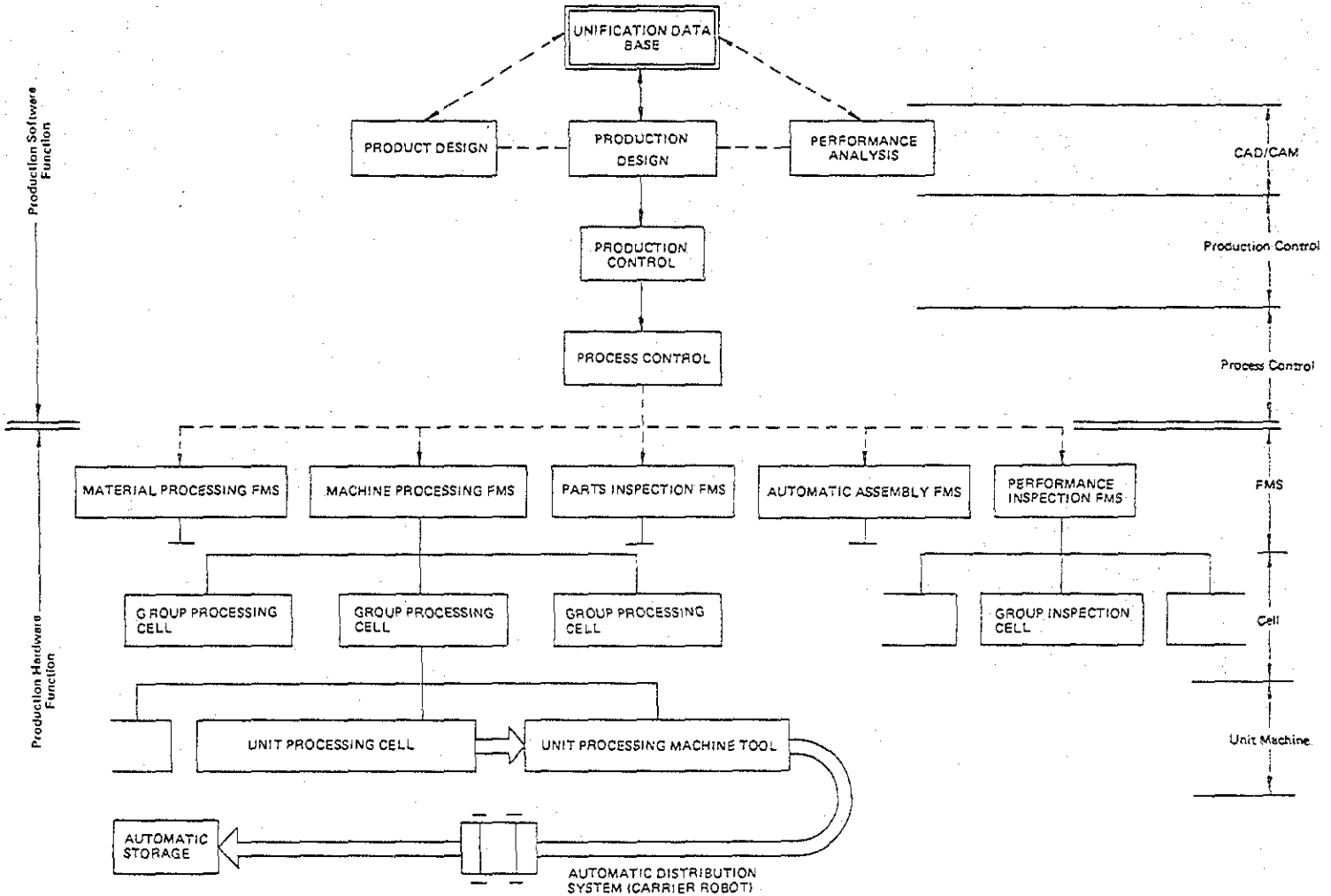
Source: Japan Society for the Promotion of the Machine Industry, Progress in Introducing FA and Future Tasks.

Figure III-4-17 Developing Process of FA Technology



Source: Y. Hasegawa and H. Awane, Production System for a Large Variety of Small Quantities.

Figure III-4-18 Conceptual Drawing of FA System



Source: Prof. Yuji Furukawa, Engineering Dept., Tokyo Metropolitan University

Table III-4-14 Range of Survey on the Introduction of FA

Process	Examples of ME Equipment or Devices (automated equipment or devices using microelectronics)	Rate of automation using ME equipment and devices %	
		Present	5 years from now
Design & drawing	CAD/CAM, automatic programming device	Present state (rate of automation)	5 years from now (approx. 1990)
Shaping processing	NC press, laser processing machine		
Machine processing	NC machine tools, FMC, FMS assembly robots		
Machine assembly	Automatic inserter		
Electric & electronic assembly	Automatic measuring instrument, CAT		
Inspection Transporation & Storage Welding Heat treatment Painting	Industrial robot, etc.		
Entire production system			

Source: Japan Society for the Promotion of the Machine Industry, Progress in Introducing FA and Future Tasks.

Note: ME means micro electronics.

possible by standardization satisfies those requirements. It, in turn, contributes to the development of FA engineering.

(c) FA information network techniques

Integration of information regarding production control is going to be obtained by connecting sophisticated information networks with CNC machines and FMS. It will contribute the improvement of productivity in large companies as well as small sized companies. It will also help the development of regional industries. For this reason, development and standardization of interface techniques should be carried out. (MAP, which GM advocates, is being examined in Japan now.)

Table III-4-15 Trends of Factory Automation

	Primary	Secondary	Tertiary
	FACTORY AUTOMATION	FLEXIBLE AUTOMATION	FUTURE AUTOMATION
[Target]	Reduction in cost by mass-production	Change in demand adaptation to diversification	Sophistication of information
[Adaptation]	Standardization Automation	Introduction of flexibility	Unification of information & distribution
[Trigger]	Electronic calculator, NC	Microcomputer, Robot	Fifth generation computer, Knowledge engineering

Source: Symposium on Production System held at Waseda University.

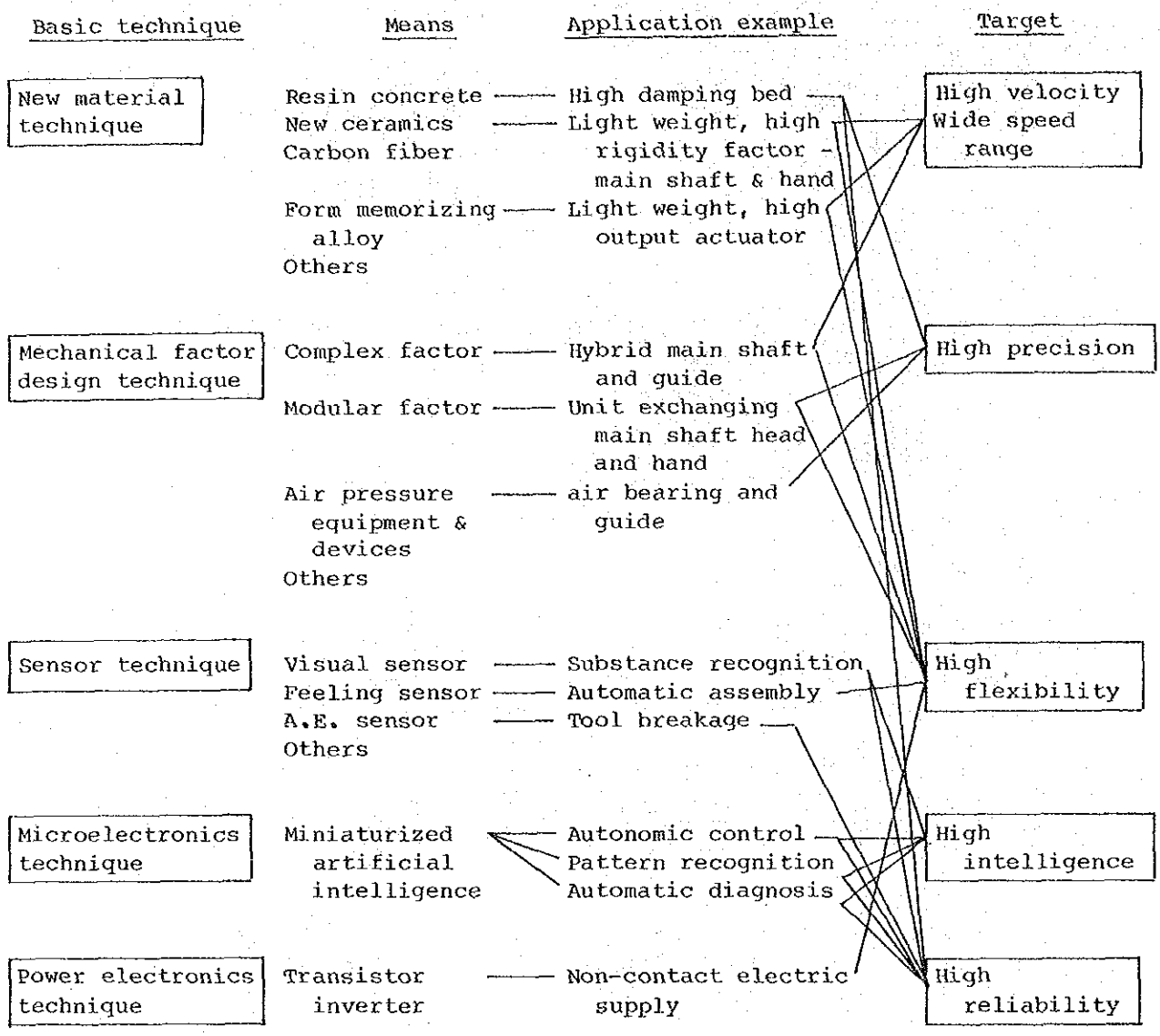
(d) Sophistication of hardware techniques

Development of related hardware techniques, as shown in Figure III-4-19, is required in order to upgrade FA from mere production to the one which can meet diversified production requirements for faster, more accurate, more flexible and more reliable machines.

The results of a survey on the introduction of FMS in Japan is shown in Table III-4-16. As of 1981, when the survey was conducted, Japan was the world leader in the introduction of FMS. Table III-4-17 shows the estimated future introduction progress.

The analysis of effects of the introduction of FMS is a topic for future study. At any rate, it is expected that the direction NC machine tool techniques will take definitely the way toward systemization. Japan is striving aggressively for systemization of machine tools at present. At the governmental level, the Ministry of International Trade and Industry began research and development of "Complex Production Systems" using "Super High Performance Lasers" in 1977, and an experimental plant was completed in 1983. Also, research is being carried out on the subject of standardizing the means of communication for LANs. In the private enterprise sector, system engineering experience is accumulating and steadily progressing. Many systems such as FMCs, FMSs, etc. have been produced commercially. Some examples are shown in Figures III-4-20 - III-4-22.

Figure III-4-19 Purpose & Application Techniques of FA-related Equipment & Devices



Source: Yuji Furukawa, Engineering Dept., Tokyo Metropolitan Univ.

Table III-4-16 Number of FMS by Country

(as of October 1981)

Country	Number	Country	Number
Japan	49	Czechoslovakia	7
U.S.A.	44	Poland	4
W. Germany	35	Bulgaria	3
U. K.	10	Sweden	3
E. Germany	9	Italy	2
U.S.S.R.	8	Romania	1
Hungary	8	Switzerland	1
Norway	8	Total	192

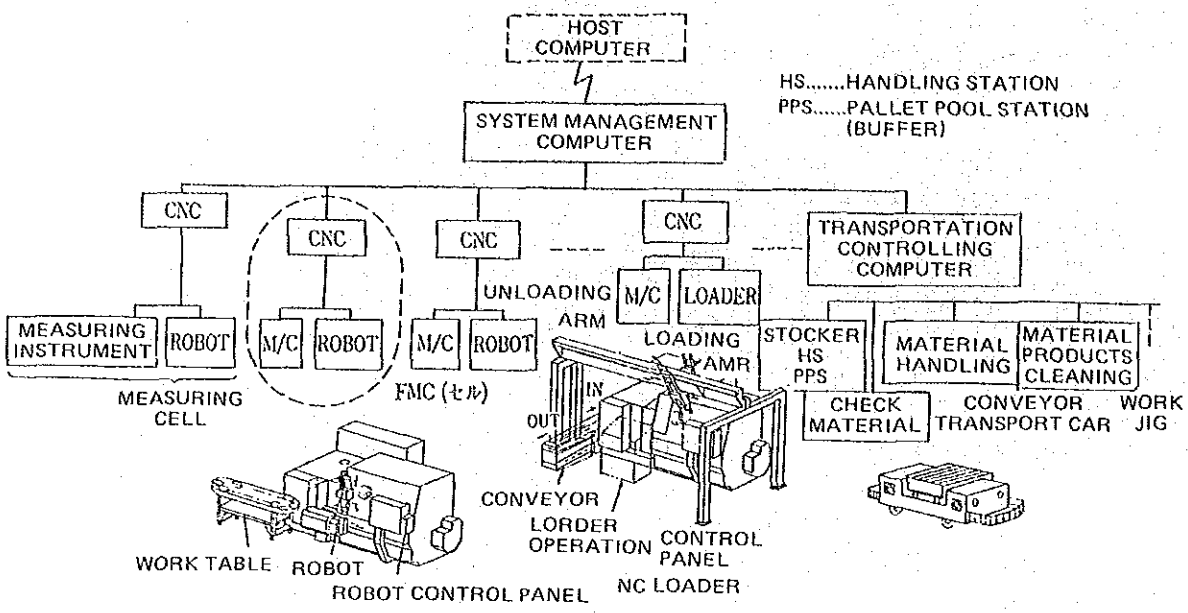
Source: Association of Mechanical Technology

Table III-4-17 Estimate of FMS Introduction

Year	No. of Estimated Production Systems
1984	20 - 25
1985	23 - 29
1986	27 - 34
1987	32 - 41
1988	35 - 45
Total	137 - 174

Source: Japan Machine Tool Builders Association

Figure III-4-20 Model of FMS for Round Shaft Items



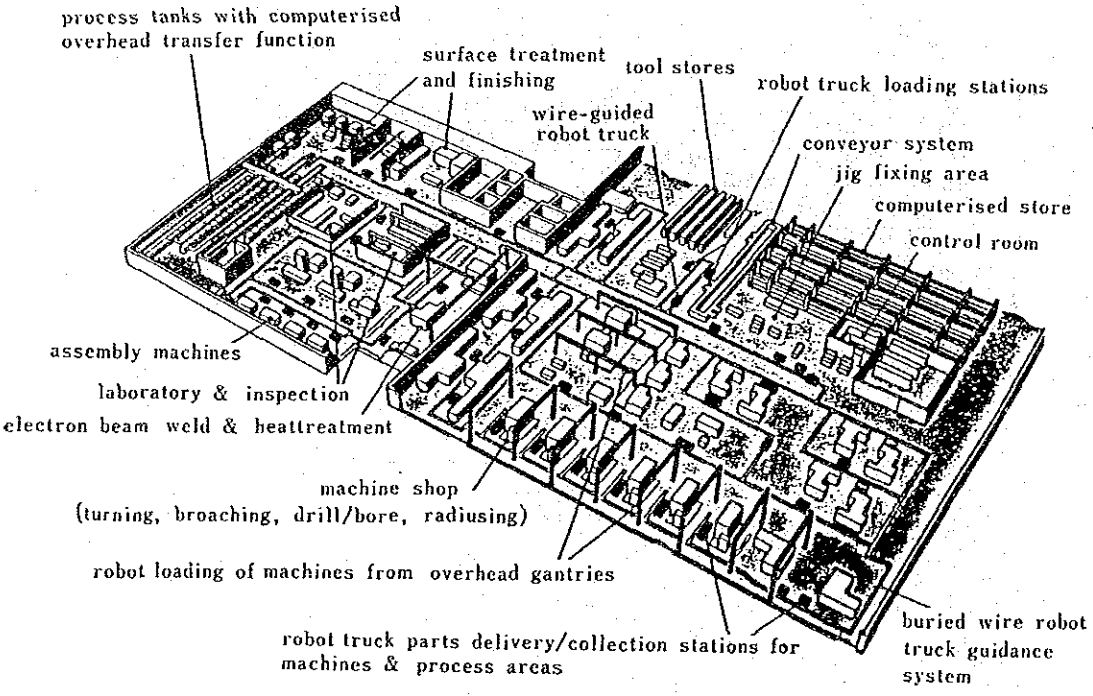
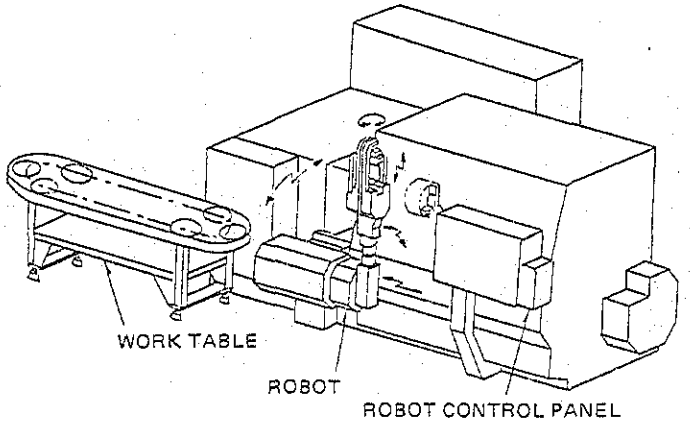
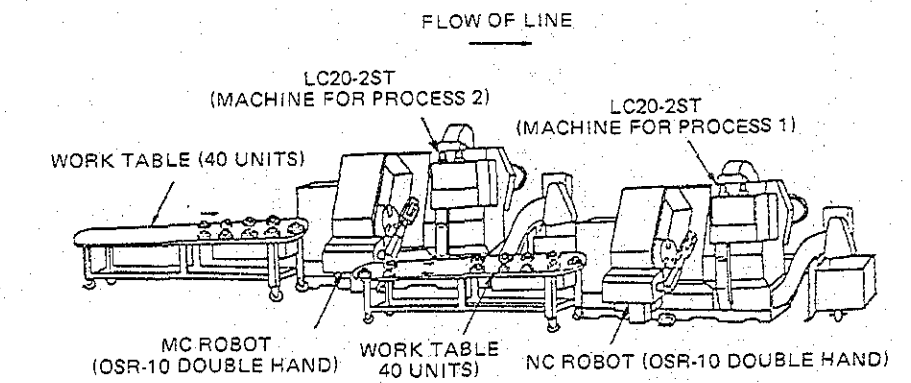


Figure III-4-21 FMC MODEL LC20 Processing Line with FMC Connected





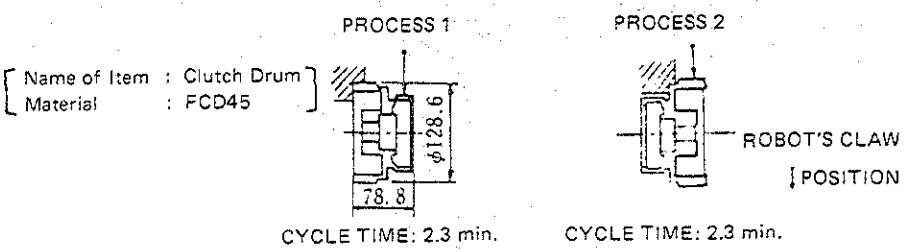
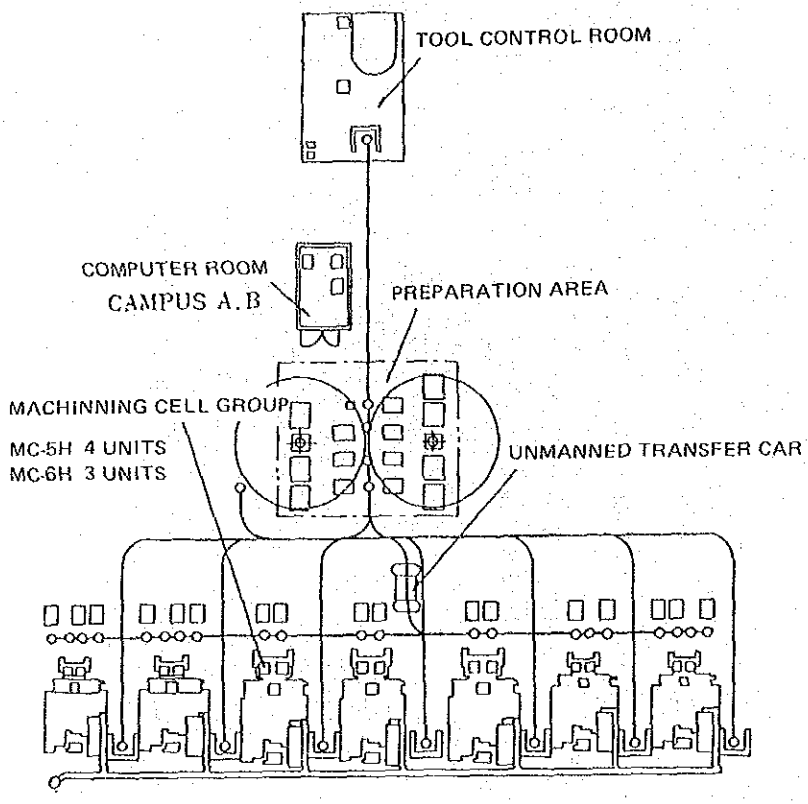


Figure III-4-22 FMS with 7 Horizontal MC's (97 types of Targets)



5. PACKAGING INDUSTRY IN JAPAN

5-1 Modernization in Packaging Industry

Modernization in packaging in Japan took place after World War II. The packaging industry in Japan established in the last half of the 1960s and grew rapidly. The scale of the industry was expanded to the second largest in the world in 1970, and the level of the packaging technology almost reached the top level of the world in 1975.

