Chapter 2 Industrial Machinery Sector

2-1 Machine Tools

2-1-1 Supply and demand trends

(1) Orders

In 2004, total order intake was ¥1,236.2 billion, up 45% from the previous year, achieving growth for two years in a row by exceeding the ¥1 trillion level for the first time in the seven years from 1997. The figure represents the third highest in history following ¥1,269.7 billion in 1989 (Diagram 2-1-1). Domestic demand was ¥672.8 billion, up 52% from the previous year, accounting for 54.4% of the total orders. The data reveal that the industry has been going strong and orders are still basically on the rise. These favorable conditions are backed by aggressive investment by automobile manufacturers. It is expected that mid- to long-term orders will remain high even when taking some variable factors into consideration.

Thanks to brisk domestic demand, orders exceeded the year-earlier level in ten of the eleven machine tool user industries. (A decrease in demand was experienced only in the public/school sector.) In particular, orders in the electrical machinery and precision instruments industries exceeded the year-earlier level by 67% and 36%, respectively, backed by high demand for digital home appliances (Diagram 2-1-2). Against a background of strong equipment investment, orders from the automobile industry, the biggest user sector, was up 42% from the year-earlier level as well. Also, orders from the general machinery sector showed a substantial 65% increase over the previous year, thanks to high demand for molds and dies for automobile manufacturers.

Foreign demand was ¥563.4 billion, up 38% from the previous year, accounting for 45.6% of the total orders. In terms of regional breakdown, orders from the EU recorded the highest 59% increase over the previous year, followed by North America (42%) and Southeast Asia (29%). In all regions, the orders exceeded those of the year-earlier level, reflecting a favorable business condition worldwide.

Diagram 2-1-1 Order trends

(Unit: billion yen, %)

	1997	1998	1999	2000	2001	2002	2003	2004
Intake of orders	1,130.6	989.2	756.6	975.0	788.9	675.8	851.1	1,236.2
	121	87	76	129	81	86	108	145
Domestic demand	635.1	457.2	361.9	521.7	411.1	350.3	441.6	672.8
	125	72	79	144	79	85	107	152
Percentage of domestic demand	56.2	46.2	47.8	53.5	52.1	51.8	51.9	54.4
Foreign demand	495.5	532.0	394.7	453.4	377.8	325.5	409.5	563.4
	116	107	74	115	83	86	108	138
Percentage of foreign demand	43.8	53.8	52.2	46.5	47.9	48.2	48.1	45.6

Note: Percentage of domestic demand = Domestic orders/total orders

Percentage of foreign demand = Foreign orders/total orders

Source: "2005 Machine Tools Statistics," Japan Machine Tool Builders' Association

Diagram 2-1-2 Machine tool order intake by industry

(Unit: million yen, %)

Industry \ Year	1997	1998	1999	2000	2001	2002	2003	2004	y/y (2004/ 2003)
1. Steel and non-ferrous metals	11,743	9,374	6,684	7,824	5,189	3,680	5,557	8,613	155
2. Metal products	24,283	15,753	13,000	18,325	13,383	9,732	15,209	22,067	145
3. General machinery	243,194	168,047	132,685	192,850	154,430	120,190	160,512	264,502	165
4. Electrical machinery	41,594	28,073	25,131	45,922	35,131	22,564	30,483	50,902	167
5. Automobiles	197,399	149,808	103,377	129,042	136,541	141,490	158,988	225,632	142
6. Shipbuilding and other transport equipment	21,646	14,991	8,642	10,227	15,587	14,287	12,074	17,328	144
7. Precision instruments	17,466	12,560	17,878	38,276	22,082	16,459	24,176	32,990	136
3-7 Subtotal: Machine manufacturing industry	521,299	373,479	287,713	416,317	363,771	314,990	386,233	591,354	153
8. Other manufacturing businesses	28,900	19,413	15,667	26,557	17,198	14,197	24,507	37,643	154
9. Government/public/school sector	3,071	4,422	3,713	3,085	3,065	2,125	1,873	1,842	98
10. Other user sectors	2,430	2,429	1,983	1,760	853	610	1,644	2,971	181
11. Trading companies and agents	43,410	32,344	33,162	47,818	7,666	4,988	6,564	8,349	127
1–11 Total: Domestic demand	635,136	457,214	361,922	521,686	411,125	350,322	441,587	672,839	152
12. Foreign demand	495,473	531,986	394,694	453,360	377,773	325,515	409,514	563,353	138
1–12 Total intake of orders	1,130,609	989,200	756,616	975,046	788,898	675,837	851,101	1,236,192	145
Numerically controlled (NC) machine tools only	1,043,303	925,861	711,742	926,477	745,409	638,831	807,208	1,176,257	146