Revolution in distribution and subsequently in consumption after the rise of supermarkets in the last half of the 1950s resulted in the necessity of prepackaging, which then triggered the packaging revolution supported by the rise of new plastic films developed in succession. Packaging revolution occurred in the following areas:

(a) Public consciousness - It was recognized that the package is "part of and also the face of goods," has the role of a silent salesman, and possesses the positive functions as a modern weapon in distribution. And the economic and industrial functions of the packages were agressively studied and developed.

(b) Materials - Instead of natural materials such as bamboo, wood and straw conventionally used, modern artificial packaging materials such as paper, plastics and metal foils were developed and quickly spread. Because these new materials can be mass-produced and quality-controlled and can be easily processed and printed. They are homogeneous, suited to processing by machines, clean and healthy, lightweight, sufficiently protective and economical, but not bulky.

(c) Techniques and working methods - Instead of conventional packaging methods based on intuition, rational packaging methods and packaging design were developed based on scientific and engineering researches and tests. In addition, the mechanization and automation of packaging work were promoted.

(d) Consciousness of top management - The importance of packaging was recognized. Departments in charge of packaging were organized in enterprises, packaging personnel was brought up, and the top management began to have interests in packaging policies.

5-2 History of Packaging Modernization

(1) Technology and Materials

Before World War II, packaging materials and methods were developed in the following fields.

- Steel Strapping
- Oil Can, Sanitary Can, Steel Drum
- Metal Container

- Glass Bottle, Carboy
- Corrugated Paperboard (1909)
- All-automated Can Manufacture (1913)
- All-automated Glass Bottle Molding (1916)
- Gummed Tape (1927)
- Cellophane (1928)

As described above, modernization in the industry started after the War. The process of packaging modernization is as follows.

1949 Start for establishing Japan Industrial Standards (JIS)
Improvement of Export Packaging
1950 Introduction of USA Military Standards (MIL-P SPEC)
1951 Establishment of "Packaging Definition" by JIS
1952 From Wooden Box to Corrugated Paperboard
1956 1st Study Team to USA for Researching Distribution by JPC
1957 Change of Consumer Packaging by Super-Market
- Pre-Package -
- Revolution of Distribution -
1958 Revolution of Consumer Living
1959 Rapid Economic Growth
1960 Revolution of Packaging
- Automatization of Packaging -
1961 Developed TFS (Tin Fres Steel)
Started Mass Production of Plastic Blow Molding Bottle
1963 Inauguration of JPI
1965 Paper Containers on the Market
1966 Held the 1st Tokyo Pack ('66 Tokyo Pack)
1967 Inauguration of Asian Packaging Federation (APF)
1968 Inauguration of World Packaging Organization (WPO)
Developed Flexible Freight Container
Made Retort Pouch Foods Practical
1969 Improvement of Packaging and Distribution Management by Computer
1972 Start for Establishing "Right Packaging Specifications"
1977 PET (Polyester = Polyethylene Terephtalate) Bottle on the Market
1980 Made Super Light Weight Corrugated Paperboard
Made New Material L-LDPE (Linear Low Density Polyethylene) Practical
1981 Packaging-Waste Rules into Consideration all over the Place
Improvement of Package Design by Computer
1982 Induction of POS (Point of Sales) System on a Full Scale
Soft Drink Container Rules and Improvement of Resin for the Container
Progress of Package Design by Computer Graphics
1983 Renovation of Distribution Technique Stated Robot Store
1984 Started Tamper Resistant Packaging
1985 Developed Diversification and Individualization of Package

Technology of production and utilization of plastics materials were introduced from USA and European countries from 1950 to 1970. These technology transfer played important role for development of

packaging technology in Japan. Followings are major introduced technology and materials for packaging.

1950 Polyvinylidene Chloride [PVDC]
1951 Nylon
1952 Aerosol Polyethylene [PE]
1955 Extrusion-coating
1957 Polyethylene Terephtalate [PET], Polystyrene [PS]
1960 Ethylene Vinyl Acetate Copolymer [EVA]
1962 Polyvinyl Alcohol [PVA], Polypropylene [PP]
1968 Stretch Packaging
1978 Co-Extrusion

(2) Institutional Development

After the War, in order to promote the modernization of the packaging industry, the following institutes and associations were developed.

1950 Japan Craft Paper Association
1951 Japan Transparent Paper Industry Association
1952 Nippon Glass Bottle Manufacturers' Association
1954 Japan Polyethylene Products Industry Association
1954 Japan Wire-Bands Manufacturers' Association
1956 Aerosol Industry Association of Japan
1958 Can Manufacturers' Institute of Japan
1963 National Corrugated Case Association of Japan
1965 All Japan Wooden Box Industry Association
1967 Japan Packaging Machinery Manufacturers' Association
1967 Japan Flexible Containers Association
1969 Japan Styrene Industry Association
1970 Japan P.P. Bands Manufacturers' Association
1971 Japan Polyolefin Film Industry Association
1972 Japan Paper Association
1973 All Japan Packaging Materials Distributors' Association
1973 Japan Polypropylene Film Industry Association
1980 Japan Banding Machine Manufacturers' Association
1981 Japan Corrugated Case Association

5-3 Classification and Roles of Packaging

(1) Classification of packaging

Japan Industrial Standard (JIS) defines the packaging such that packaging is the technique or condition where the products are packaged by several materials to protect their value, JIS classifies the packaging into three areas as follows:

(a) Item packaging - Item packaging means the packaging of product, each by each, to protect them from damages and to increase the value.

(b) Interior packaging - Interior packaging means the packaging technique or the condition of packaging regarding the interior of each packaged products to protect from several hazards such as water and shocks.

(c) Exterior packaging - Exterior packaging means the packaging technique or the condition of packaging regarding the exterior of packaging such as cartoon and bags.

There is a way of classification where packaging would be classified to packaging for domestic use and that for export. Export packaging differs from domestic packaging in a sense that it requires sufficient packaging for protection and should pay careful consideration for the difference of culture of each country.

Transportation period of export is usually longer than that of domestic sales. Also it will be either on sea or by air and hence number of times of loading and unloading increases tremendously in comparison to domestic transportation. Well designed and sufficient packaging are necessary for this reason.

From the viewpoint of consumer packaging, careful attention must be paid to the difference of culture and way of life to appeal to the consumers of each different country. Importance of marketing research would be emphasized in the consumer packaging of export.

(2) Roles of packaging in modern economic activities

Sometimes, it is more convenient to classify the packaging by functions. Various kinds of purposes, functions and roles are given to the modern packaging. They can be summarized to three points described below.

(a) Protection of contents

The modern packages must protect the goods as contents. Packaging is performed to prevent the quality of contents from being degraded by various obstacles and dangers which may occur during transport, storing, cargo handling and distribution from the manufacturers to final consumers.

(b) Convenience in handling

The modern packaging must be able to make the handling of goods more convenient. Modern packaging is performed for the convenience of handling goods in every occasion during transport, storing, cargo handling, sales and delivery to consumers.

(c) Promotion of sales

The modern packaging must be able to make the selling of goods as the contents more easier. Because of labor shortage and the spread of self-service method in sales, pre-packaging has spread and the packages are now required to accurately inform the buyers of the

contents of packages.

5-4 Problems Related to Packaging

As the packaging becomes more closely related to the daily life of human beings, some problems related to packaging has been raised recently.

First problem is the overpackaging and excessive packaging. As a result of the overemphasis of sales functions of packages, overpacking and excessive packaging have arisen. Since consumers are becoming sensitive to this problem, the Ministry of International Trade and Industry is making efforts for correcting the problem by preparing the standards for packaging.

Secondly, the packaging must establish the reliability of packages by means of fair indications on packages, thereby eliminating the unfair, misleading packaging.

Thirdly, the problem of disposal of waste packaging materials must be solved. The waste packaging materials as rubbish create the urban cleaning problems, and the disposability of packaging materials is required to be solved.

Fourthly, there is also the problem of the conservation of resources and energy. Most packaging materials are the imported resources such as paper, car board, plastics and metal cans, and the recovery, reuse and recycling of these materials are strongly demanded. In addition, it is required to examine the amount of energy and costs required from the production to disposal of the packaging materials, and the energy conservation must be promoted with respect to the packaging materials.

Fifthly, there is the problem of packaging safety. Especially, the safety of packaging materials and containers for consumers must be secured from both the viewpoints of health and prevention of injuries.

These packages must be able to fully respond to the social problems stated above. However, in order to create good packages, efforts made only by the industries and especially by the packaging industry alone are insufficient, and it will be required to combine together all the efforts made by enterprises, consumers and the administrative organs.

5-5 Packaging Industry in Japan

The shipping value of Japanese packaging materials and containers in 1984 was 5,294.9 billion yen and packaging machinery shipping value was 329.0 billion yen (approximately 22.3 billion and 1.4 billion dollars respectively).

The scale of packaging industry increased every year, and this industry becomes important in Japanese society. The ratio of the total

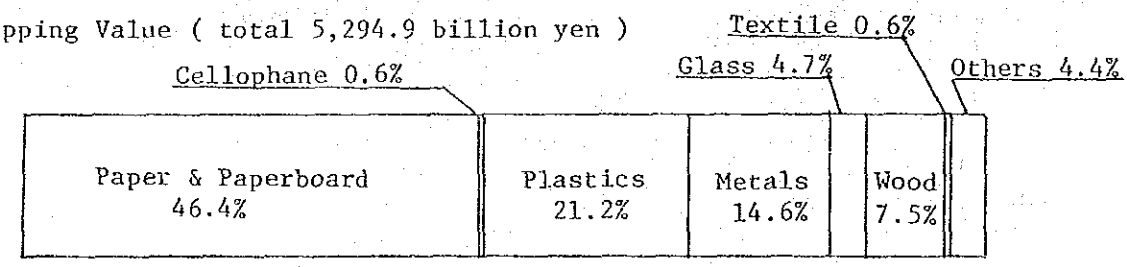
shipping value (materials and machinery) to GNP was estimated 1.9% in 1984. The scale of this industry is the second largest in the world next to the USA.

The structure of materials for packaging and containers is shown in Figure III-5-1 (Breakdown of each materials is shown appendix table of this section). Paper and paperboard is the most important materials for packaging and containers not only on shipping value but on shipping volume. Plastics are the second on shipping value meanwhile glass products rank the second on shipping volume. The structure of materials is changing (see Table III-5-1). The share of plastics is increasing and that of metal products is decreasing.

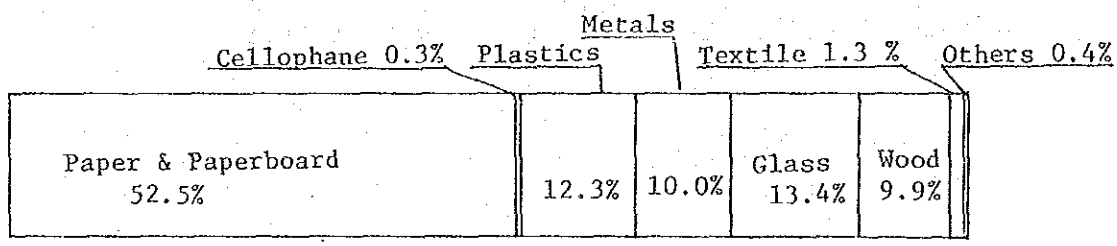
The production of packaging machinery is shown in Table III-5-2. The production grew more than 14 times from 1965 to 1984.

Figure III-5-1 Structure of Materials for Packaging & Containers (shipping base)

(1) Shipping Value (total 5,294.9 billion yen)



(2) Shipping Volume (total 17.9 million tons)



Source: Japan Packaging Institute

Table III-5-1 Structure of Shipments by Packaging Material

Materials	1965	1970	1975	1980	1984	1965	1970	1975	1980	1984
< shipping value : ¥ billion , % >										
Paper & Paperboard	376.1	761.8	1.252.2	2.171.6	2.457.5	49.9	47.1	46.4	48.2	46.4
Cellophane	18.7	26.3	38.9	40.1	33.5	2.5	1.6	1.4	0.9	0.6
Plastics	68.3	284.4	443.0	751.8	1.120.2	9.1	17.6	16.4	16.7	21.2
Metals	130.3	221.3	340.5	695.2	773.4	17.3	13.7	12.6	15.4	14.6
Glass	39.2	81.6	122.5	201.9	245.9	5.2	5.0	4.5	4.5	4.6
Wood	76.0	164.7	351.0	412.9	399.1	10.1	10.2	13.0	9.2	7.5
Textiles	15.0	15.8	29.5	33.8	31.2	2.0	1.0	1.1	0.8	0.6
Others	30.1	60.8	120.6	196.0	234.1	4.0	3.8	4.5	4.4	4.4
Total	753.7	1.616.7 (2.15)	2.698.2 (1.67)	4.503.3 (1.67)	5.294.9 (1.18)	100.0	100.0	100.0	100.0	100.0
< shipping volume : thousand tons , % >										
Paper & Paperboard	n.a.	5.697.6	6.422.5	8.398.1	9.399.5	n.a.	49.3	49.3	52.8	52.5
Cellophane	n.a.	89.7	61.4	65.6	56.4	n.a.	0.8	0.5	0.4	0.3
Plastics	n.a.	950.9	1.168.5	1.586.0	2.184.7	n.a.	8.2	9.0	10.0	12.2
Metals	n.a.	1.047.6	1.109.7	1.585.1	1.791.6	n.a.	9.1	8.5	10.0	10.0
Glass	n.a.	1.597.6	1.706.2	2.083.8	2.394.6	n.a.	13.8	13.1	13.1	13.4
Wood	n.a.	1.786.5	2.144.5	1.820.0	1.767.5	n.a.	15.5	16.5	11.4	9.9
Textiles	n.a.	150.2	266.7	261.0	230.3	n.a.	1.3	2.0	1.6	1.3
Others	n.a.	238.9	141.7	108.4	70.0	n.a.	2.1	1.1	0.7	0.4
Total	n.a.	11.559.0	13.021.3 (1.13)	15.908.0 (1.22)	17.894.6 (1.12)	n.a.	100.0	100.0	100.0	100.0

Source : Japan Packaging Institute
Note : ( ) indicates increase rate of the five year period.

Table III-5-2 Synthesized Table of Packaging Machineries by Production (quantity) & Value Combined Statistics

Name of machine	1965		1970		1975		1980		1984	
	Sets	¥billion	Sets	¥billion	Sets	¥billion	Sets	¥billion	Sets	¥billion
Packaging & packing machineries	-	17.4	-	55.4 (316)	421,526	107.1 (193)	481,103 (114)	190.2 (178)	538,292 (112)	290.9 (153)
Consumer packaging machines	-	15.8	-	43.5 (275)	262,859	83.9 (193)	302,752 (115)	147.2 (175)	380,693 (126)	227.8 (155)
Outer packaging & packing machine	-	1.6	-	11.9 (726)	158,667	23.2 (195)	178,351 (112)	43.1 (185)	157,599 (88)	63.0 (146)
Bag forming machine	-	-	-	-	488	2.4	942 (193)	5.6 (236)	822 (87)	8.1 (145)
Paper packaging machine	-	5.6	-	11.4 (203)	1,022	10.5 (92)	1,019 (100)	13.1 (125)	1,091 (107)	30.0 (229)
Total	-	23.1	-	66.8 (290)	423,036	119.9 (180)	483,064 (114)	208.9 (174)	540,205 (112)	329.0 (157)

Source: Japan Packaging Institute
Note: ( ) indicates increase rate of the five year period.

5-6 The Rule of Packaging on Distribution System

Regarding the distribution of goods, dimension, weight, specification and security & sanitation have to be considered as a rule to packaging.

(1) The rule on dimension

(a) Road vehicles and freight containers

- The size of road vehicles (Except trailers)
  Length : under 12 m long
  Width : under 2.5 m wide
  Height : under 3.8 m high

- Freight containers (Except ISO Series 1 Containers) - JIS -
  Height : 2438 mm or 2350 mm high
  Width : 2438 mm wide
  Length : 3658 mm or 6058 mm long

(b) Package

- Unit load sizes - JIS -
  Following the ISO 3676 (Packaging - Unit load sizes - Dimension), the plan dimension is based on 1200 mm x 1000 mm and 1140 mm x 1140 mm (max.).

- Transport package size by modular coordination - JIS -
  Above 2 unit load sizes (1100 mm x 1100 mm and 1200 mm x 1000 mm) are the basic numerical value and the external dimension is standardized by integral number division or their combination.

- Handling
  In the rule of transport packages authorized by Japan National Railway, to drop from more than 60 cm high is prohibited.

(2) The rule on weight

(a) Road vehicles and freight containers

- Gross weight of road vehicle (except trailers)
  Gross weight : under 20 tons
  Chaft weight : under 10 tons
  Wheel weight : under 5 tons

- Freight containers (Except ISO Series 1 Containers) - JIS -
  Pay load : under 5 tons or 10 tons

(b) Package - JIS -

- Wooden boxes for export packing
  Net wieght : under 1500 kg

- Wooden framed boxes for export packing
  Net weight : under 60000 kg

- Wooden skid-assemblies for export packing
  Net weight : under 60000 kg

- Corrugated shipping containers
  In case of using single wall corrugated fibreboard
  Gross weight : 40 kg (max.)
  In case of using double wall corrugated fibreboard
  Gross weight : 50 kg (max.)

(c) Handling
Generally, it is said in Japan that in case of manual handling, adequate weight of transport packages for a person is 60% of his weight.

(3) The rule on specification

In Japan, there are about 200 standards concerning packaging in JIS (Japanese Industrial Standards) authorized by MITI (Ministry of International Trade and Industry). More than half of them put the points on the standardization of packaging specification.

(4) The rule on security & sanitation

In particular, regarding the customer goods, not only standards of containers, restriction of use of them and their testing but also standards of materials and restriction of re-use of them are established as a regulation for the purpose of maintaining the security & sanitation of contents. In addition, the duty of indicating the contents on packaging is included in this regulations.

The main regulations are as follows.

(a) Food hygiene law by Ministry of Health and Welfare
(b) Pharmaceutical affairs law by Ministry of Health and Welfare
(c) Weighter law by Ministry of International Trade and Industry
(d) Regulation on safety for high pressure gas container by Ministry of International Trade and Industry
(e) Japanese agricultural standards by Ministry of Agriculture, Foresty and Fishery
(f) Law on restriction of dangerous goods by Ministry of Home Affairs

Table III-5-A(1) Breakdown Detailed Statistics of Packaging Materials & Containers Shipping Value

Packaging Materials & Containers	1980		1984		1984 / 1980
	(¥billion)	(%)	(¥billion)	(%)	
Total	4,503.3	100.0	5,294.9	100.0	1.18
1. Paper & Paperboard	2,171.6	48.2	2,457.5	46.4	1.13
1.1 Wrapping paper	233.6	5.2	305.7	5.8	1.31
Printing paper	6.3	0.1	7.3	0.1	1.15
Wrapping paper (kraft)	62.4	1.4	75.6	1.4	1.21
Wrapping paper (roll)	45.7	1.0	57.6	1.1	1.26
Thin leaf paper	14.4	0.3	15.2	0.3	1.06
Wrapping processed paper	96.0	2.1	140.6	2.7	1.47
Others (cardboard)	8.8	0.2	9.3	0.2	1.06
1.2 Heavy duties kraft paper bag	127.3	2.8	125.7	2.4	0.99
1.3 Corrugated fiberboard box	1,228.6	27.3	1,343.3	25.4	1.09
Outer box	1,108.9	24.6	1,222.4	23.1	1.10
Inner box	119.7	2.7	120.9	2.3	1.01
1.4 Paper container	509.1	11.3	601.8	11.4	1.18
Folding box	204.5	4.5	251.6	4.8	1.23
Machinery box	101.9	2.3	123.6	2.3	1.21
Laminated box	87.9	2.0	88.5	1.7	1.01
Other containers	114.8	2.5	138.1	2.6	1.20
1.5 Paper tube	63.9	1.4	72.1	1.4	1.13
1.6 Solid, vulcanized fiber products	9.2	0.2	8.8	0.2	0.96
2. Cellophane	40.1	0.9	33.5	0.6	0.84
2.1 Ordinary cellophane	18.7	0.4	16.9	0.3	0.90
2.2 Moisture-proof cellophane	21.5	0.5	16.6	0.3	0.78
3. Plastics Materials Containers	751.8	16.7	1,120.2	21.2	1.49
3.1 Film & sheet	375.2	8.3	475.5	9.0	1.27
Polyethylene	206.6	4.6	215.6	4.1	1.04
Polypropyrene	72.0	1.6	119.5	2.3	1.66
Polyvinyl chloride (soft)	37.5	0.8	42.6	0.8	1.14
Polyvinyl chloride (rigid)	27.0	0.6	38.3	0.7	1.42
Polystyrene	32.0	0.7	44.2	0.8	1.38
Polyester	-	-	15.3	0.3	-
3.2 Blow molding containers	132.5	2.9	183.6	3.5	1.39
Polyvinyl chloride	13.2	0.3	18.8	0.4	1.43
Polyethylene	96.1	2.1	111.2	2.1	1.16
Polypropyrene	14.0	0.3	15.6	0.3	1.11
Polyester	9.2	0.2	38.0	0.7	4.11
3.3 Injection molding containers	77.8	1.7	112.8	2.1	1.45
Polyethylene (high density)	32.9	0.7	55.5	1.0	1.69
Polypropyrene	19.8	0.4	34.8	0.7	1.76
3.4 Polystyrene	19.8	0.4	22.6	0.4	1.14
3.5 Laminated flexible products	50.3	1.1	73.1	1.4	1.45
Polyethylene (low density)	50.3	1.1	63.4	1.2	1.26
Polypropyrene	-	-	9.8	0.2	-
3.6 Oriented flat yarn (tape)	61.6	1.4	89.6	1.7	1.46
Polyethylene (high density)	18.3	0.4	30.1	0.6	1.65
Polypropyrene	43.3	1.0	59.5	1.1	1.37
3.7 Foam products	54.4	1.2	185.5	3.5	3.41
Expanded polystyrene beads	-	-	78.2	1.5	-
P S P	-	-	60.0	1.1	-
Laminated PSP	-	-	27.3	0.5	-
High expanded polyetyrene foam	-	-	20.0	0.4	-

Table III-5-A(1) (cont.)