Source: "2005 Machine Tools Statistics," Japan Machine Tool Builders' Association

(2) Production

The production in 2004 was ¥878.1 billion, up 27% over the year-earlier level, achieving an increase for two years in a row (Diagram 2-1-3). Diagram 2-1-3 shows that production has recovered to a level well above the ¥814.6 billion recorded in 2000. However, the 27% (20% in terms of number of units) increase from the year-earlier level was not so good when compared with the 45% increase in order intake. This suggests that production recovery is lagging behind growth in the order intake. When it comes to numerically controlled (NC) machine tools, the production was ¥773.5 billion, up 29% over the year-earlier level. This means that NC machine tools accounted for 88.1% of the total machine tool production, representing a 1.6% increase from the previous year.

Diagram 2-1-3 Production trends

(Unit: billion yen, %)

	1997	1998	1999	2000	2001	2002	2003	2004
Volume of production	1,017.1	1,010.5	739.5	814.6	776.5	585.1	690.2	878.1
	121	99	73	110	95	75	118	127
NC machine tools	850.1	876.8	635.4	721.9	680.2	509.7	597.3	773.5
	122	103	72	114	94	75	117	129
Percentage of NC machine tools (%)	83.6	86.8	85.9	88.6	87.6	87.1	86.5	88.1

Note: The lower figure in each cell represents a year-on-year growth rate.

Source: "2005 Machine Tools Statistics," Japan Machine Tool Builders' Association

(3) Exports and imports

Diagram 2-1-4 shows machine tool export and import trends. The exports in 2004 totaled ¥683.1 billion, up 21% from the previous year, achieving an increase for two consecutive years. The figure represents the highest in six years, exceeding ¥657.1 billion in 1998. The percentage of exports to total production was 77.8%, or a 3.9% decrease from the year earlier. In terms of regional breakdown, exports to the East Asian region, including China and Taiwan, have remained strong, representing a 32.5% increase from the year-earlier level.

The imports in 2004 totaled ¥88.2 billion, showing a 66% increase on a year-on-year basis and achieving an increase for two consecutive years. The figure exceeded ¥85.6 billion in 2000, representing the highest in four years. The degree of dependence on imports (imports/[production – exports + imports]) exceeded the 30% level, reaching 31.2%, up 1.5% from the year-earlier level. The major countries of origin are the United States (doubled from the level of the previous year), followed by Germany and Switzerland. (The three countries account for more than 70% of the total imports.)

Diagram 2-1-4 Export and import trends

(Unit: billion yen, %)

	1997	1998	1999	2000	2001	2002	2003	2004
Exports	649.4 110	657.1 101	529.2 81	620.1 117	558.4 90	484.8 87	564.1 116	683.1 121
Percentage of exports	63.8	65.0	71.6	76.1	71.9	82.8	81.7	77.8
Imports	71.4 111	65.8 92	63.7 97	85.6 134	69.6 81	50.9 73	53.2 105	88.2 166
Degree of dependence on imports	16.3	15.7	23.3	34.9	24.2	33.6	29.7	31.2

Note: Percentage of exports = the volume of exports/the volume of production

Degree of dependence on imports = imports/(production – exports + imports)

Source: "2005 Machine Tools Statistics," Japan Machine Tool Builders' Association

2-1-2 Industry trends and challenges

(1) Profit and cost status

The Machine Tool Builders Business Conditions, a survey on 32 machine tool builders conducted by the Japan Machine Tool Builders' Association shows that the profitability of machine tool builders in 2003 substantially exceeded their 2002 performance in all of the indicators used, reflecting booming domestic and foreign orders (Diagram 2-1-5). As sales and sales administrative expenses were kept at a low level (3.9% increase against 2002), the operating profit in 2003 reached ¥45.9 billion, or 4.7 times more than 2002. The pretax profit enjoyed a substantial increase of 11.4 times more than 2002, including ¥6.7 billion in interest and discount expenses and ¥5.6 billion in foreign exchange loss.