Packaging Materials & Containers	1980		1984		1984 / 1980
	(¥billion)	(%)	(¥billion)	(%)	
4. Metal Materials & Containners	695.2	15.4	773.4	14.6	1.11
Food can	269.9	6.0	321.7	6.1	1.19
18 litter can	45.2	1.0	56.6	1.1	1.25
Metalic coated containers	157.1	3.5	150.7	2.8	0.96
Metalic squeezable tube	13.2	0.3	12.5	0.2	0.95
Aluminum foil	34.0	0.8	461.4	8.7	13.56
Aluminum containers	77.1	1.7	90.5	1.7	1.17
High-pressure containers	58.9	1.3	49.4	0.9	0.84
Drum can	39.8	0.9	45.9	0.9	1.15
5. Glass Containers	201.9	4.5	245.9	4.6	1.22
Beverage bottle	104.7	2.3	130.4	2.5	1.25
Liquor, sake bottle	67.5	1.5	75.5	1.4	1.12
Soft drink	30.1	0.7	48.5	0.9	1.61
Favorite, health-care	7.1	0.2	6.3	0.1	0.89
Bottle for food, seasoning	39.5	0.9	46.8	0.9	1.18
Bottle for cosmetics	19.1	0.4	18.8	0.4	0.99
Drug and chemical stock bottle	38.6	0.9	50.0	0.9	1.30
6. Wooden Materials & Containers	412.9	9.2	399.1	7.5	0.97
Wooden box	209.9	4.7	179.8	3.4	0.86
Folding box	29.5	0.7	24.4	0.5	0.83
Chips & chip made products	9.0	0.2	6.9	0.1	0.77
Crete & frame	26.8	0.6	21.6	0.4	0.81
Cask & barrel	7.1	0.2	5.4	0.1	0.76
Export containers	129.0	2.9	160.0	3.0	1.24
Excelsion wood	1.7	0.0	1.0	0.0	0.60
7. Textile Containers	33.8	0.8	31.2	0.6	0.92
Jute bag	7.7	0.2	4.6	0.1	0.60
Other textile bag	26.1	0.6	26.6	0.5	1.02
8. Other Materials & Containers	196.0	4.4	234.1	4.4	1.19
8.1 Straw rope	2.6	0.1	1.3	0.0	0.52
8.2 Other straw products	1.8	0.0	0.9	0.0	0.51
8.3 Bamboo, rattan products	7.7	0.2	4.2	0.1	0.55
8.4 Closure	27.8	0.6	30.9	0.6	1.11
8.5 Gummed tape	12.8	0.3	12.4	0.2	0.97
8.6 Pressure sensitive tape	58.3	1.3	75.8	1.4	1.30
8.7 Flexible containers	14.2	0.3	14.7	0.3	1.03
Running use	9.7	0.2	8.0	0.2	0.82
One-way use	4.5	0.1	6.7	0.1	1.48
8.8 Pallet	35.3	0.8	32.5	0.6	0.92
8.9 Others	3.5	0.1	61.3	1.2	17.48

Source: Japan Packaging Institute

Table III-5-A(2) Breakdown Detailed Statistics of Packaging Materials and Containers Shipping Volume

Packaging Materials & Containers	1980		1984		1984 / 1980
	(1,000 t)	(%)	(1,000 t)	(%)	
Total	15,908.0	100.0	17,894.5	100.0	1.12
1. Paper & Paperboard	8,398.1	52.8	9,399.5	52.5	1.12
1.1 Wrapping paper	1,189.6	7.5	1,490.6	8.3	1.25
Printing paper	37.3	0.2	41.7	0.2	1.12
Wrapping paper (kraft)	367.2	2.3	444.4	2.5	1.21
Wrapping paper (roll)	246.9	1.6	281.0	1.6	1.14
Thin leaf paper	37.8	0.2	44.1	0.2	1.17
Wrapping processed paper	412.0	2.6	586.0	3.3	1.42
Others (cardboard)	88.4	0.6	93.4	0.5	1.06
1.2 Heavy duties kraft paper bag	407.6	2.6	355.4	2.0	0.87
1.3 Paperboard for corrugated	5,512.2	34.7	6,141.9	34.3	1.11
Outer box	5,107.6	32.1	5,764.8	32.2	1.13
Inner box	404.6	2.5	377.1	2.1	0.93
1.4 Paper box cardboard	1,093.5	6.9	1,188.5	6.6	1.09
Manila cardboard	266.8	1.7	302.4	1.7	1.13
White cardboard	504.8	3.2	556.3	3.1	1.10
Coated whiteboard	324.5	2.0	360.1	2.0	1.11
Non coated whiteboard	180.3	1.1	196.2	1.1	1.09
Yellow cardboard	16.9	0.1	17.9	0.1	1.06
Chipboard	174.8	1.1	183.3	1.0	1.05
1.5 Collored cardboard	130.2	0.8	128.6	0.7	0.99
1.6 Roll of paper tube	195.2	1.2	223.1	1.2	1.14
2. Cellophane	65.6	0.4	56.4	0.3	0.86
2.1 Ordinary cellophane	32.8	0.2	30.8	0.2	0.94
2.2 Moisture-proof cellophane	32.8	0.2	25.6	0.1	0.78
3. Plastics Materials Containers	1,586.0	10.0	2,184.7	12.2	1.38
3.1 Film & sheet	903.4	5.7	1,152.9	6.4	1.28
Polyethylene (low density)	355.1	2.2	383.9	2.1	1.08
Polyethylene (high density)	136.9	0.9	215.0	1.2	1.57
Polypropyrene	180.1	1.1	225.5	1.3	1.25
Polyvinyl chloride (flexible)	83.7	0.5	94.3	0.5	1.13
Polyvinyl chloride (rigid)	56.2	0.4	84.7	0.5	1.51
Polystyrene	91.4	0.6	133.9	0.7	1.46
Polyester	-	-	15.6	0.1	-
3.2 Blow molding containers	188.1	1.2	238.0	1.3	1.27
Polyvinyl chloride	17.6	0.1	25.1	0.1	1.43
Polyethylene	139.2	0.9	153.4	0.9	1.10
Polypropyrene	20.3	0.1	21.5	0.1	1.06
Polyester	11.0	0.1	38.0	0.2	3.45
3.3 Injection molding containers	183.9	1.2	203.0	1.1	1.10
Polyethylene (high density)	85.0	0.5	91.0	0.5	1.07
Polypropyrene	43.9	0.3	57.0	0.3	1.30
Polystyrene	55.0	0.3	55.0	0.3	1.00
3.4 Laminated and flexible products	93.7	0.6	208.9	1.2	2.23
Polyethylene (low density)	93.7	0.6	181.1	1.0	1.93
Polypropyrene	-	-	27.8	0.2	-
3.5 Oriented flat yarn (tape)	122.1	0.8	159.8	0.9	1.31
Polyethylene (high density)	36.5	0.2	54.3	0.3	1.49
Polypropyrene	85.6	0.5	105.3	0.6	1.23
3.6 Foam products	94.8	0.6	222.3	1.2	2.34
Expanded polystyrene beads	-	-	130.3	0.7	-
P S P	-	-	81.0	0.5	-
High expanded polyetyrene foam	-	-	11.0	0.1	-

Table III-5-A(2) (cont.)

Packaging Materials & Containers	1980		1984		1984 / 1980
	(1,000 t)	(%)	(1,000 t)	(%)	
4. Metal Materials & Containners	1,585.1	10.0	1,791.6	10.0	1.13
Food can	704.7	4.4	839.9	4.7	1.19
18 liter can	228.5	1.4	258.6	1.4	1.13
Aluminum foil	33.2	0.2	37.6	0.2	1.13
Aluminum containers	115.7	0.7	153.1	0.9	1.32
High-pressure containers	216.4	1.4	208.4	1.2	0.96
Drum can	286.6	1.8	294.0	1.6	1.03
5. Glass Containers	2,083.8	13.1	2,394.6	13.4	1.15
Beverage bottle	1,206.6	7.6	1,355.5	7.6	1.12
Liquor, sake bottle	828.3	5.2	829.9	4.6	1.00
Soft drink	307.6	1.9	464.8	2.6	1.51
Favorite, health-care	70.7	0.4	60.8	0.3	0.86
Bottle for food, seasoning	423.3	2.7	481.0	2.7	1.14
Bottle for cosmetics	67.9	0.4	60.4	0.3	0.89
Drug and chemical stock bottle	386.0	2.4	497.7	2.8	1.29
6. Wooden Materials & Containers	364.0	2.3	353.5	2.0	0.97
Wooden box	190.6	1.2	156.0	0.9	0.82
Folding box	3.6	0.0	3.0	0.0	0.83
Chips & chip made products	7.2	0.0	5.9	0.0	0.82
Crete & frame	25.0	0.2	20.5	0.1	0.82
Cask & barrel	2.6	0.0	2.1	0.0	0.81
Export containers	135.0	0.8	166.0	0.9	1.23
7. Textile Containers	261.0	1.6	230.3	1.3	0.88
Jute bag	22.7	0.1	14.3	0.1	0.63
Other textile bag	238.3	1.5	216.0	1.2	0.91
8. Other Materials & Containers	108.4	0.7	70.0	0.4	0.65
8.1 Straw rope	53.4	0.3	40.0	0.2	0.75
8.2 Other straw products	55.0	0.3	30.0	0.2	0.55
8.3 Pressure sensitive tape	452.6	2.8	561.5	3.1	1.24
8.4 Flexible containers	165.9	1.0	239.0	1.3	1.44
Running use	34.5	0.2	30.0	0.2	0.87

Source: Japan Packaging Institute

IV. TRANSPORTATION

IV. TRANSPORTATION

1. PROVISION AND IMPROVEMENT OF TRANSPORT SYSTEMS IN THE COURSE OF JAPAN'S DEVELOPMENT

Introduction

For several years after World War II, utmost efforts were made to reconstruct the completely destroyed traffic facilities and to reopen their operations. This priority was an essential course of action requiring proper measures. Many problems existed; how to obtain the necessary funds, machinery and equipment, and materials in an exhausted economy; by what procedures could reconstruction of tranport facilities be achieved. Adding to these was the problem of rampant inflation.

The existing transport facilities required to be modernized, so the reconstruction was planned to be accompanied by modernization. The greatest efforts in this reconstruction program were exerted in the 10 years following the end of the War.

Around 1955, the Japanese economy was released from the postwar reconstruction period and entered its first high-growth period, with the result that investment in transport and its concurrent modernization was accelerated. In particular, expressways and the Shinkansen railway routes were built, and mammoth tankers and jet aircrafts entered service. This formed the basis for the modern Japanese transport system. Use of the automobile also accelerated remarkably in this period.

During this period, the provision and improvement of the transport system was not always achieved smoothly, and many difficulties had to be confronted. Development of transport networks causes regional differentials, pollution, environmental disruption and depletion of energy resources. The reality is that Japan has managed to attain its present level of transport network by repeatedly employing technical developments and institutional devices to overcome these difficulties.

Although the above-mentioned development of transport has been achieved by the originality and great efforts of the transport business world, the efforts of the Japanese government to intentionally stimulate the acceleration of transport development towards the proper system of transport should not be overlooked. It is claimed that one of the characteristics of deciding the Japanese transport policy was the participation by private experts in the decision-making process. When formulating a transport policy in Japan, government departments, such as the Ministry of Transport, Ministry of Construction, Economic Planning Agency and National Land Agency are involved. In addition, a council is established with representatives from industry, academia, general consumers and other experienced men, in order to reflect a diverse range of opinions in the decision-making process.

This article covers the following items:

(a) The process by which the provision and improvement of transport systems has been accelerated under the three Comprehensive National Development Plans and the two Comprehensive Transport Policy Plans during the course of postwar development in Japan.

(b) Demands to be met and intentions to be expressed for the future provision and improvement of transport systems under the Fourth Comprehensive National Development Plan, which is now being formulated.

(c) The process of the provision and improvement of railway system, the role of which to the whole transport system has significantly changed during the past forty years and which is explained in detail in the Appendix of this chapter.

Argentina is also planning to accelerate the provision and improvement of its transport systems to support economic and industrial reactivation and to stimulate exports. It does not seem to be appropriate to apply the Japanese transport policy or facilities to Argentina without cautious examination of both countries' situations. This is because differences exist between the type of problems being faced in the provision and improvement of transport systems in Argentina at present compared with those problems that Japan confronted during its postwar development. Adding further to the differences is the different rate and type of capital accumulation between the two countries at the initial stages of the task.

However, the Japanese method of solving problems associated with the provision and improvement of transport systems in the past and in the future seems to offer some useful indications for Argentina.

1-1 National Land Plan and Transport System Plan in Policy System

1-1-1 Role and System of the National Land Plan

Around 1950, the policy system for national land development was established in Japan. In this year, the Comprehensive National Development Act was enacted, which was to be, in a broad sense, the basis of the National Land Policy, including the National Land Plan. This system has remained virtually unchanged as the basic system, with the exception of the significant revision made to incorporate an environmental policy as a new item in the 1970s, a time in which the environmental problem became a subject of social discussion.

The basic system of the Japanese national land administration is structurally based on an economic plan and a national land plan. The economic plan is formulated as a medium-term plan, with a span of about five years, in order to illustrate the goals of the economy. The government releases projections for the gross national product and commodity prices, while informing the people of the basic goals of governmental policy, such as goals for government financing and major public investments.

The national land plan incorporates development of the economy and national life by clarifying the scope of responsibility to be borne by the government. It is a long-term plan, covering the next 10 to 20 years, much longer than that of the economic plan. In the fundamental relation between the economic plan and the national land plan, the latter is the spatial development of the former, while the former is a total indication of all components of the latter from the standpoint of the national economy. In practice, it has been a habit in Japan since the War to renew the economic plan whenever the national land plan is revised, and vice versa.

The national land plan consists of the Comprehensive National Development Plan, Regional Land Development Plans (10 regions), Land Development Plans for Designated Regions and Prefectural Land Development Plans (47 prefectures), and scale and location of major facilities to be constructed under public investment are determined in the national land plan. However, the overall investment level is determined after consultation with the economic plan. This also occurs to plans formulated by each government department responsible to supervise each public work and implement the relevant policy, and the government has given the authority to make any necessary adjustments to the Director-General of the National Land Agency, who has responsibility over the national land plan, and to the Director-General of the Economic Planning Agency, who has responsibility over the economic plan.

In these plans the transport policy has the basic aims of securing a smooth transport service through sound, open competition, and of contributing to the improvement of national economic activities and living standards. In a practical sense, the policy aims at full transport infrastructure development and removal of factors which might limit sound open competition. The national land plan has a close and indivisible relation with the above stated aims of the transport policy. Transport infrastructure development by central and local public bodies is based on the national land plan. In addition, the government plays a major role in the transport infrastructure development, which is financed mostly by government investment. The concept of employing the private sector's energy has recently appeared, and the materialization of this may be a problem in the future.

1-1-2 Development Policy on Comprehensive Transport System

The above-mentioned transport infrastructure development in the national land plan is a very important element in the transport policy, because construction of transport networks defines use of the national land space. Success of national land and/or local development depends on whether or not effective transport networks are constructed. However, the national land plan is closely related to the transport policy during the transport infrastructure development phase. The other phase, the smooth supply of transport services, is entrusted to the transport enterprises which consist of government agencies and private companies. The role of the national land plan in this phase is, (by stating the goals of the transport infrastructure development), to clarify the responsibilities of each main promoter of the development

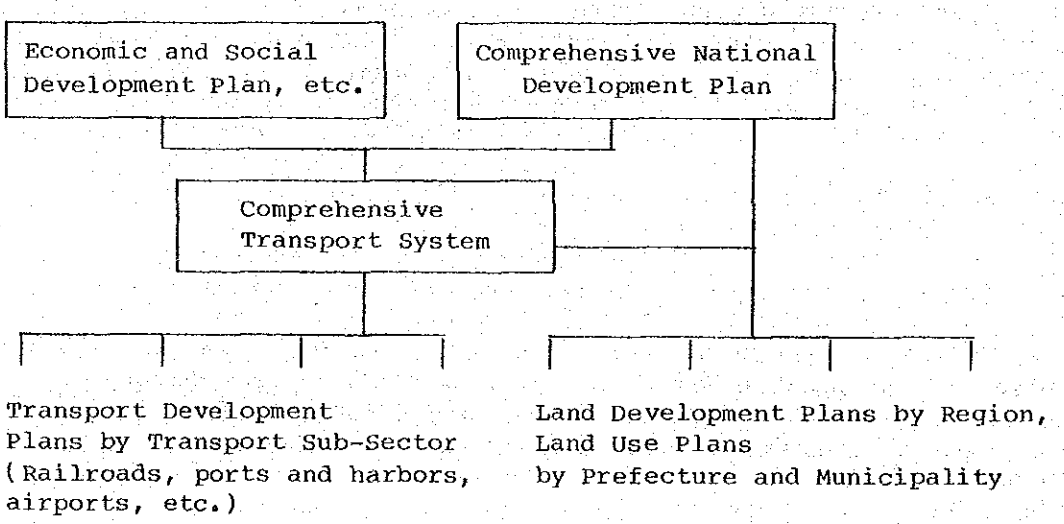
and to specify the guidelines for the transport services to be supplied by these transport enterprises.

Accordingly, the Ministry of Transport, which has responsibility over transportation, takes charge of outlining the overall transport policy, including the transport infrastructure development and supply of transport services. Furthermore, the Minister of Transport consults with the Transportation Policy Council on how the transport policy should assist economic development and improve living standards. The Council carefully discusses the matter from the comprehensive and long-term viewpoint before formulating a report. Up to now, two reports on the comprehensive transport system have been submitted in 1971 and 1981 to the Minister of Transport.

In these reports, the Council estimated future transport demands based on a trend analysis of the changing economic society in accordance with the items planned in the economic plan and the national land plan, and also clarified the long-term tasks in the transport policy. At the same time, the Council presented details of the provision and improvement plan for transport facilities as well as an outline for a concrete transport policy including administrative measures for forming the comprehensive transport system

Figure IV-1-1 illustrates the relationship between the economic plan, national land plan, comprehensive transport system, and the concrete provisions and improvement plans in each sector.

Figure IV-1-1 Administration System for the Transport System Development



1-2 Provision and Improvement of Transport System before Formulating the Comprehensive National Development Plan

In the latter half of 1940s, Japan first started to reconstruct and reopen the transport facilities which had been completely destroyed during the War. It was an extremely difficult task to manage to raise the necessary funds for this reconstruction in the midst of postwar inflation with rampant black marketeering, and furthermore, to secure the various machinery, equipment and materials required which were also being demanded by other sectors for uses other than in transport facilities. During the 1950s, the Japanese economy began to recover steadily, with the Korean War as a turning point. At first, industrial reconstruction was accelerated to supply basic construction materials to certain sectors and to supply the basic necessities of life, and by 1955, the Japanese economy had recovered to the pre-war level. During this period, the Comprehensive National Development Act was enacted in 1950 and the basis of the national land planning system was established. This enactment is said to highlight the requirement for a new policy to be developed for a recovering economy.

After the War, transport services were chiefly supported by the Japanese National Railways. This was due to the fact that coastal shipping transportation was completely destroyed during the War, and emphasis was placed on railroads, for the time being, to secure and expand transport capacity. On the other hand, economic recovery created severe bottlenecks in transportation, and this led to extremely crowded rush hours, especially in the big cities.

By the time the Japanese economy had accomplished its reconstruction in 1955, and began to grow thereafter, most Japanese had reached a consensus that Japan, with its limited natural resources, should place its emphasis on the exporting of manufactured products from imported raw materials. The "Doubling National Income Plan" was decided by a Cabinet Council in 1960, with the aim of doubling national income within ten years in accordance with the above-mentioned national consensus. This Cabinet decision guided the Japanese economy towards the growth period. The aim of this plan was to double the national income while increasing industrial production by 3.3 times. In order to support the additional industrial production, reclamation and construction of new seaside industrial zones became an important task. Under this plan, 7,150 billion yen was allocated to the three sectors; road, railway, and port and harbor. This accounted for 46% of the total planned public investment of 15,500 billion yen during the 10 years. This was due to the recognition of the fact that the poor development of transport infrastructure, such as road, railway, and port and harbor, was hampering high economic growth.

In addition, the completely destroyed marine and coastal shipping transportation exerted extremely serious effects on the national life in Japan, an island country, with the result that great emphasis was placed on the reconstruction of marine and coastal shipping transportation through the support for financing of shipbuilding and the provision of grant for paying a fixed rate of interest. After the completion of the peace treaties with the Allies in 1952, Japan began to intentionally

accelerate shipbuilding, with the aim of reconstructing the merchant fleet on a full scale. This policy also greatly supported general economic reconstruction.

1-3 The First Comprehensive National Development Plan (1CNDP) and Removal of Bottlenecks

While the Doubling National Income Plan was formulated as a national policy, and processing trade was recognized as the basic national policy, the first Comprehensive National Development Plan (Ichizenso, 1CNDP) was adopted by the Cabinet in 1962, under the authority of the Comprehensive National Development Act (see Table IV-1-1).

The plan's concept was to develop a basis for the processing trade. The provision and improvement of industrial bases was accomplished by designating "New Industrial Cities and Specified Industrial Improvement Districts" (Figure IV-1-2).

In the 1CNDP, the provision and improvement of transport facilities formed an integral part of the industrial infrastructure development. The government, therefore, adopted the policy to preferentially convert the existing trunk routes into major arteries to develop large-scale local bases, and to gain easier access to the existing major physical distribution centers of Keihin (in and around Tokyo and Yokohama), Hanshin (in and around Osaka and Kobe) and Chukyo (in and around Nagoya) districts. For this purpose, the provision and improvement of tranport systems aimed at the following:

(a) Removing bottlenecks as the basic intention of the transport policy

(b) Placing emphasis on the completion of transport networks, especially primary national highways, conventional trunk railroad lines, and ports and harbors, which connect industrial bases with each other

(c) Accelerating construction of the "Tokaido Shinkansen" (between Tokyo and Osaka) and "Meishin Expressway" (between Nagoya and Kobe) to contribute to a modernized transport system

Among the above items, constructions of the Tokaido Shinkansen and Meishin Expressway were forerunning projects to subsequent large-scale development projects. At that time, however, the two projects were generally regarded as means of removing the transport bottlenecks of insufficient capacities in the conventional Tokaido-Line and the National Highway Route 1 (between Tokyo and Osaka). The two projects have been recognized for their significance in influencing national land development after they became operational in 1964.

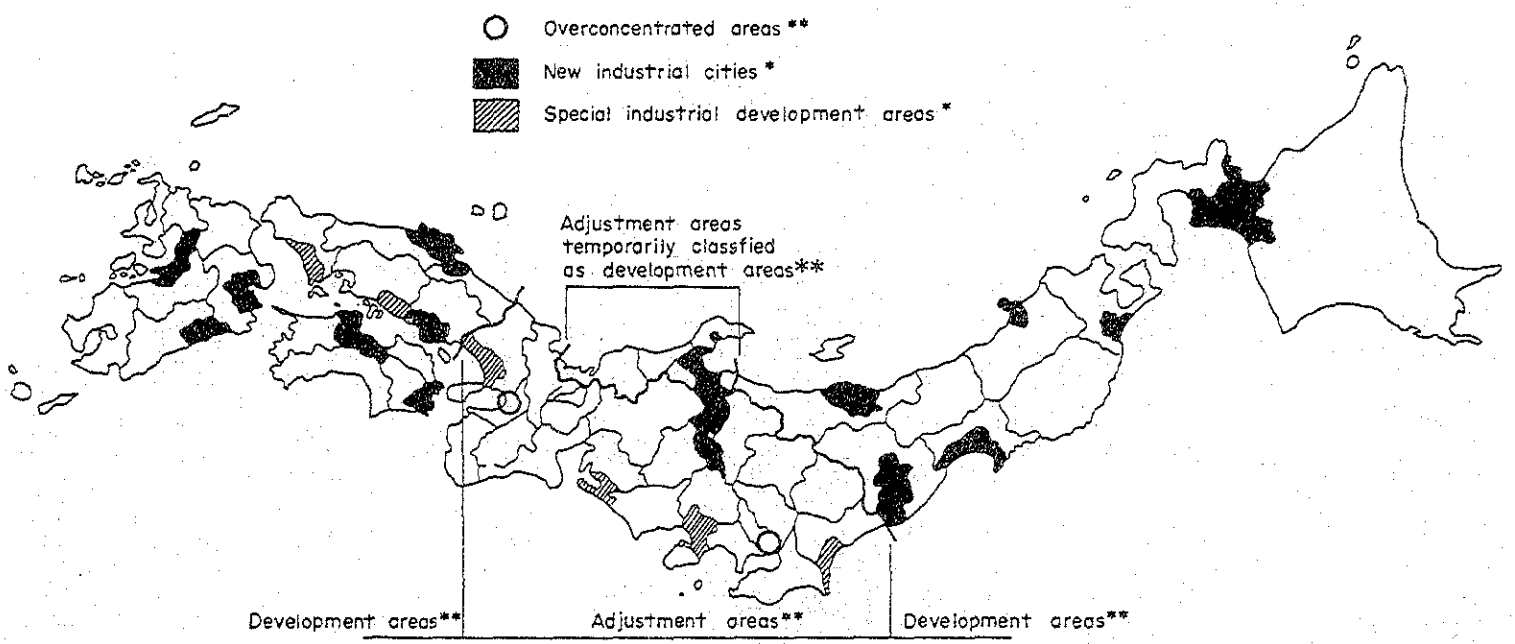
The provision and improvement of facilities was carried out for each transport sub-sector as follows:

Table IV-1-1 Japanese National Land Plan and Transport System Development

	The First Comprehensive National Development Plan	The Second Comprehensive National Development Plan	The Third Comprehensive National Development Plan
1. Time of preparation	Cabinet decision: October 1962	Cabinet decision: May 1969	Cabinet decision: November 1977
2. Planned term	1960 to 1970	1965 to 1985	Approximately 10 years; The starting year was set at 1975 and goal year, 1985 with prospects towards the year 2000.
Goal year	1970	1985	
3. Development Issues	(1) Shift from low growth to high growth economy (2) Spotlighted regional problems: a) Problem of megalopolises b) Wider regional income differentials (3) Preparation of the Doubling National Income Plan--Pan Pacific Concept	(1) High growth economy (2) Concentration of population and industries in big cities (3) Regional income differential (4) Acceleration of effective resource use	(1) Stable growth economy (2) Signs of population settling in local areas and of industries to be dispersed into local areas (3) Comprehensive regional differential (4) Spotlighted limitation of resources (5) Change in national consensus
4. Basic goal	Regional balanced development (1) Prevention of megalopolis and reduction of regional differentials (2) Effective use of natural resources (3) Proper regional distribution of resources such as capital, labor, and technology	Creation of comfortable environment (1) Harmony between men and nature over a long period of time, and permanent protection and preservation of nature (2) Develop basic infrastructure equitable to raise development potentials all over the national territory (3) Securing new, efficient national land use through the development and improvement of local characteristics (4) Provision, improvement and maintenance of a safe, comfortable and cultural environment	Provision and improvement of overall environment for human settling (1) The premise that domestic resources are limited (2) To respect local characristics, historical and traditional culture (3) To aim at harmony between man and nature
5. Developing method and major planning task	Concept of base development To locate development bases in relation with existing large integrated areas such as Tokyo because it is necessary to disperse industries in order to achieve the goal. To link these development bases by using transport and communication facilities and to have these bases influence each other, and at the same time, to realize balanced regional development by proceeding with development in a chain reacton manner while efficiently integrating the characteristics of neighboring districts.	Concept of large-scale projects To correct unbalanced national land use by providing transport networks such as Shinkansen 'bullet' train lines and expressways, accelerating large-scale projects, and to dissolve overpopulation, underpopulation and regional differentials.	Concept of Permanent Settling To secure balanced national land use by tackling the overpopulation/underpopulation problem through limiting the concentration of pouplation and industries in large cities, by encouraging development of local economies, and to form an overall environment conducive for human residence.

Source: National Land Agency, National Land Statistic Survey, 1985.

Figure IV-1-2 New Industrial Cities and Special Industrial Development Areas (1963)



*Designated by specific laws in 1963.
**Classification according to the 1962 comprehensive national land development plan.

Source: M. Honjo, "Trends in Development Planning in Japan", in Fu-chen Lo and Kamel Salih ed., Growth Pole Strategy and Regional Development Policy, Pergamon Press, 1978

(a) For roads, emphasis was placed on the construction of expressways between the major cities and completion of the previous road network system.

(b) For railroads, emphasis was directed at the doubling and electrification of trunk lines, and completion of the Shinkansen route between Tokyo and Osaka.

(c) For ports and harbors, emphasis was placed on the removal of urgent bottlenecks, and selective investment in new industrial ports in order to develop industrial cities and areas along the coast.

(d) For air transport, emphasis was directed at the provision and improvement of airports.

We cannot help recognizing that these were not always well coordinated and integrated under one comprehensive consideration. An unavoidable reason was that projects were undertaken in order of easiness to start, to remove bottlenecks as quickly as possible. However, changes in transportation that developed after the 1CNDP were not accurately foreseen, and the share of automobiles was consequently underestimated in the projections of transport demand by carriers.

As mentioned above, the transport infrastructure development policy based on 1CNDP was strongly supported and accelerated by the concrete program of provision and improvement in the New Industrial Cities and Specified Industrial Improvement Districts. In particular, the intention of undertaking processing trade resulted in the typical seaside industrial area found in Japan for heavy and chemical industries. It can be said that ports and harbors, which are an integral part of the infrastructure of seaside industries, have contributed greatly to Japanese economic growth.

1-4 The Second Comprehensive National Development Plan (2CNDP) and Concept of Large-Scale Projects

During the 1960s, the basic energy source in Japan had changed remarkably from coal to oil under the influence of the world-wide energy change. Due to this fact, some coal mining districts were ruined and new petrochemical complexes appeared. Meanwhile, the Japanese economy continued to experience higher growth than expected and in such a way that the Doubling National Income Plan was fulfilled in 1966, four years earlier than the initial goal of 1970. This high economic growth caused a concentration of population and industries in the big city spheres and serious problems of overpopulation and underpopulation arose. Massive and dense urbanization continued and led to the formation of megalopolises. Some examples of successful new industrial cities can be found in such cities as Oita and Mizushima. However, it was widely recognized that the concentration of population and industries in the big cities was very difficult to check while there existed a general tendency to accelerate regional development through the base development system of the 1CNDP.

The rapid expansion of economic scale and the unbalanced national land use resulting from such high growth were recognized to be a hindrance to long-term economic growth. At this stage of the economic growth path, another national land plan which would be the new guideline for national land use, was formulated by revising the 1CNDP. This was a necessity because the high economic growth had made it feasible to initiate considerably large-scale projects.

In 1964, the Tokaido Shinkansen (between Tokyo and Shin-Osaka) was opened to traffic. With this new service, the Japanese transport system, including expressways and jet aircraft, heralded the start of the high-speed transport age.

The 2CNDP included large-scale development project systems. As a framework for national land development, a new network was to be created, with data communication, jet aircraft, Shinkansen railroads and expressways. In addition, the SCNDP aimed at forming networks between the big cities, with their centralized control functions, and the northern core cities, and to provide a new transport network comprehensively connecting all cities (see Table IV-1-1 and Figure IV-1-3).

Before the 2CNDP was resolved in the Cabinet meeting, such large-scaled development projects as mentioned above were already being planned and implemented, one after another.

For the expressway network, the Meishin Expressway (between Nagoya and Kobe) was completed in 1965 and the Tomei Expressway (between Tokyo and Nagoya) in 1969. In 1966, it was decided to build 32 new highway routes for a total extension of 7,600 km.

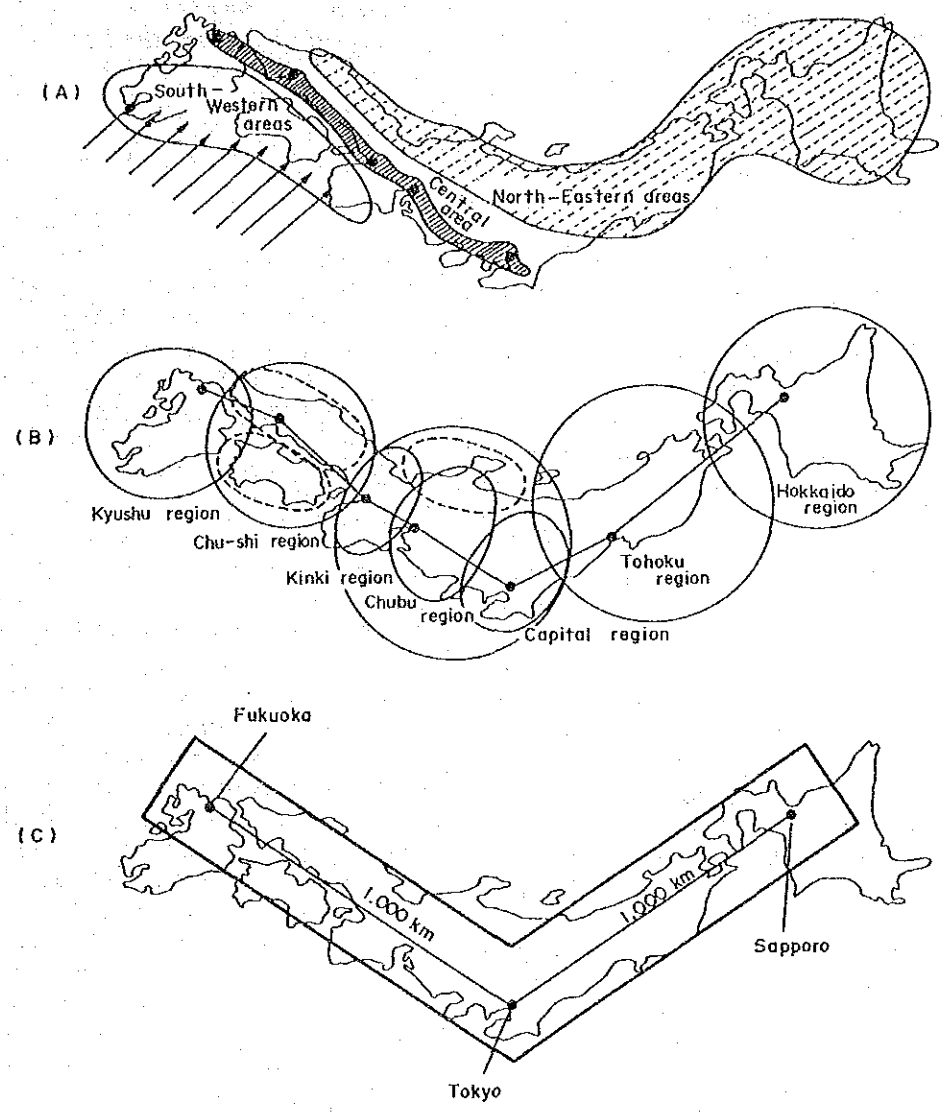
For Shinkansen railroads, the Tokaido Shinkansen (between Tokyo and Shin-Osaka) was completed in 1964, and the Sanyo Shinkansen (between Shin-Osaka and Okayama), in 1972. In 1970, the national Shinkansen Bullet Train Lines Development Act was enacted and a basic plan was formulated for the construction of around 7,000 km of new lines.

As for other large-scale projects, the construction of bridges between Honshu (Japanese mainisland) and Shikoku, the Seikan Tunnel (connecting Honshu with Hokkaido) and the New Tokyo International Airport in Narita were all decided to be started, or were already executed between 1966 and 1971. Each survey had been initiated on the premise that construction should go ahead.

For the transport infrastructure development in the 2CNDP, many projects had already been completed by 1985, which was the goal year of the plan, with the result that the development is said to have achieved a considerably high progress rate. After considering the two oil crises and the demand management measures adopted due to fiscal financial difficulties, the transport infrastructure development has obtained good results from the viewpoint of intentional execution of projects in the plan.

During the two years following the release of the 2CNDP, pollution and environmental problems became very serious in Japan. The govern-

Figure IV-1-3 Idea of the "New Comprehensive National Development Plan"



Source: M. Honjo, op. cit.

(A) Present land use in Japan is polarized in the central area along the Pacific Coastal Belt. The north-eastern areas with heavy snowfall, and the south-western areas with frequent attack of typhoon are left underdeveloped, notwithstanding their wide land resources. These areas have been very much handicapped by their natural environment, but progress in technology and the expansion of the scale of the Japanese economy is now making their development possible.

(B) In order to disperse the concentrated land use into wider regions, the total national land is divided into seven regions, and the development will be promoted by injecting the central managerial functions into the big urban centres of respective regions, and by connecting them by the new network.

(C) When the new network is fully utilized with intensified communication and high-speed transportation activities, the total Japanese Archipelago of 2000 km in length will function as one whole entity.

ment, therefore, established the Environment Agency (The Director-General is the Minister of State) to immediately implement strong anti-pollution measures. As the pollution problems became more serious, noise problems of the Shinkansen bullet trains and expressways became issues of social concern. Since then, attention to environmental matters has become a prerequisite for the execution of transport infrastructure development projects.

1-5 Preparation of the First Comprehensive Transportation Policy

The high economic growth and accelerated transportation infrastructure development during the 1960s had, on one hand, formed the basis for constructing a rich economic society, while on the other hand, allowed the rapid concentration of population and industries in the cities. As a result, various transportation issues arose; for example, wider regional economic differentials, traffic congestion in large cities, increased traffic pollution, and deterioration in the operation of the public transportation service. To counter this trend, concrete measures were required to capitalize on the individual characteristics of each means of transport: land, sea and air, and to produce an integrated, efficient and comprehensive transportation system able to play a strategic role in the construction of a welfare society.

For this purpose, the Transportation Policy Council prepared the Comprehensive Transport Infrastructure Development Plan, to be realized in 1985, based on an analysis of the latest transportation model. In addition, to provide the administrative and financial measures necessary to formulate the comprehensive transportation policy, the council presented suggestions on the rationalization of cost bearing, improvement in the freight and fare system, and the establishment of a new fund raising and distribution system. In particular, by highlighting the financial difficulties in operating the Japanese National Railways and other transportation services, the Council introduced the principle of bearing social costs by transportation services and that of bearing development profit by beneficiaries in order to return the profits to the transportation enterprises. Although these principles were not always practiced they significantly influenced the orientation of the cost bearing method to be applied in future transportation infrastructure development.

1-6 The Third Comprehensive National Development Plan (3CNDP) and Concept of TEIJYU (Permanent Settling)

Around the same time in 1972 as the release of the first report on the comprehensive transportation system, the Tanaka Cabinet initiated capital spending and the "Building a New Japan" written by the Prime Minister, was published. In the 1973 National Budget, the Tanaka Cabinet significantly increased public investment, with the leading item of Public Works being increased by 28%. However, the first oil crisis which occurred in October, 1973, completely altered the foundations of the world economy, and also had a strong inflationary impact on Japan. The government, therefore, had little option but to cut government

expenditure by, among other things, limiting public investment.

Under these circumstances, the government revised the conventional national land plan and produced the TCNDP so as to cope with the new conditions following the oil crisis. The active characteristics of the 2CNDP and "Building a New Japan" were found to be unnecessary in the preparation of the 3CNDP, and the moderate development concept to cope with the age of limited resources, i.e. the concept of TEIJYU, was incorporated in the plan.

The concept of TEIJYU has to secure balanced national land use by tackling the overpopulation/underpopulation problem by limiting the concentration of population and industries in the large cities, while on the other hand, encouraging local economies, and providing an overall environment congenial for human residence. According to the concept, 200 to 300 permanent resident areas were to be established throughout the country. The permanent setting area mentioned here represents a district where use and control of the natural environment, and the maintenance, improvement, and control of public and production facilities are coordinated in one system, and in addition, where the residents' intentions are fully reflected.

Transportation facility development in the 3CNDP aims at rebuilding the trunk line transportation system. The concept of the plan was to modify the conventional trunk line system centralized around Tokyo and to combine networks by sea and air with those of land, which consist of the spine lines running lengthwise down the country and the ribs lines running across. Its concrete projects follow the intention of the large-scale development projects outlined in the 2CNDP, and included expansion of the Shinkansen 'bullet' train network, acceleration of the Honshu-Shikoku Bridge and Seikan Tunnel construction works, completion of Narita Airport, and promotion of the construction of a New Kansai International Airport.

Due to a reduction in investment capacity, however, it became increasingly difficult for the transportation sector to fully support the concept of TEIJYU, which was to provide and improve a comprehensive environment for human residence by limiting the concentration of population in large cities and by encouraging the development of local economies. In addition, a further problem remains: how to operate a transportation business that is consistent with the social responsibility of such a system. No clear direction was given on this matter (Table IV-1-2).

1-7 Preparation of the Second Comprehensive Transportation Policy

In 1971, when the first comprehensive transportation policy report was released amidst high economic growth and the assumption that transportation demand would rapidly increase in the future, the intent of the Japanese was directed at developing a comprehensive transport policy that would enable the entire area of Japan to be developed.

Table IV-1-2 Planned Traffic Volume

		1975 (Actual)		1985 (Planned)		1990 (Planned)		Index (1975 = 100)		
		Volume	%	Volume	%	Volume	%	1975	1985	1990
Passenger (Mil Pass)	Total	46,176	100.0	60,200	100	67,500	100	100	130	146
	Road	28,412	61.5	41,000	68	45,000	67	100	144	159
	Rail	17,588	38.1	19,000	32	22,000	33	100	108	126
	Ship	151	0.3	200	0.3	220	0.3	100	132	148
	Air	25	0.1	60	0.1	110	0.2	100	228	445
Passenger (Bil Pass-Km)	Total	710	100.0	1,010	100	1,170	100	100	141	164
	Road	361	50.8	580	57	640	55	100	160	177
	Rail	324	45.6	380	38	440	38	100	117	137
	Ship	7	0.9	10	1	12	1	100	158	182
	Air	19	2.7	39	4	74	6	100	204	385
Freight (Mil-Ton)	Total	5,030	100.0	8,600	100	10,000	100	100	171	199
	Road	4,393	87.3	7,500	87	8,600	86	100	170	196
	Rail	185	3.7	170	2	190	2	100	94	103
	Ship	452	9.0	960	11	1,200	12	100	212	269
Freight (Bil Ton-Km)	Total	361	100.0	630	100	760	100	100	176	210
	Road	130	35.9	240	39	290	38	100	189	224
	Rail	47	13.1	46	7	50	7	100	96	107
	Ship	184	50.9	340	54	410	55	100	187	226

Source: 3 CNDP
Note: "Total" of freight transport includes traffic by air.