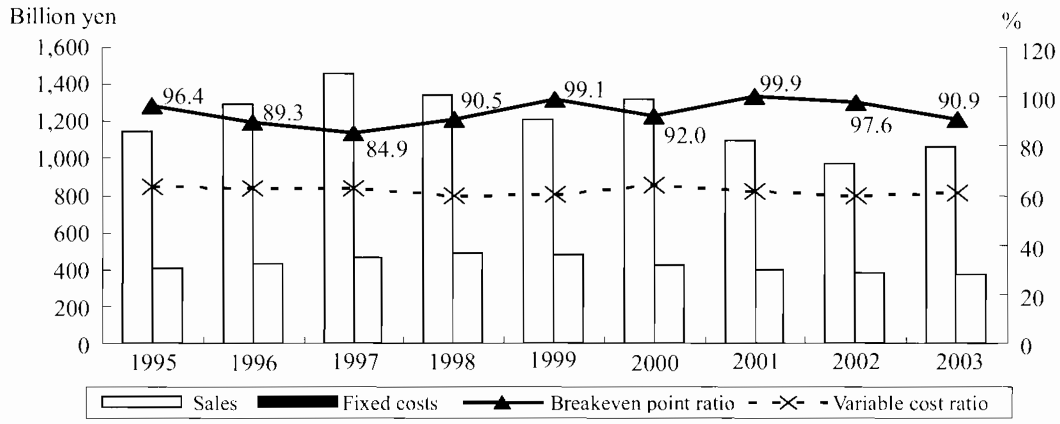
Diagram 2-1-5 Profitability trends

(Unit: billion yen, %)

	2001	2002	2003	y/y
Sales	1,092,025	969,294	1,058,918	109.2
Operating profit	988	9,733	45,983	472.4
Operating profit ratio	0.1	1.0	4.3	+3.3
Pretax profit	1,194	3,539	40,362	1140.5
Pretax profit ratio	0.1	0.4	3.8	+3.4
Current after-tax profit	△32,730	△18,546	16,297	—
Current after-tax profit ratio	△3.0	△1.9	1.5	+3.4

Source: "Machine Tool Builders' Business Conditions Survey 2003," Japan Machine Tool Builders' Association

Diagram 2-1-6 shows year-to-year sales, fixed costs, the ratio of variable costs, and the ratio of breakeven point from 1995 to 2003. The breakeven point ratio in 2003 was 90.9%, showing a 6.7% improvement against 2002. In recent years, the machine tool building industry has been making efforts to constantly cut labor cost and other fixed costs including auxiliary labor cost and expenses. 2003 saw a decrease of about 1.5% from the previous term. The ratio of variable costs was 60.9%, representing a 1.3% increase from the previous term. Presumably this reflects the increased costs of raw material and processing outsourcing necessitated by stepped-up production. Under these circumstances, the industry is required to address the challenge of how to cut back on not only fixed costs but also variable costs. In view of the looming pressure of increasing material prices in 2004, it will be a major challenge for the industry to lower the ratio of variable costs by increasing product prices and cutting costs even more.



Source: "Machine Tool Builders' Business Conditions Survey 2003," Japan Machine Tool Builders' Association

Diagram 2-1-6 Changes in the breakeven point ratio of machine tool builders

(2) Performance of six major companies

The performance (consolidated) of the six major machine tool builders as of March 2004 shows that the pretax profit ratio turned positive at all of the companies. Each company has been doing well thanks to strong equipment investment in the automobile industry and robust business in the digital home appliance industry. It is expected that the machine tool building industry will remain booming for some time in the future. However, it must be noted that there still exist unstable factors such as volatile crude oil and steel material prices. Moreover, unstable profitability has been and still is a typical attribute of the industry. It is, therefore, necessary for each company to build up a robust business structure by taking advantage of today's favorable macroeconomic conditions. There is a mountain of challenges to address: pushing with the "concentration and choice" strategy using the company's strengths; consolidating group companies and reinforcing partnership; enhancing the effectiveness of production systems; and developing strategic products, to name just a few. What counts in such a situation is each company's management capability.