After the 3CNDP, however, great structural changes from high-growth yielding to stable-growth occurred in the Japanese economy. Also, the industrial structure changed with the development of the processing, assembly, and tertiary industries, with the result that the demands for transportation changed significantly. Due to the fact that no revision was undertaken in transportation system development, which was based on measures designed to cope with high economic growth, a new transportation policy became necessary to manage the remarkable changes and new demands in the economy, including the connection of central city in any permanent settling area to the nearest airport or Shinkansen railway station within 1-2 hours. In order to meet such requirements, the first comprehensive transportation policy was required to be revised according to the change of economic situation and the second comprehensive transportation policy was released in 1981 by the Transportation Policy Council.

The new report differed from the 1971 report in the following four characteristics:

(a) For a low-growth period, emphasis was placed on efficiency and careful selection of total transportation investments and operations. Specifically:

- Expansion of high-speed transportation networks in which Shinkansen 'bullet' train lines, air routes, expressways, and ordinary railroad lines were suitably integrated, incorporating the characteristics of each mode of transport;

- Preferential use of air transportation for long distances or between districts where transportation demands are small; and

- Joint use of private vehicles by 4-5 passengers in underpopulated districts.

(b) For the future development of transporation facilities, it was projected that constraints by energy, environment, and national land space would be further intensified and be tightened. Therefore, although the transportation system was to be improved by competition between transportation services, it was recognized that government intervention would become necessary to replace energy-inefficient systems with more efficient systems, and to introduce costly but time-efficient public transportation services to cities;

(c) To overcome low growth and financial restrictions, and to satisfy the population's high level demands for transportation, a software type policy approach was emphasized, such as the review of tariffs, introduction of an efficient trucking system, and efficient business control, in contrast to a hardware-type policy such as the expansion of facilities;

(d) Emphasis was placed on the long-term view towards the 21st century, and not on daily fluctuating economic situations.

As mentioned above, in the 1981 report, the desirable form of long-term transportation system development was examined from various viewpoints such as facilities, freight and fares, business control, subsidies, and financial resources.

1-8 Concept of the Transportation System Development in the Fourth Comprehensive National Development Plan (4CNDP)

After the 3CNDP was prepared, Japan experienced remarkable changes in extensive fields such as the movement of population, industrial structure, the National sense of values and lifestyle, state of overpopulation/underpopulation in national land use, and conditions of land and water usage. In addition, Japan has been required to cope with preparation for the 21st century, with new tasks such as aging, urbanization, technological renovation and the information society, and internationalization.

In light of these conditions, National Land Agency decided to prepare the Fourth Comprehensive National Development Plan; the National Land Council has been preparing the plan since October, 1983. The 4CNDP will be completed in 1986, giving guidelines for national land development in preparation for the 21st century, with the goal set in the year 2000.

In the plan, the provision and improvement of transportation networks is directed at coping with the new national and economic requirements in preparing for the 21st century. Concrete measures to be proposed in the 4CNDP cannot be clarified until preparatory work undertaken by the National Land Council is sufficiently completed. However, the basic concept was clarified in the "Interim Summary of Long-Term Prospect in the 4CNDP" (November, 1984). An outline of that summary is as follows:

1-8-1 New Requests for Transportation towards the Early 21st Century

In recent years, while the basis of Japanese economic activity has radically changed from high growth to stable growth, and the national lifestyle and values have been increasingly diversified, emphasis is now being placed on the function and role of transportation as an infrastructure for better life in addition to its conventional function and role as production infrastructure. The transportation system able to cope with such a trend is projected to be more sophisticated and diversified than ever before, because a wider selection will be requested in transportation methods, routes, and times. In particular, the following points are highlighted:

(a) With the sophistication of the industrial structure it will become necessary to more frequently transport high value-added products. The time factor in transportation will increase, as well as the trend of internationalization of Japan, through stronger ties and direct connection between local and overseas districts. Consequently, transportation effort will be directed at providing

higher speeds.

(b) In order to decentralize industries to local districts, and also to accelerate regional division of labor, reliable transportation with time regularity and stability will become indispensable. With the expansion of information network systems for physical goods distribution, transportation will be required to provide a higher quality service through efficient and optimum transport patterns to respond, for example, to reduced stock volumes.

(c) With the increasing national desires for a comfortable and rewarding lifestyle, all transportation means will be strongly requested to provide comfort. In particular, people will demand dissolution of traffic congestion to allow easier commuting, and improvement in comfort for sightseeing and recreation.

1-8-2 Trend of Transportation Demands toward the 21st Century

With the change in needs for transportation mentioned above (1-8-1), transport demands for both passengers and cargoes will experience the following great changes in quality and quantity:

(a) Total domestic passenger transportation increased at an average annual rate of 3.1% from 31 billion journeys in 1965 to 52 billion in 1982. This increase was supported by the expansion of automobile transportation due to the advances in motorization, together with improved service and comparatively lower fares in air-transportation in which really all services have been converted to jet aircraft. The growth rates in the number of passengers will be lower in the future, however the number is expected to be double the 1982 figure by 2025.

(b) Total domestic cargo transportation increased at an average annual rate of 4.7% from 2.6 billion tons in 1965 to 5.7 billion tons in 1982. In recent years, however, the total tonnage transported has decreased due to the influence of reduced transportation volumes of construction-related materials through limited public investment, and of volumes of oil due to energy conservation. Estimated transportation tonnage demand, based on the premise that a sophisticated economic structure will follow a mature stable growth line, is projected to be double the 1982 levels by the year 2025. However, the volume of cargo per trip will be reduced because of the trend toward lighter and smaller cargo, while the number of trips will increase.

(c) International passenger transportation has experienced a great surge in the number of Japanese tourists, reflecting high Japanese economic growth and substantial reductions in air-fares. Passenger numbers increased at an average annual rate of 14.6% from 1.2 million passenger in 1965 to 14 million in 1982. The number of tourists from newly industrialized Asian countries has experienced high growth rates for the past several years as well, and this trend is expected to continue.

It is projected that by the year 2025 the number of passengers will increase by approximately four to eight times the number in 1982.

(d) International cargo transportation increased significantly during the economic high-growth period, being supported by the importation of raw materials such as crude oil and iron ore. However, the level of cargo transportation has leveled off, with some fluctuations, since the first oil crisis. During these times, the transportation of cargo by containers has experienced steady growth due to high reliability and speed. As a result, total cargo tonnage has increased from 200 million tons in 1965 to 600 million tons in 1982, an annual average growth rate of 6.4%. The volume of cargo transported in the year 2025 is projected to be only 1.5 times the 1982 volume. This is based on the premise that imports of raw materials will probably be reduced the 21st century with the advent of a sophisticated industrial structure and further energy conservation in Japan. However, the transportation of air cargo is steadily increasing with the advent of small high-valued commodities that can absorb high freight costs.

1-8-3 Future Transportation Networks

Since World War II, the Tokyo sphere has played the leading role in Japanese economic development, while other districts have also developed by reinforcing their connection with Tokyo. Accordingly, transportation networks have formed into tree-type systems starting from Tokyo. In particular, the construction of high-speed transportation facilities such as express highways, Shinkansen 'bullet' train lines, and airports suitable for jet aircraft have also been undertaken to fulfill the request for high-speed transportation raised after the high-growth period, and as a consequence, mainly Tokyo received improved access.

For the purpose of fulfilling transportation requests in preparation for the 21st century, the provision and improvement of networks which place emphasis on links between local cities is required. In addition, improved qualities such as high-speed performance, reliability, and comfort will be required of future networks. When these networks are developed, these qualities must be consistent with low-pollution generating transportation equipment.

For improvement of high-speed performance, emphasis must be placed on high accessibility to high-speed transportation terminals such as interchanges on expressways, Shinkansen stations, and airports capable of handling jet aircraft, and on improved links between high-speed transportation equipment. Through the provision and improvement of transportation networks, any place in Japan will be within one day's access for passengers, and any cargo will be able to reach its destination within a day. This will be realized by around the year 2025.

1-APPENDIX PROGRESS OF RAILWAY IMPROVEMENT IN JAPAN

1-A-1 Socioeconomic Development

(1) Demographic changes

The population of Japan increased about 1.4 times in 34 years, from 1950 to 1984. The trend of the population to concentrate in cities, particularly in three largest urban spheres (Tokyo, Osaka, Nagoya), continued until 1975; thenceforth, population dispersion to outlying areas began. In regional areas the population tended to concentrate in local nucleus cities, and in the large urban spheres the population growth was great in the peripheral areas where residences could be obtained more easily, bringing about the "doughnut phenomenon" in the shift of the population (see Figure IV-1-A(1)).

(2) Economic and industrial development

Large-scale development took place in the economy and industry of postwar Japan, accompanied by huge capital investment in the private and public sectors. While the national income per capita was 0.23 million yen (at 1980 prices: $1 = ¥230 in 1980) in 1950, it reached 1.82 million yen in 1983. As to changes in the relative weight of each production sector, the primary industry declined, the secondary remained at the same level, and the tertiary increased. With brisk economic and industrial activity, capital investment in transportation greatly increased (see Figure IV-1-A(2) and IV-1-A(3)).

(3) Change in people's living

With the curtailment of working hours, the proportion of the time under restraint decreased from 40% in 1960 to 30% in 1980. The increase in free time and the rise in personal income, together with the change in the sense of values, oriented the people toward a more leisurely and affluent life. Housing environment improved, eating habits changed, new developments took place in energy and communication, and motor vehicle ownership greatly increased in the past 30 years (see Figure IV-1-A(4)).

(4) Progress of railway improvement (see Figure IV-1-A(5))

1) 1945-1959

Railways undertook the main role of transportation in the postwar economic recovery period, making the most of their damaged facilities. From about 1955, superannuated and damaged facilities were replaced to strengthen the infrastructure for the coming high-growth economy.

Figure IV-1-A(1) Transition of Population

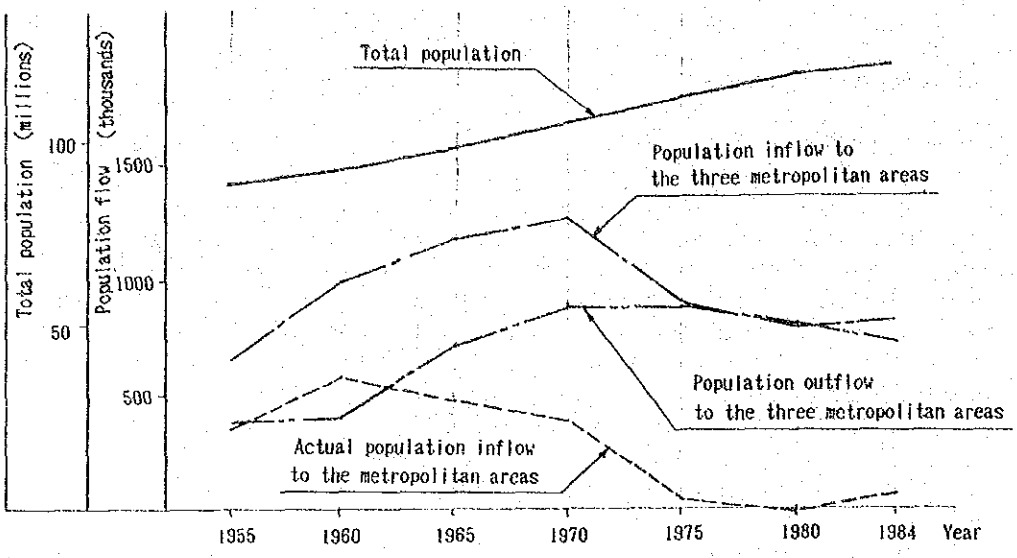


Figure IV-1-A(2) Product Shares of Industrial Groups

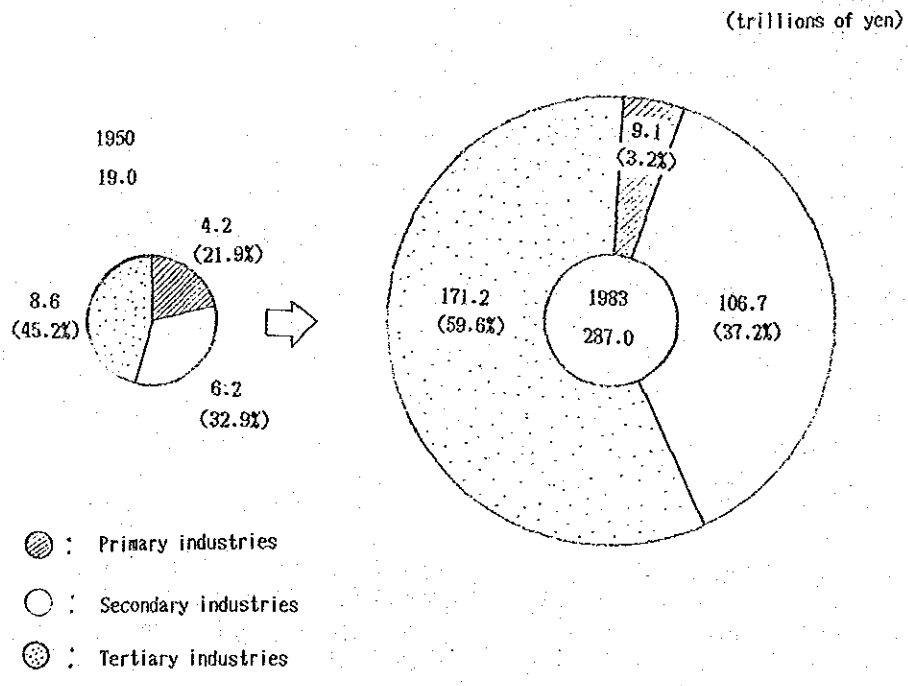


Figure IV-1-A(3) GNP and Investments by Sector

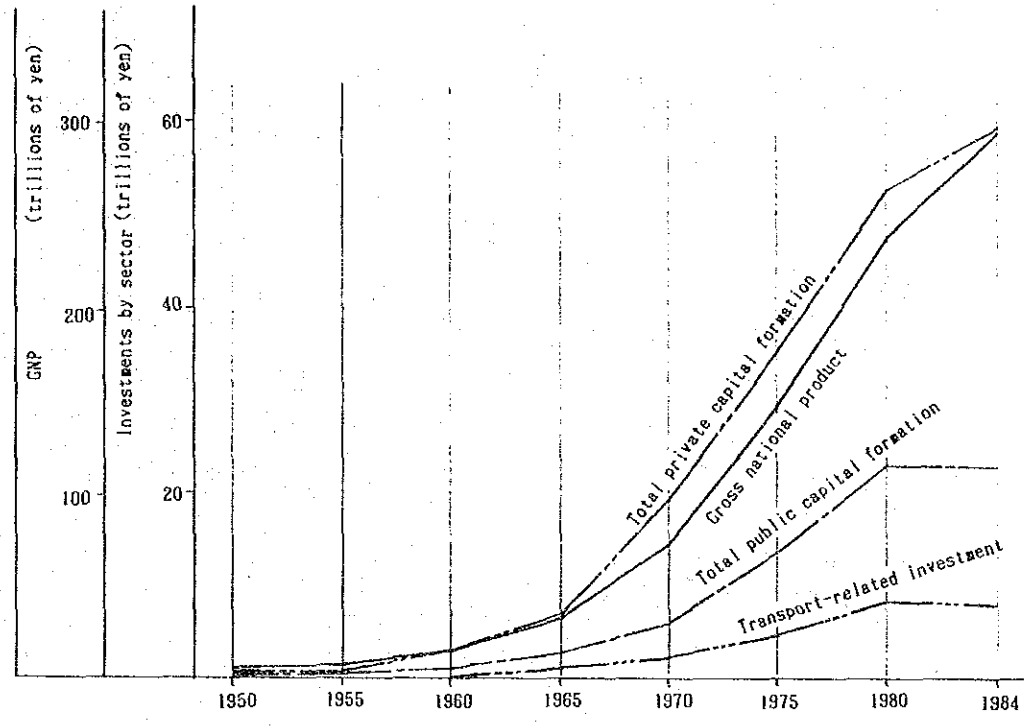


Figure IV-1-A(4) Number of Automobiles and Trucks Registered

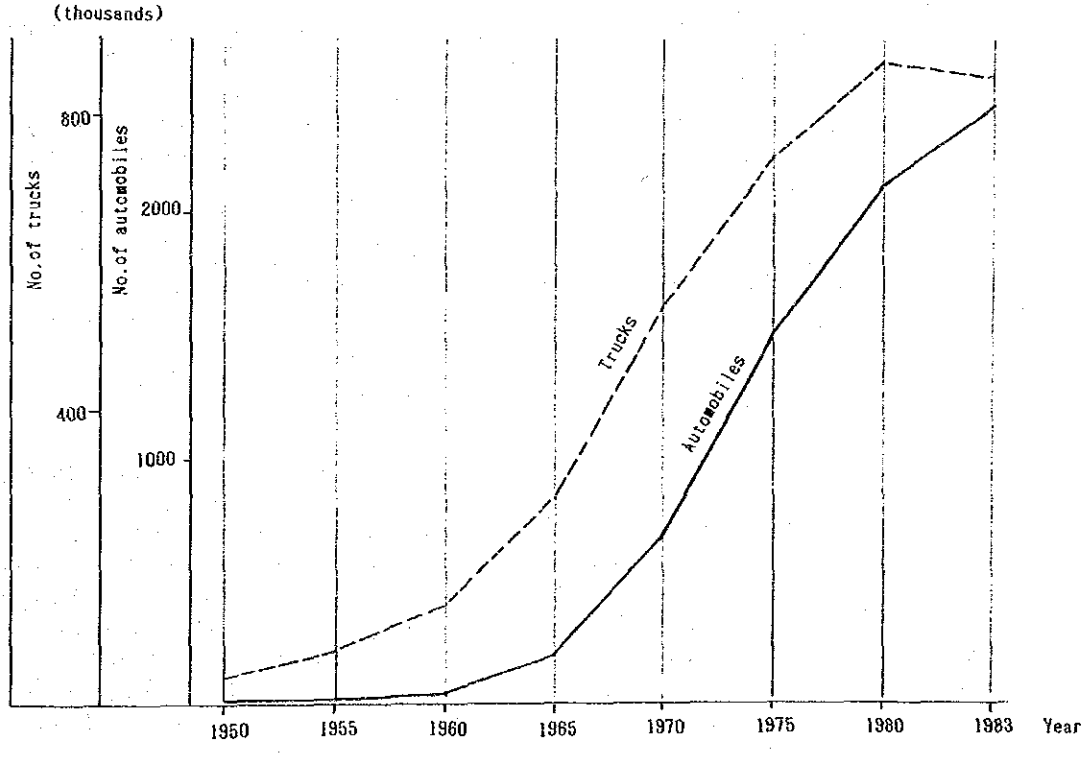
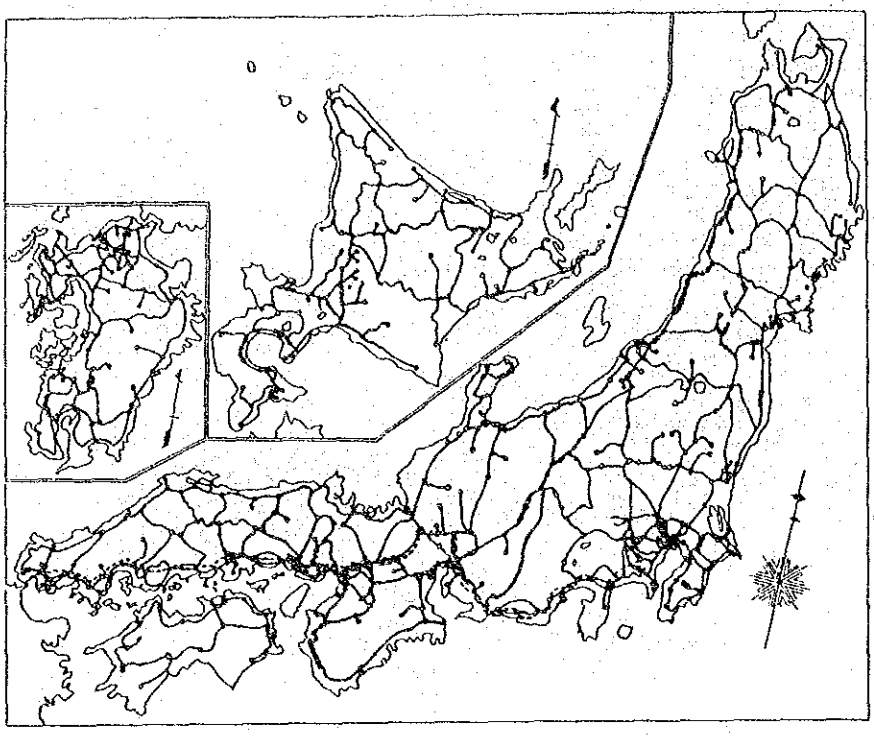


Figure IV-1-A(5) JNR Network



2) 1960-1969

This was the high-growth period and it was in the period (1964) that the Olympic Games were held in Tokyo. To meet the increased demand, emphasis was placed on raising transport capacity and modernizing motive power. Further, a new high-speed railway, the Tokaido Shinkansen, was opened in 1964, greatly increased railway traffic volume.

In large urban areas, large-scale improvement was made in commuter transport. In freight transport, limited express container trains called "Freight Liners" were put to service and work to improve the main freight terminals began.

3) 1970-1979

Such trials as the oil shock and environmental pollution were encountered in this period. Japanese National Railways (JNR) finances began to aggravate, so to put it on a sounder footing, railway investment was directed mainly to the fields where the merits of the railway can be displayed, namely, large city commuter transport, inter-city passenger transport, and long- and middle-distance large volume freight transport. However, with the less rapid pace of economic growth from around 1975, railway traffic, too, began to slacken. Furthermore, large-scale improvement in the facilities of

other transport modes, such as roads and airports, tended to reduce the relative competitive power of JNR, further worsening JNR finances.

Railway improvement was seen in the fulfillment of a plan to improve commuter transportation in five directions in the Tokyo area, progress in the construction of the Tohoku and Joetsu Shinkansen and implementation of modernization and rationalization measures.

4) 1980-

JNR's share of the domestic traffic has tended to decrease with the great improvement in other transport modes and change in user's preferences. Particularly, a great drop was seen in freight traffic, as a result of which, a large-scale reformation was made in freight services. During this period, the Tohoku and Joetsu Shinkansen were opened, but for the conventional lines improvement was restricted to safety and modernization measures.

1-A-2 Railway Improvement from the Viewpoint of Transportation as a Whole

(1) Trend of investment in transportation

Statistics on public investments in transportation indicate that while road investment and railway investment were about equal in fiscal 1950, road investment rapidly increased since 1961, from which year the Third Road Improvement Plan was implemented, reaching 70% of the total in 1980.

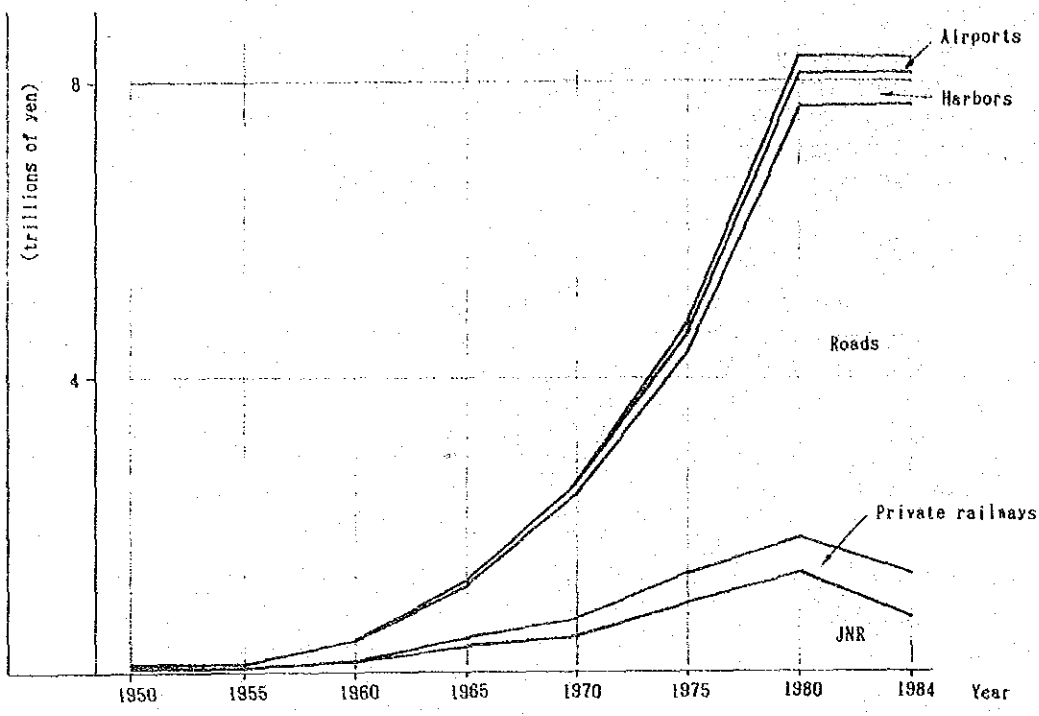
The investment in air transport rose since the implementation of the First Airport Improvement Plan in 1967 and accelerated in the 1970s.

The investment of JNR decreased from 37% in fiscal 1950 to 12% in fiscal 1980. The improvement in other transport modes, including private railways, has been substantial, but the upkeep and improvement of JNR's facilities have been relatively restricted (see Figure IV-1-A(6)).

(2) Trend in the improvement of each transport mode

The trend in the improvement of the main facilities of each transport mode is shown in Figure IV-1-A(7). JNR has executed much facility improvement as seen in Shinkansen construction, track addition, electrification, urban area commuter transport measures, etc. However, the expansion and improvement in road and air facilities are much greater.

Figure IV-1-A(6) Transport-related Investments



(3) Trend in the traffic volume of each mode

1) Passenger transport

The total domestic passenger traffic volume was 822.3 billion passenger-km in fiscal 1984, about 7.0 times that of fiscal 1950. The traffic ratio of railways to motor cars declined from 12:1 to 0.7:1 during this period and air traffic has also gone up remarkably, reducing the weight of the railway.

2) Freight transport

The total domestic freight traffic volume was 434.6 billion ton-km in fiscal 1984 about 6.7 times that of fiscal 1950. The railway's share had been reduced from 51.0% to 5.2% during this period, while on the other hand the share of trucks rose extremely and the share of domestic shipping went up by about 9% (See Figure IV-1-A(8) and IV-1-A(9)).

1-A-3 Role and Improvement of Railway Transport in Japan

In the midst of improvement in road and air transport, it could be said that the role of railway transport is focused on large city commuter transport, inter-city passenger transport, and long- and middle-distance large volume freight transport.

Figure IV-1-A(7) Transition of Transport Facility Improvement

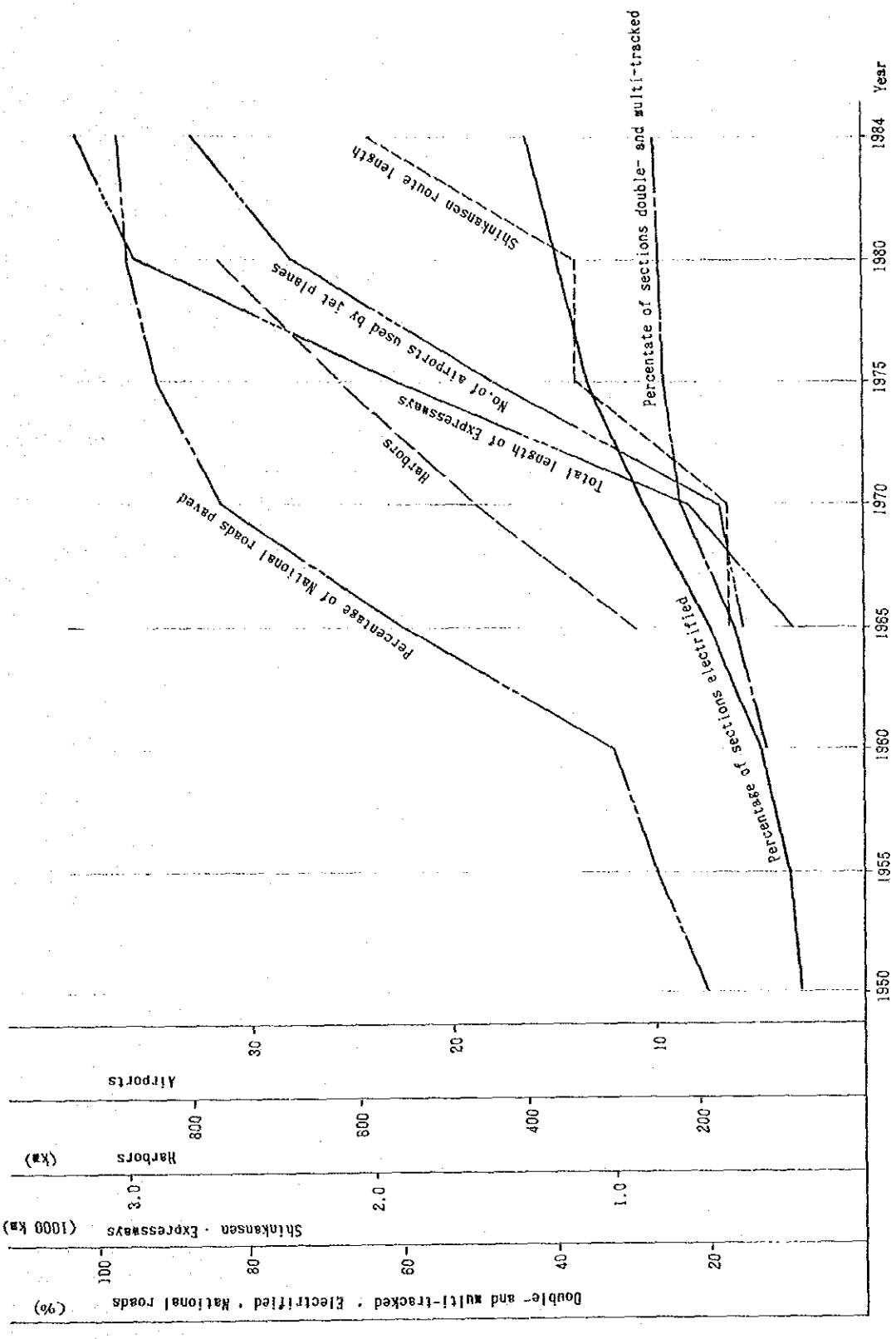


Figure IV-1-A(8) Passenger Traffic Volume by Transport Modes

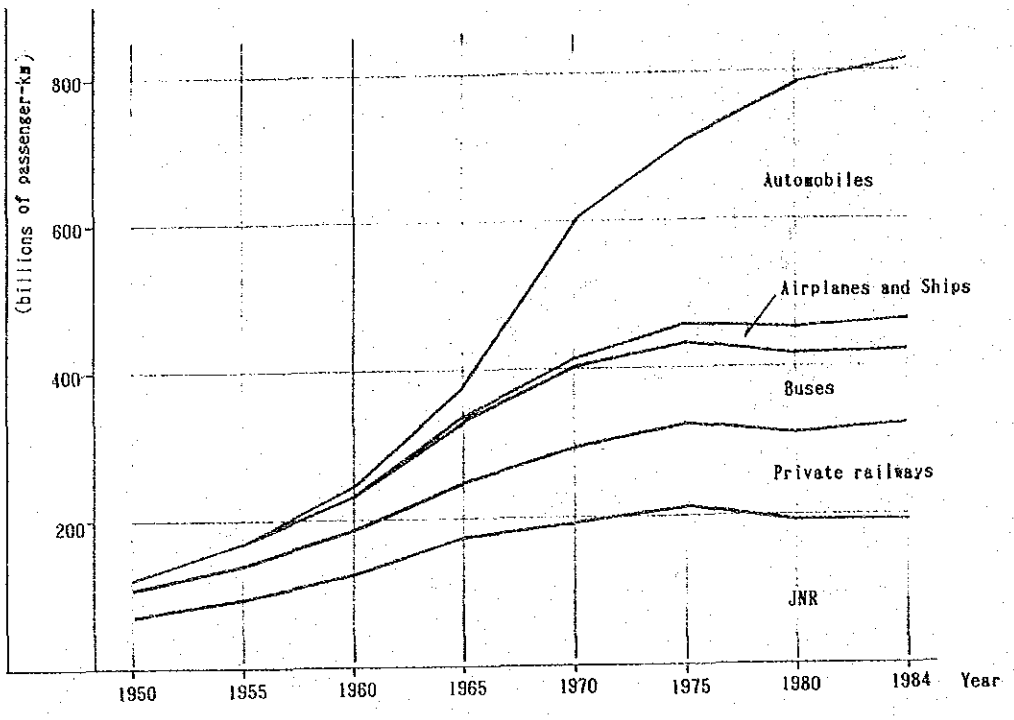
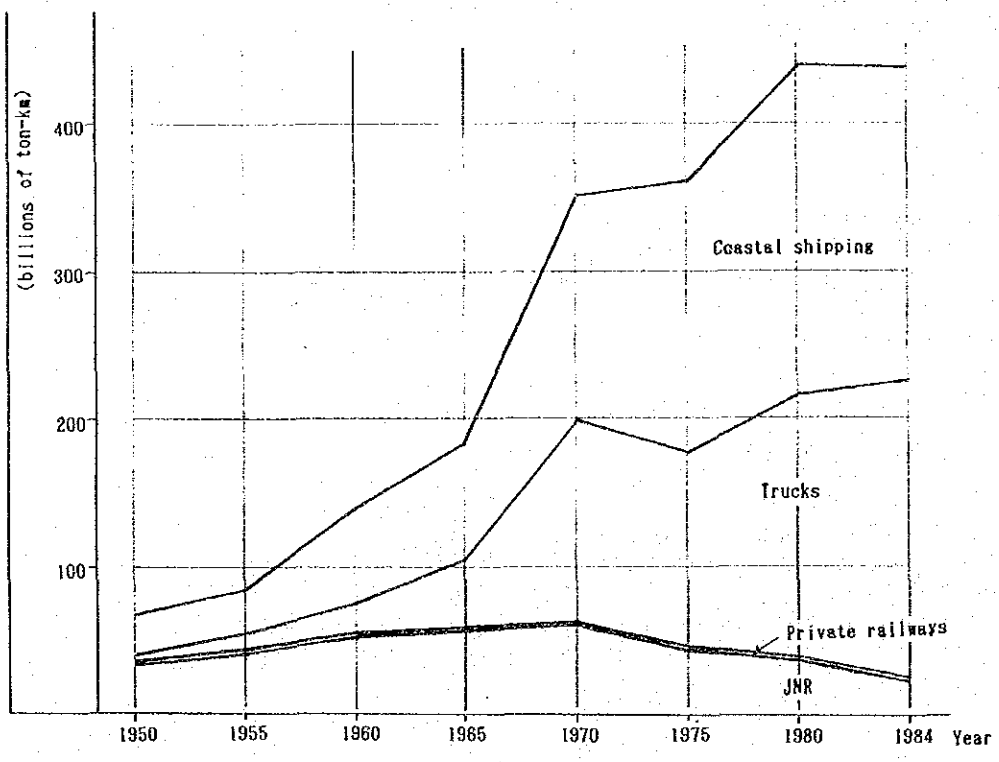


Figure IV-1-A(9) Freight Traffic Volume by Transport Modes



(1) Large city commuter transport

In consideration of the population concentration in urban areas and road congestion, railways have a great role to play in mass transport of commuters. In Tokyo, for example, the expansion of railways and the growth in passenger traffic are shown in Table IV-1-A-1 and Figure IV-1-A-10. Specifically, JNR carried out large-scale improvements such as quadruple tracking and inter-line through service with subways on five lines radiating out from the city center, and also, undertook grade separation of road/rail level crossings, lengthened the train consist, and put into service improved rolling stock.

(2) Inter-city passenger transport

In the high growth period, JNR pushed forward track additions, electrification and other measures to increase the traffic capacity on main lines to meet the rising traffic demand. Particularly, as a solution to the urgent need to increase the capacity on the Tokaido line connecting Tokyo and Osaka, distance about 520 km, the Tokaido Shinkansen, a new-high-speed bullet train system (maximum speed 2.10 km/h), was opened in October 1, 1964, and thereafter the Sanyo, Tohoku, and Joetsu Shinkansens followed raising the Shinkansen total route length to 2,085 km.

(3) Freight transport

With the improvement in road transport and change in traffic commodities from bulky agricultural and mining products to small and high-priced industrial products, the freight transportation system underwent a considerable change and railway freight transport showed a great decline. This necessitated to changing, the freight transportation system from carload freight traffic, composing trains in marshalling yards, to direct terminal to terminal transportation, resorting to containerization and unit trains for specific commodities (see Figure IV-1-A(11) and IV-1-A(12)).

1-A-4 Progress of Modernization in JNR

(1) Motive power modernization

The motive power energy source has changed from coal to petroleum and electricity having high heat efficiency. Along with this, the modernization of train operation and maintenance has been advanced (see Figure IV-1-A(13)).

(2) Safety measures

To operate more trains, raise the train speed, curtail personnel and prevent train accidents, JNR has taken such safety measures as wider adoption of the automatic signal system, centralized traffic control system (CTC), and grade separation of level crossings (see Figure IV-1-A(14)).

Table IV-1-A(1) Railway Route Length in the Tokyo Metropolitan Area

(Km)

Year	J N R	Private railways	Subways	Total
1930	586.9	657.5	3.8	1248.2
1935	652.1	720.3	8.0	1380.4
1940	682.7	720.3	14.3	1417.3
1945	701.5	725.3	14.3	1441.1
1950	701.5	741.0	14.3	1456.8
1955	701.5	759.9	20.7	1482.1
1960	701.5	759.9	30.9	1492.3
1965	709.0	779.2	75.7	1567.3
1970	713.6	830.1	131.4	1675.1
1975	767.6	756.3	168.5	1792.4
1980	787.6	903.0	198.2	1888.8
1984	805.4	920.5	210.2	1936.1

Figure IV-1-A(10) Traffic Volume in the Tokyo Metropolitan Area

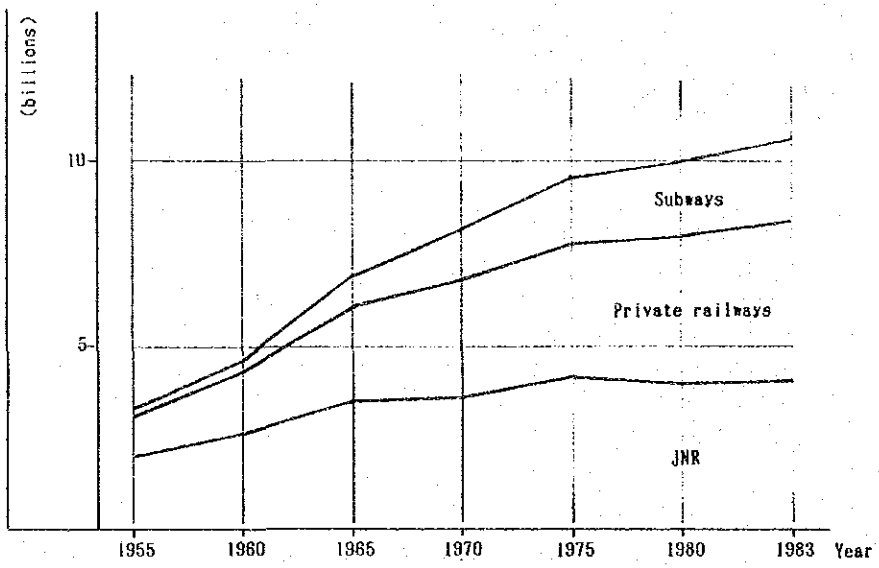


Figure IV-1-A(11) Railway Passenger-km

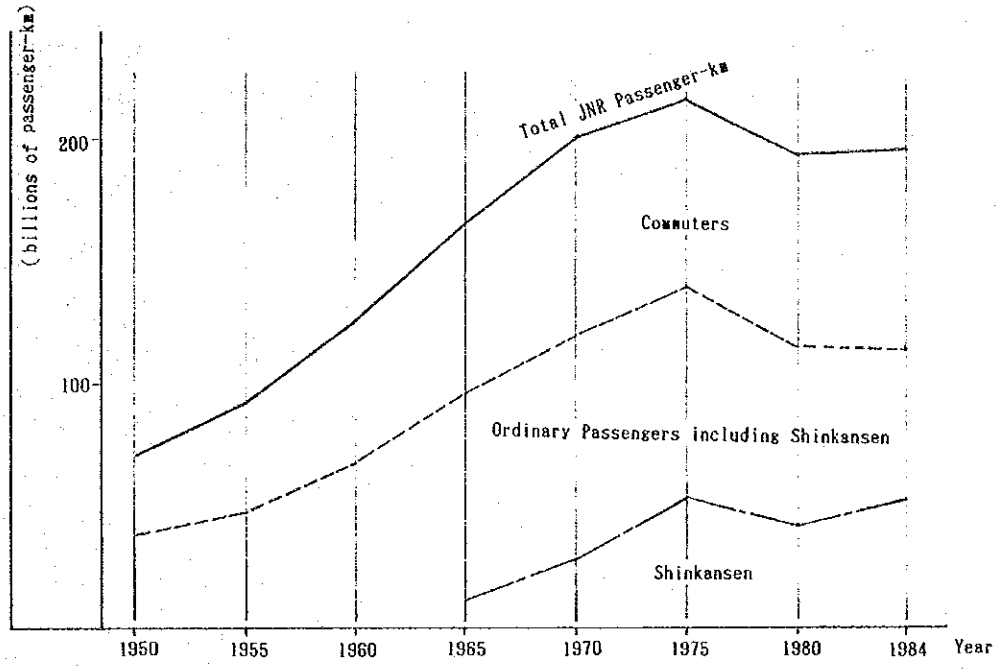


Figure IV-1-A(12) Railway Freight Traffic Volume by Commodity

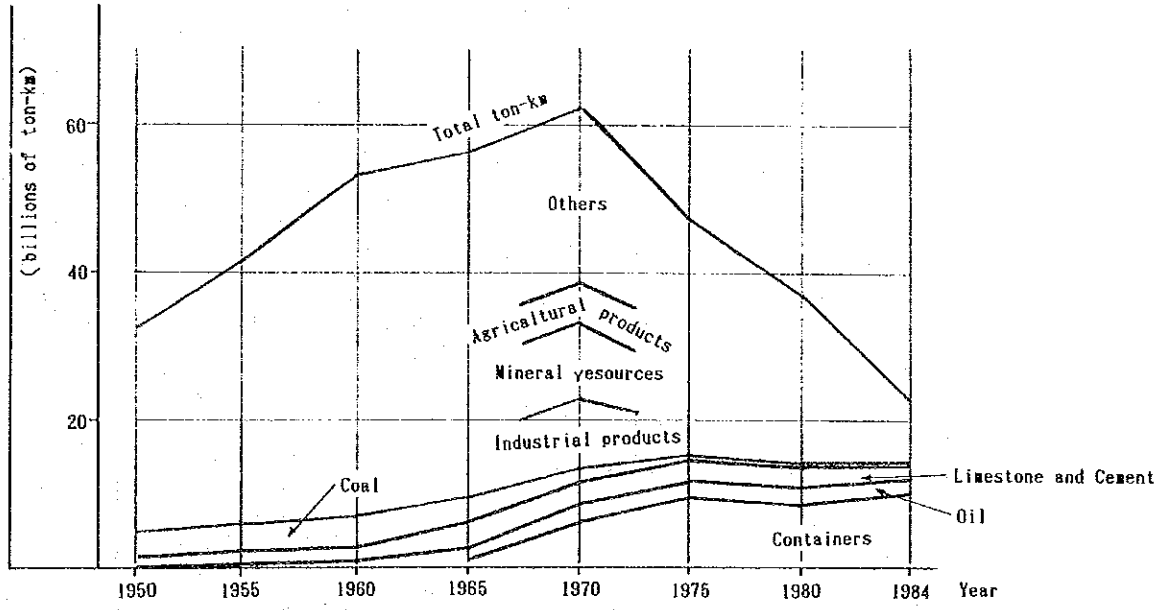


Figure IV-1-A(13) JNR Route Length, Electrified Sections, and Double- and Multi-tracked Sections

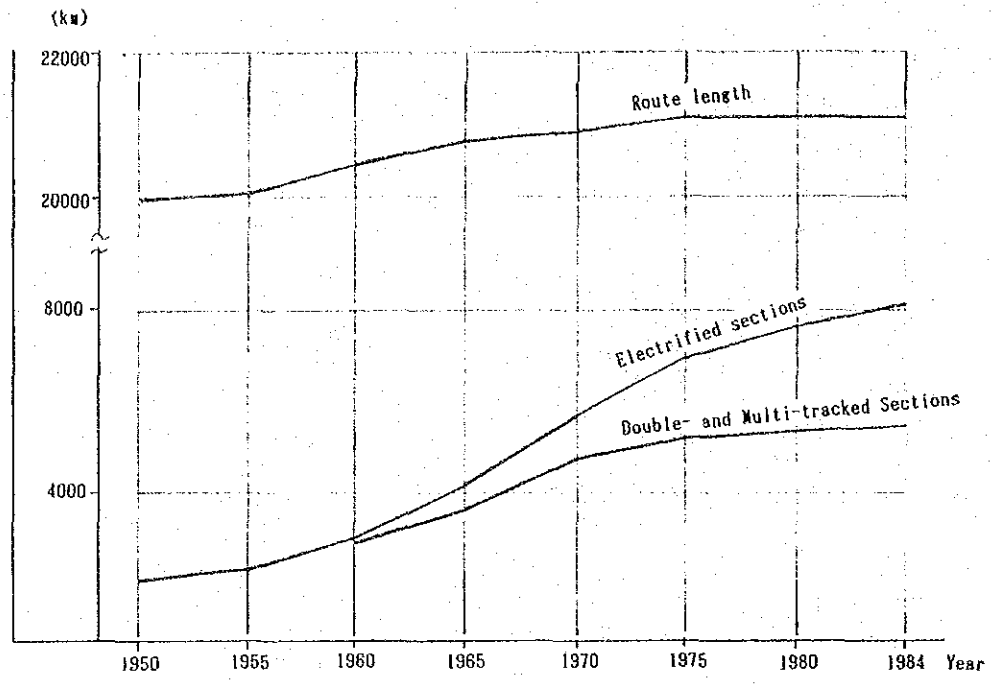
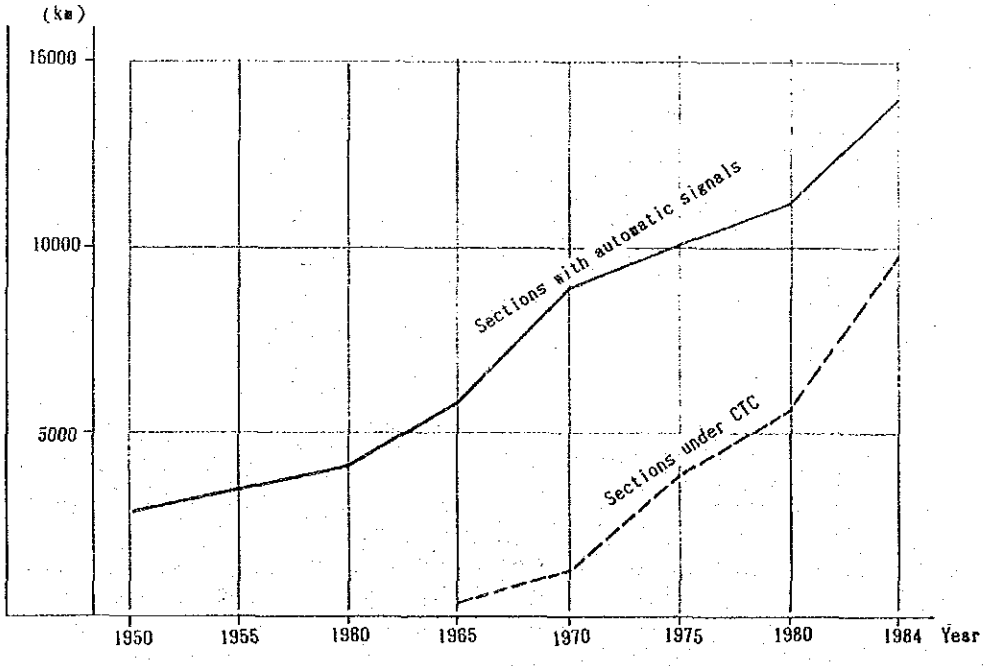


Figure IV-1-A(14) Sections with Automatic Signals and Under CTC



(3) Service improvement

To improve the service JNR has:

1) raised the train frequency to shorten the waiting time of commuting passengers,
2) raised the train speed up to reduce travel time,
3) improved passenger car accommodation,
4) introduced the computerized seat reservation system in 1960 (see Figure IV-1-A(15)).

(4) Freight transport modernization

Measures being taken to achieve the mission of the railway in inland freight transport are:

1) containerization of freight transport,
2) establishment and improvement of freight terminals exclusively for specific commodities that can be amassed in quantity (coal, petroleum, cement, agricultural products, etc.) and adoption of freight trains exclusively for such commodities,
3) realization of direct transport between key terminals, bypassing marshaling yards (effective, February 1984).

An example of the new key freight terminal is given in Figure IV-1-A(16)).

1-A-5 Transition in the Form of JNR Management

(1) Period of government and private operation

The first railway in Japan was opened by the government between Shimbashi (in Tokyo) and Yokohama (29 km) in 1872. Since then, many main lines were constructed by private companies and the Tokaido Line and a few others by the government.

(2) Period of government operation

With the advancement of political unification and the necessity for unification of transport from the military viewpoint, the "Railways Nationalization Law" was enacted in 1906 and all of the main lines became nationalized, 7,152 km in total route length. Therefore, railway construction was continued, and rolling stock and facilities were vigorously improved to increase transport capacity in the wartime regime.

After World War II, the railway lay in a devastated state, in spite of which, JNR contributed greatly to the postwar recovery of the nation.

(3) Period of operation as a public corporation

In 1949, JNR was reorganized from a government enterprise to a

Figure IV-1-A(15) Reduction in Travel Time

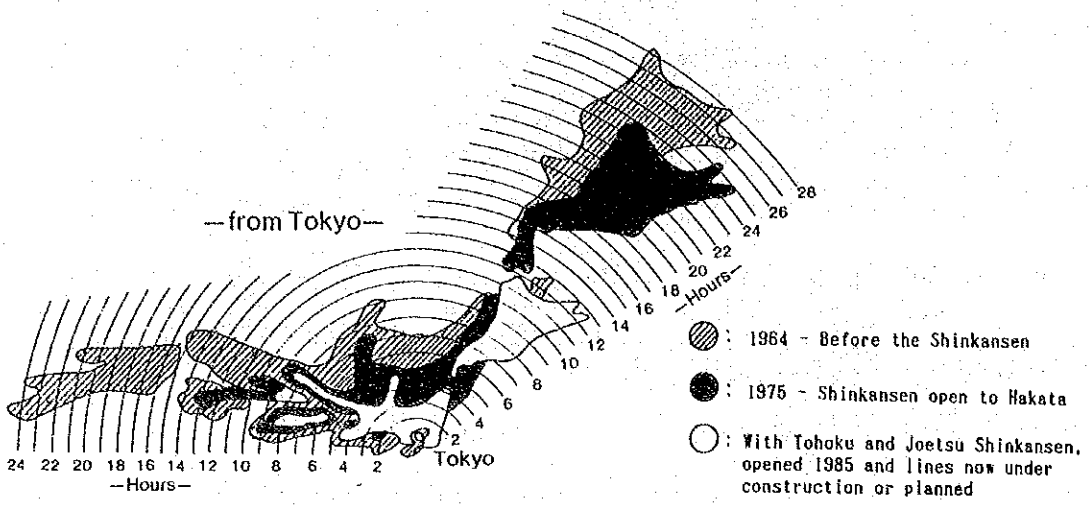
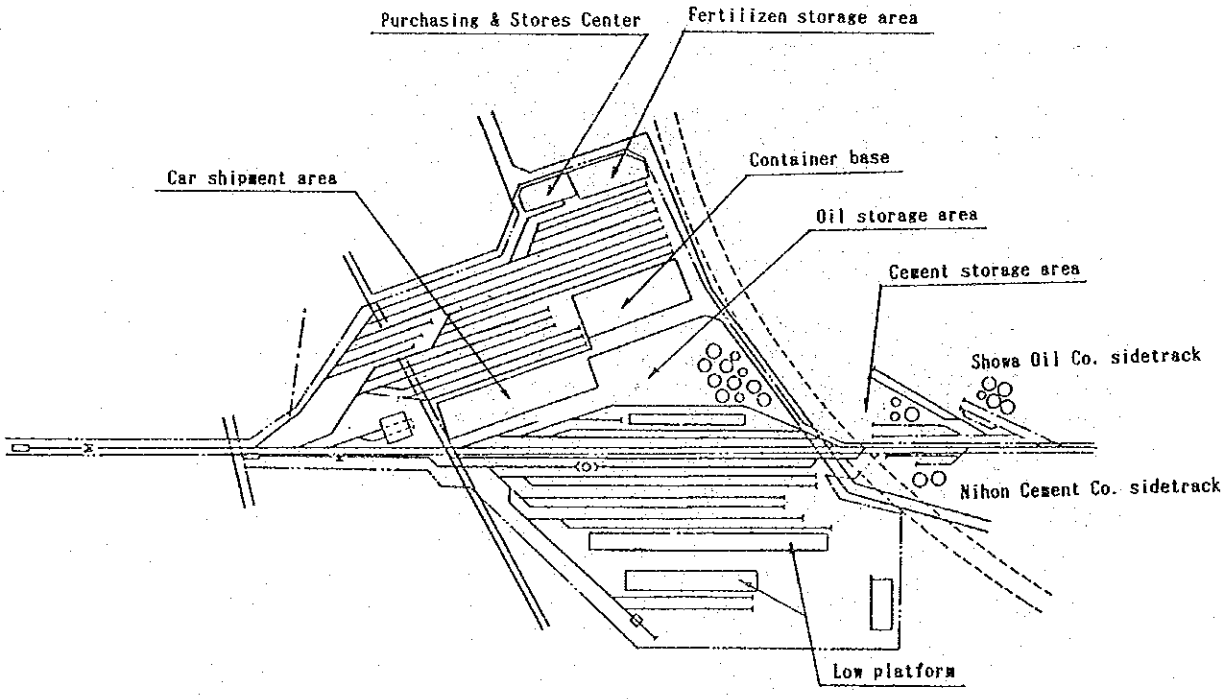


Figure IV-1-A(16) Takasaki Freight Terminal



public corporation under a special law, and this form of management has been kept until present. JNR had performed a great role, particularly until the high growth period, however, the improvement of other transport modes and the change in user's needs combined to reduce the share of JNR, aggravating the finance of JNR.

(4) Toward privatization

To rehabilitate JNR under these stringent conditions, the policy to privatize the railway was adopted and it is to make a new start in private company form in April 1987.

2. CARGO INFORMATION SYSTEM IN JAPANESE PORTS

2-1 Background of Cargo Information System

The cargo information system in Japanese ports has not been in full operation, but it has been undergoing trial operation at ports in Tokyo Bay since October 1985 with a view to starting full operation in April 1986.

The increase in size and speed of ships brought about by transport innovation, including containerization and mechanization, and advancement of shipbuilding technology has resulted in a jump in the volume of cargoes to be loaded and unloaded in a short time to and from a ship, for which a number of shipping documents are necessary, and this turn has increased the amount of information.

In order to cope with such a change, research into simplifying and rationalizing the information system synthetically by introducing computers to trading business was started in 1972 by Japan Information Processing and Development Association, which was under the jurisdiction of the Ministry of International Trade and Industry. In 1974, the results were turned over to the Japan Transport Economics Research Center, which was under the jurisdiction of the Ministry of Transport. As a result of the research at the Center, the creation of the Shipping Cargo Information Network System (SHIPNETS) was proposed to the business concerned.

At present, a lot of information on shipments of cargoes for export is exchanged in the form of documents or communication by phone among businesses of different categories. In order to coordinate and rationalize such exchange of information, companies in related businesses must be linked up with each other with a network.

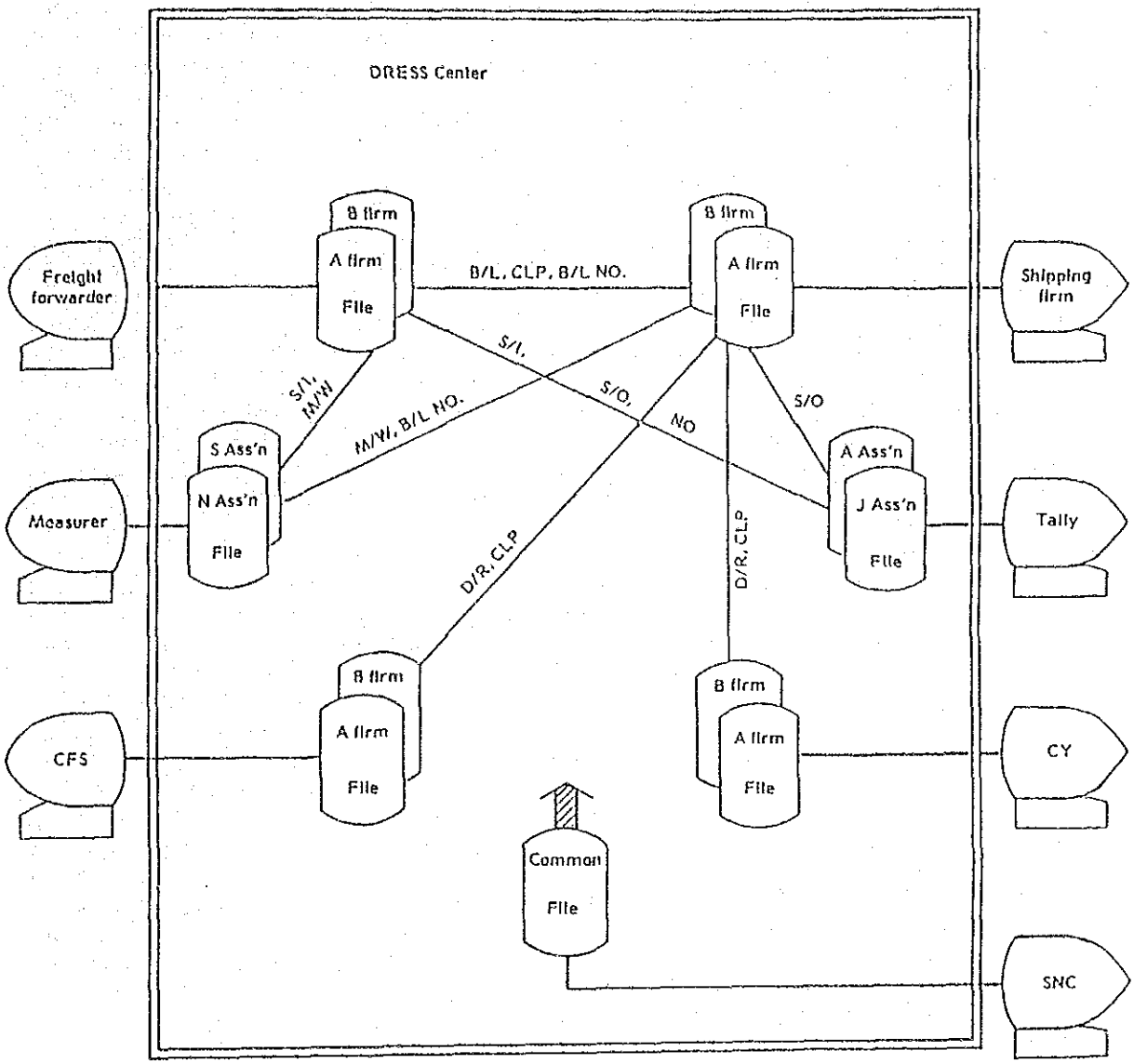
2-2 The Shipping Cargo Information Network System (SHIPNETS)

In SHIPNETS, companies belonging to four different categories of businesses - shipping companies, freight forwarders, measuring associations and tallying companies - are connected with on-line network through DRESS (a public data communication equipment service), the computer center of Nippon Telegraph and Telephone Corporation (NTT).

In other words, if SHIPNETS is adopted, the flow of information via documents or phone among companies in related businesses will be replaced by exchange of information conducted through the medium of the DRESS center among companies of different categories of businesses.

It will thus become possible to speed up preparation of shipping documents and deliveries as well as reduce the number of documents. Also, if information contained in shipping documents is once fed into the computer, other companies will not have to feed it again, thus it will become possible to save labor and to cut down typing errors.

Figure IV-2-1 Outline of SHIPNETS



Source: SHIPNETS Center Promotors' Association
Note: B/L = bill of lading, D/R = dock recipt
M/W = measure and weight information
S/I = shipping instruction, S/O = shipping order
CLP = container load plan, OY = container yard
SNC = SHIPNET center, CFS = container freight station

A sketch of SHIPNETS is shown in Figure IV-2-1. Companies participating in this system will each have their own file (mailbox). Information on any one cargo fed into a computer by any of the companies belonging to one of the four categories of business is transmitted to the mailboxes.

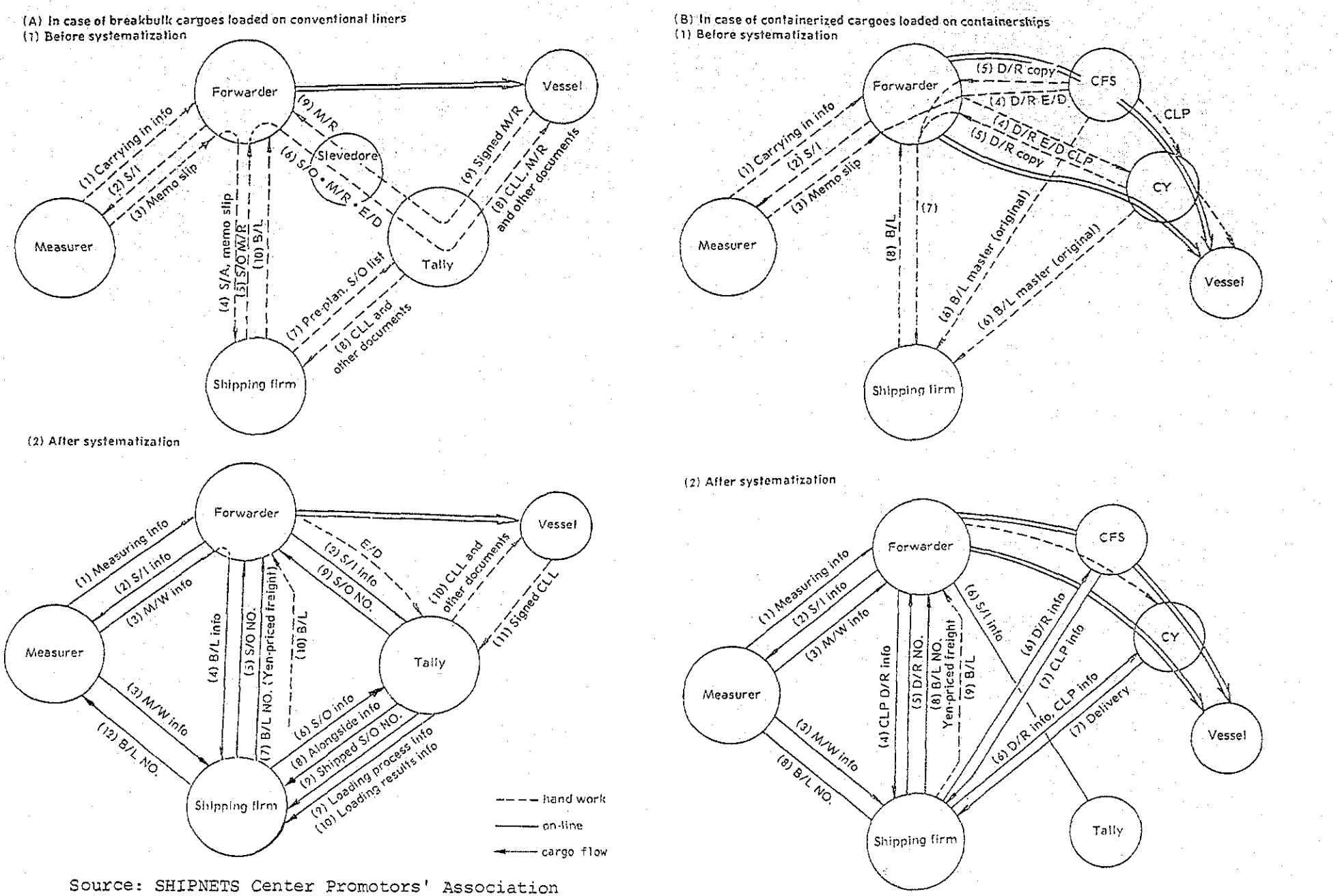
If a freight forwarder feeds S/I (shipping instruction) and B/L information, a measuring company M/W (measure and weight information), a shipping line S/O (shipping order) and D/R (dock receipt), and B/L numbers and a tallying company information on cargo alongside, loading progress and S/O number upon completion of loading into computers at the DRESS center, other firms can draw out whatever information they need and also output shipping documents including B/Ls. At the present, the function of the system ranges from input of S/I information to shipping lines' composition of B/Ls.

Figure IV-2-2 shows comparison of the flow of information for conventional ships and container ships before and after SHIPNETS is adopted. It can be seen from the figure that most of what was done by hand before is networked on-line and less documents are involved. Also, information gleaned through the network will not have to be fed into the computer again and it can be used for the companies' own systems. Furthermore, there will be no need to retype the information when using it for statistical purposes. Secrecy of information, a matter the companies are most concerned about, is fully protected as companies have their own file (mailbox) and with this as a major premise the companies are introducing the system.

In order to realize SHIPNETS, the then Nippon Telegraph and Telephone Public Corporation initiated a research program in 1979 and came out with the concept of a system to network on-line reception and transmission of cargo information in February 1980. The Japan Transport Economics Research Center accordingly set up a committee to investigate and research into the use of SHIPNETS. In 1981, the basic framework of SHIPNETS was formulated and detailed specifications were drawn up on the basis of a survey conducted on the conditions at ports in Tokyo Bay and the system was built. From August to December 1982, one company from each of the four different categories of business experimented with the newly developed system at ports in Tokyo Bay. This was the first of a series of experiments with SHIPNETS. Although very few companies participated in this experiment and the experiment period was short, the purpose of testing the system's function was fully attained. With the results and problems of the first experiment taken into consideration, a second experiment was prepared for. To prepare for the second experiment, an Experiment Management Committee was formed in October 1983. It was decided to have more than one company from each of the four different categories of business participate in the experiment. These were the six major Japanese shipping lines, 33 freight forwarders, two measuring associations and two tallying companies, totaling 43. Over a period of one year and ten months, the committee completed the compilation of the 1,000-page SHIPNETS manual, which explains the system and service, in August 1985. Taking into consideration the progress of the preparation and development of the companies scheduled to participate in the system, the Experiment Management Committee decided to start the experiment in October 1985. The committee accordingly was dissolved and the SHIPNETS Center Promoters' Association was established.

Two roles were set for the association: to manage and control the experiment and make preparation to set up an organization for starting

Figure IV-2-2 Comparison of Business Flow Before and After Systematization



Source: SHIPNETS Center Promotors' Association

the full-fledged operation of SHIPNETS targeted for April 1986. As it involves four different categories of business and a non-profit organization, the association came under civil law. The legal status was to be passed on to the organization that would undertake the real operation. The association's investment was 10.4 million yen. In the first experiment, all four participating companies used DRESS terminals but in the second experiment, all participating companies, except 10 companies that used DRESS terminals, connected host computers used in their in-house systems to DRESS, making up an on-line network system covering different categories of business and different type of computer system. DRESS' host computers consist of two computers, which were domestically manufactured to NTT's specifications.

To connect these computers to different types of host computers at the companies, the companies themselves had to match their protocol (a process for communication control or a certain rule for conversation among computers) to DRESS. There were many cases in which a network was built among different companies in one category of business with a uniform protocol set, but rarely has a uniform protocol been set among four different categories of business. This is where SHIPNETS differs from other systems.

SHIPNETS Center is scheduled to undertake the full-fledged operation of SHIPNETS set for April 1986. SHIPNETS Center will not only undertake SHIPNETS operation at ports in Tokyo Bay, but also at other ports in the nation and for this purpose companies will be invited to participate in the system. The investment is to be more than 50 million yen.

Since all measuring and tallying companies are participating in the network system covering different categories of business, unless all shipping lines and freight forwarders take part, the conventional method of preparing shipping documents will be still used along with that of SHIPNETS. This is not an efficient way of preparing such documents. SHIPNETS will have more merit for shipping lines if as many freight forwarders as possible participate in the system and the same will be true for freight forwarders if as many shipping lines as possible participate in the system. To enhance the efficiency of the system, active efforts are being made to increase the number of companies participating in the system. As a result, 108 freight forwarders, 16 foreign shipping lines, and 4 Japanese shipping lines have so far indicated their willingness to participate in SHIPNETS.

2-3 Future Direction of Operation of SHIPNETS

At present, the operation of SHIPNETS is limited to four different categories of business, but in the near future other trade-related industries may have to be approached in connection with the system. It may not be long before banks, insurance firms, customshouses, warehousing companies, land transportation concerns, port and harbor administrators and shippers will be called upon to be participants in the system as their office automation system makes headway.

Under the circumstances, chances are that the remaining work done by hand - signing and handing over B/Ls, for example - will be studied for on-line networking in the future. However, problems such as establishing such a waybill system are matters that cannot be resolved by Japan alone and they must be dealt with internationally.

3. CONTAINER TERMINALS IN JAPAN

3-1 Ports and Economy

3-1-1 Japanese Ports and Economic Development

(1) The Postwar Period of Rapid Economic Growth (1945-1960/65) and Ports

Japanese ports in the postwar years were in poor shape because of heavy war damage and because port construction had been inevitably suspended during the war's final stages. For the nation as a whole, urgent priorities requiring public expenditure included such items as rehabilitation of housing, assurance of food and energy, and the securing of jobs for repatriated military personnel.

Ports, for the most part, received only the minimum funding necessary for essential repairs, so fundamental restoration was extremely limited. Port facilities were so deteriorated, in fact, that full economic rehabilitation, begun in 1950, and economic growth, from about 1955, were bottlenecked by a lack of functional port facilities.

The importance of port improvement began to be recognized as a drive was launched in 1947 to invest as much materials and funds as possible into key industries such as iron/steel and coal (railways and energy production were added from 1948).

The Port and Harbor Law, enacted in 1950, prescribed rules concerning the administration, planning, construction, and management of ports.

The law clearly defined the responsibilities as follows:

- Local governments were to be responsible for the management of their respective ports.
- The central government would be responsible for overall port planning, and local government would be in charge of the planning of individual ports.
- A well-defined funding ratio was established for paying the costs of infrastructure construction.

In 1953, the "Law for Promotion of Port Improvement" was enacted, making government funds available for the preparation of port sites (including industrial sites) and the construction of cargo handling equipment, transit sheds and other functional facilities. The drastic improvement of ports in postwar Japan can be fundamentally attributed to this law, as well as to the Port and Harbor Law and the Law for Emergency Measures for Port Improvement (which outlined a five year investment plan) (Table-IV-3-1).

Table IV-3-1 Outline of Five-Year Plans for Port Improvement

	1st 5-Year Plan	2nd 5-Year Plan	3rd 5-Year Plan	4th 5-Year Plan	5th 5-Year Plan	6th 5-Year Plan
Program Period	1961-1965	1965-1969	1968-1972	1971-1975	1976-1980	1981-1985
Target Cargo Volume	620 million tons	1,050 million tons	1,530 million tons	3,380 million tons	3,700 million tons	4,100 million tons
Actual Cargo Volume	810 million tons	1,600 million tons	2,220 million tons	2,530 million tons	2,910 million tons	-
Planned Investments (A)	250 billion yen	650 billion yen	1,030 million yen	2,100 million yen	3,100 million yen	4,260 billion yen
Actual Investments (B)	209.6 billion yen (1961-1964)	289.5 billion yen (1965-1967)	502.1 billion yen (1968-1970)	1,662.8 billion yen (1971-1975)	2,415.1 billion yen (1976-1980)	-
Achievement Ratio (B)/(A)	83.8%	44.5%	48.7%	79.1%	77.9%	-

Source: Ports and Harbours Bureau, MOT.
Note: Program periods are expressed in fiscal years. For example, fiscal 1961-1965 extends from April 1, 1961 through March 31, 1966.

Specifically, these laws greatly helped to facilitate the systematic construction of ports and ultimately the development of today's coastal industrial zones.

The postwar confusion had more or less subsided by 1955, and the brisk growth of industry sparked a new age of development.

Development and growth from 1955 began with the reestablishment of heavy metal and chemical industries at reclaimed sites in the bays of Tokyo and Osaka, and at industrial sites in Tokuyama and Yokkaichi which had been coastal military installations. Early in this period, large-scale land reclamation was begun in Tokyo Bay and later in Osaka and Ise Bays. Land preparation was carried out systematically.

Deep channels and anchorages were dredged to enable large vessels to use the ports and the resulting material was used for land reclamation. Sites were designed so that the plants could have their own deep water quays, and thus raw materials, brought by large vessels, could proceed to the plants with ease. Planners sought to integrate the ports and industrial sites, an arrangement which would be impossible at existing inland sites.

Private companies paid for the construction of quays for their exclusive use. Breakwaters and main channels were constructed with public funds on the assumption that they would serve a general shipping function. Beyond a certain water depth, however, private companies which would share the benefits also shared the cost. Land reclamation was financed with government-guaranteed bonds in accordance with the above-mentioned law for Promotion of Port Improvement.

Iron, steel, petroleum, chemical, paper manufacturing, power, cement and other industrial plants were constructed in these coastal

industrial zones. Industrial complexes of mutually dependent industries (related industries in close proximity) were constructed and ports and industries were integrated as part of comprehensive plans.

The integrating of ports and industrial sites is one characteristic of Japanese port policy. The product of this strategy is what we call an "Industrial Port."

Japan must import almost all the raw materials necessary to its industry - sometimes from as far away as the other side of the globe. Thus, it was decided to build large ports and large vessels to help cut transportation costs.

As industry in the Tokyo, Ise and Osaka Bays intensified, population and industry continued to concentrate in the Pacific belt area, particularly in the large cities. In the early 1960s, a significant shortage of social overhead capital in those areas, particularly for transportation facilities, became apparent. Major ports, especially those for export, were extremely congested, putting a strangle hold on the nation's economy.

In 1960, the government formulated a "National Income Doubling Plan" (period: 1961-1970) to ensure the growth of Japanese industry and in particular to emphasize the development of heavy and chemical industries to promote overall national economic development. One high priority was a buildup of social overhead capital to strengthen the industrial base. Accordingly, the Law for Emergency Measures For Port Improvement was enacted in 1961 to "speed systematic and urgently needed port improvements, thereby contributing to the sound development of the national economy." Under this law, the government specified what improvements were necessary for each port and how much money was to be spent for each project over the next five years. These projects were considered to be under the central government.

In Japan, port management is fundamentally under the jurisdiction of local governments. The central government sees that their policies conform to certain rules, and provides subsidies (on the average, 50% of expenses). Again, it is important to note that the government regards port improvement as critical to the nation's economic policies, and thus legally defines the volume of improvement work for a period of five years. To date, the plan has been renewed five times, and the 6th five-year plan (1981-1985) is currently in effect (Table IV-3-1).

(2) Expanded Regional Development (1960/65-1973)

Japanese ports have undergone systematic improvement since the 1960s. Credit can be given to the Port and Harbor Law, the Law for Promotion of Port Improvement and the Law for Emergency Measures for Port Improvement as they clearly outline the financial roles of the central government and the port management bodies (local government). In addition, economic conditions were favorable, and the GNP and volume of cargo handled by ports increased, invariably surpassing ini-

tial goals.

Meanwhile, population continued to concentrate in large cities, resulting in overcrowding, and other areas experienced depopulation. 38% of the population and 43% of all industry were concentrated in only 7.5% of the nation's land.

Environmental pollution beset the overcrowded areas and the quality of seawater began to deteriorate. Improved production became a lost cause. Depopulated areas suffered even greater population flight and economic stagnation set in. Local government leaders began to cry out for regional development.

The Comprehensive National Development Plan (period: 1960-1970), was approved by the Cabinet in 1962, seeking to prevent overcrowding in large cities and to effect balanced economic development nationwide. Industrial development bases were subsequently set up in rural districts, specifically developed in advance as suitable areas for expanding industrial activities. By attracting industrial relocation away from overcrowded cities, the industrial zones promoted regional development. A total of 21 zones were designated nationally and, with one exception, all were located along the coast.

Industrial zones involving large tracts of reclaimed land were planned as well. Here the concept of the "developer port" came into existence. A "developer port" is a port constructed to bring about development in areas that have potential, but little population, industry or plans for new industry. Specifically, such port construction includes breakwaters, channels and public quays making the area attractive to industry.

Tokyo, Osaka and Ise Bays, and the coasts of the Seto Inland Sea have relatively calm waters surrounded by land. Because land reclamation and port development were fairly easy in these places, regional economic development advanced smoothly.

However, areas where land reclamation and port construction are difficult are considered to be underdeveloped areas. In order to industrialize such areas, attractive "developer" ports must be constructed.

Where there are no calm waters, marginally productive land along the sea must be utilized. Some examples of artificially excavated ports constructed as developer ports are the Port of Kashima, Niigata Port (East), the Port of Tomakomai, Sendai Port (all of these can handle 200,000 D/W ships), and the Ports of Toyama and Kanazawa (both can handle 50,000 D/W ships). In the case of the Port of Kashima, 4,000 ha of wilderness were turned into industrial sites, and 20,000 ha of urban area, including industrial sites, have nearly been completed. The area has become a leading Japanese industrial zone with a population of about 110,000 producing 200 billion yen worth of goods annually.

Construction of large industrial bases to handle 300,000 -

500,000 D/W ships was begun in the eastern part of the Tomakomai area and in the Mutsu Ogawara area in 1974 and 1975, respectively.

(3) The Era of Port and City Co-existence (1973-Present)

The oil crisis of 1973 profoundly affected the Japanese economy - ports, as well, suffered directly and indirectly from its effects. The 1974 GNP fell somewhat below the previous year's level and the volume of cargoes handled at ports also dropped. That volume began to increase again in 1976 due to the low cost of sea transportation and its efficient use of energy, though the rate of the volume increase was below the pre-crisis level (Table IV-3-2).

Table IV-3-2 Energy Consumption by Type of Transport (1978)

Means of transportation	*Transportation Volume (100 million ton-km)*	*Energy Consumption (10 billion Kcal)*	*Energy Consumption per transportation volume (Kcal/ton-km)*	*Index where coastal transportation (ships)= 1*
Railroad	412	584	142	0.6
Truck	1,561	20,889	1,338	5.7
Ship	2,120	4,955	234	1.0

Source: Ports and Harbours Bureau, MOT

This current period is characterized by an increase in demands for environmental protection. The importance of greater interaction between ports and cities has also become apparent.

Environmental impact is assessed when ports are being planned and green areas and waste disposal plants are being constructed under port improvement projects. In addition, sea surface areas are being cleaned and bottom sludge dredged. The net effect, then, is not only preservation but also enhancement of the environment. Today, the cost of this kind of work amounts to 14% of the total cost of port improvement projects.

Geographic conditions have always made for close relations between ports and cities in Japan. However, as ports and ships increase in size, so do the physical and psychological distance between ports and city-dwellers. Although local residents understand the economic value of ports, they no longer feel a connection to them.

At the same time, cities require more land for expansion and remodeling. Port plans now often include reclamation in port zones for use by the city - typical examples are Port Town at the South Port of Osaka and Port Island at Kobe Port. Thus, integration of port and city is considered necessary for the development of both.

Several of the older ports are being redeveloped as well. In most cases, this is because their facilities have become timeworn or

obsolete. Others are being redeveloped to provide the local population with greater opportunities to involve themselves with the ports and their functions.

Ports not only function as links between sea and land transportation, but they also provide space for industries, and play an important role in developing urban areas. Ports are administered primarily by local governments or by port authorities. Port development is planned by these local authorities or management bodies.

In Japan, the government sets the fundamental policy for improving existing ports. But it is the port management body that makes the improvements, keeping in mind the economic well-being of the local inhabitants and the development of the region as a whole. Planning is done with the notion that the port should be integrated with the city.

3-1-2 Role of the Port Authority, Central Government and Local Government

The philosophy and system of port administration throughout the world varies greatly from country to country and from port to port due to socioeconomic, geographic and political differences. In general, there are currently two different basic philosophies which underlie the administrative and development systems at different ports.

Under the first concept, ports are regarded as profitable entities: their administrative bodies should be profitable, and port improvements must be financed by revenues from the Port. Thus ports are considered as autonomous bodies. Governments provide no subsidies and should make no regulations interfering with the operations of individual ports. Essentially, this is a laissez-faire approach under which individual ports must support themselves by the revenues they earn from their activities.

Under this concept, there is free competition among neighboring ports. On the one hand, this may stimulate efficient operations through the competitive mechanism. On the other hand, unregulated competition may result in imbalanced growth whereby only the most profitable sectors are emphasized and other less profitable sectors including various essential services may not be provided at all.

Thus, under the laissez-faire concept there is no linkage of the development policy among various ports, and port development plans are not determined in conjunction with regional and national development policy. This is a serious shortcoming as ports can only develop smoothly in conjunction with the industrial development of near areas and the development of other major infrastructures, especially roads.

The second major philosophy concerning the administration and development of ports is that ports are essential infrastructures for regional and national development. As ports benefit the entire nation, they should be subsidized by local and central governments. Especially,

large scale development and expansion projects should be financed with government assistance.

Under this second concept, ports are managed by semi-autonomous administrative bodies, but local and central governments retain the right to regulate and coordinate port management, finance and planning.

Some governments make long-term regional and national port development plans in conjunction with regional and national plans for comprehensive economic development. Thus, the development of ports takes place as part of larger development plans designed to benefit the entire nation.

Among the countries of Europe and America, Britain, France, Belgium and Canada have national port policies, while in the Netherlands, West Germany, Sweden and the United States national port policies are either non-existent or insubstantial.

The details of national port policies, of course, vary by country. France, Belgium and Canada - much like Japan - seem to regard ports as social overhead capital, having port policies in conjunction with national economic policies, regional development policies and transportation policies. In the case of Britain, port policies for the main ports are based on the recognition that ports are a major investment of capital for the transportation industry, though in general ports are not a primary factor in formulating policy for the nation's regional development and overall transportation system. In the U.S., administrators of main U.S. ports also generally regard ports as capital investments for the transportation industry rather than as national or regional social overhead capital.

Nevertheless, regardless of what direction a national port policy might take (assuming there is a national policy at all), one idea that is common to the ports of Europe and America is that port use fees should be set so as to make the ports economically self-sufficient. Of course, there actually are many different cases, and many of the ostensibly self-sustaining port authorities in Europe and the U.S. are actually supported by the central governments through indirect subsidies in the form of free services such as dredging channels and maintaining navigational aids.

In Japan port management bodies, composed primarily of local governmental entities, are charged with handling all phases of port planning and construction, based on the recognition that ports are the foundation of national economic policy, regional development policy and transportation policy. Nevertheless, the central government determines overall national port development policy and executes some port construction in keeping with regional policies and national land development policies.

In many other countries, ports are operated independently, with special attention paid to the port as an economic enterprise. Even in cases where governmental guidance, in terms of regional development, transportation policy, etc., is provided, a profitable return on port

investment is regarded as vital.

Among developing countries, many now employ methods of port development and administration that were introduced when these countries were under the control of western nations. Naturally, a suitable form of port administration should be determined within the framework of each nation's overall administrative system, but it is necessary that port development projects be devised so as to contribute to the economic and social development of regions, and ultimately, of entire nations.

In other words, the port authority or port management body must recognize that ports are social overhead capital, strategic to regional development. In planning ports, they must also establish policies for regional development. At the same time, central and local governments must provide financial and other assistance to port authorities and port management bodies, with a clear understanding of the role to be played by the ports in the development of their respective regions.

It is expected that ports in developing countries will play an important role in smoothly accomplishing regional and national economic development. However, it is most doubtful that the ports of developing nations will be able to perform this important mission if the port development methods that have evolved and are now employed in western countries are applied in their entirety.

If ports in developing countries were regarded as enterprises required to balance their revenues and expenditures, only the largest ports would be successful, and these would be far too few to effect significant overall regional development. Further, ports that are planned as nuclei of regional development cannnot be expected to yield substantial port revenues at first, due to the fact that ship calls and cargo handling volume will be limited until industrialization of the hinterland progresses. Since it is an extremely effective policy to proceed with port construction in advance, thereby inducing regional development, an investment of public funds is necessary to correct the immediate imbalance of revenue and expenditure.

Investing public funds is highly useful in that the port authority or port management body can construct facilities without having to consider this immediate balance of revenue and expenditure. Profit from port improvements can then be returned to the region or the entire nation. Further, the government can anticipate recovering its investment from an increase in tax revenue accrued through development of the region.

This method of port development achieved great success in its actual application to Japanese regional development, and it is expected that the same method could also prove effective for the economic growth of developing countries.

In conclusion, long-term port development projects can only be successful when they are carried out in conjunction with regional and national economic development. Proper development of ports stimulates economic activity in the hinterlands, and is of the utmost importance