Diagram 2-1-7 Transition of performance of six major machine tool builders

(Unit: billion yen)

	March 2001		March 2002		March 2003		March 2004	
	Sales	Ordinary profit & loss	Sales	Ordinary profit & loss	Sales	Ordinary profit & loss	Sales	Ordinary profit & loss
Toyoda Machine Works	189.3	5.8	188.5	3.0	201.3	5.6	216.2	6.9
Okuma Corp.	1,025	0.4	92.0	△3.2	80.2	△4.2	86.8	1.9
Mori Seiki	86.9	3.5	69.7	△3.0	63.8	△3.5	87.5	1.9
Makino Milling Machine	84.4	2.4	75.7	△0.5	65.8	△1.7	83.8	3.0
OKK	28.7	0.8	21.4	△0.5	18.2	△1.8	25.3	0.4
Tsugami Corp.	21.7	1.4	15.6	△0.2	16.3	△0.08	19.9	1.3

Source: Securities reports

(3) Recent industry trends: New sales and service approaches

In recent years, companies have been attaching more and more importance to total business strength, proposal development, and problem-solving skills in relation to selling and service, as well as high product functionality and competitive pricing, reflecting a shift of industry focus from technology to customer satisfaction. Customer orientation is the most important factor in corporate activity. However, it seems that there is a wide gap between customer orientation in practice and customer orientation in policy. Let us examine a number of cases of distinctive sales and service activities conducted by individual companies.

Okuma Corporation created a techno -marketing division in an effort to shift its focus from technology to customers. The division comprises a total of about 15 marketing and engineering people, who are assigned to visit the production engineering divisions of automobile manufacturers to discuss specifications and installation schedules of equipment.

Some companies have increased the number of marketing personnel and opened new branches in China and Southeast Asian countries. Others have expanded their manufacturing facilities. Generally, machine tool builders are making efforts to expand their customer bases through well-coordinated efforts of both production and marketing in concert with automobile manufacturers' beefed-up activity.

It seems that the development of high value-added products including compound machines e.g. five-axis compound machines, shows a possible direction in which machine tool builders can follow in their future product development efforts. At the same time, it is necessary to beef up marketing efforts to include proposing new uses of equipment to users in addition to meeting their needs. In this light, DMG

Nippon's activities are being conducted to disseminate its five-axis machining center. To help its customers deepen their understanding of the five-axis machining center, the company conducts seminars for its sales agents in the Chubu district. In these seminars, the company answers each and every question from customers in detail, such as: 1) Isn't the machine too expensive? 2) Isn't it difficult to make full use of the machine? 3) Aren't its uses too limited? 4) Isn't the necessary software too expensive? In addition to holding seminars, the company also arranges a tour of metal mold makers that use its five-axis machining center. It is now necessary for Japanese manufacturers to take a new approach to developing new markets.

In marketing, it is important to make a clear explanation to the customer to help them get a solid understanding of the product offered. In this respect, Nakamura-Tome Precision Industry's sales expansion strategy is very interesting. To help increase sales, the company has a PC-based sales support system geared to the company's combined processing machine, their flagship product. The system displays on the screen how the machine works and the customer can see it. Animations are used as well to show the machine's minute movements that are difficult to perceive by means of video images. While delivering such functions as cutting and drilling, compound machines are equipped with a tool rest as well. Generally, compound machines have been evolving as much more sophisticated multifunction systems. This calls for manufacturers to have marketing support tools to help salespersons give their customers an easy-to-understand explanation of the machine's performance and functionality. Nakamura-Tome Precision Industry's sales support system is one solution. The system supports five languages, namely, Japanese, English, Chinese, Italian, and German, in order to be capable for use in overseas marketing. At present, the system is used by about 60 people including engineers. To allow those who are less experienced in marketing to use the system, the machine explanation is given in a sequential manner using short sentences. The data obtained from the system can be distributed to customers. The company reviews, and improves if necessary, the data and the system every three months on average.

Yamazaki Mazak Corp. has technical centers in Europe and the United States to teach in-house service personnel and customer operators how to operate Mazak compound machines, which are getting increasingly complex and sophisticated. The prevailing shortage of skilled operators is a headache for machine tool builders and user companies as well. In this situation, it would help conduct positive marketing and service activities for increased sales if both a manufacturer and its customers get familiarized with the operations of the combined processing machine offered. In October 2005, Yamazaki Mazak opened a technical center in its National Technology Center, the company's engineering support hub, in Kentucky, USA. The company has plans to open similar centers in the United Kingdom, Germany, and Italy. The details, such as the number of lecturers assigned and the training fee, are now in the stage of finalization. It is likely that these centers will offer courses that are in conformity with the ones offered in Japan. According to the company, each course will accept two to three trainees per class and be made capable of addressing user problems flexibly.

Yamazaki Mazak uses a new approach to customer support as well. That is, the company is deploying a maintenance service, dubbed Maza Care, using cellphone mail on a global scale. The service works this way: A cellular phone is built in the user's machine tool. If the machine tool develops an abnormal condition, the cellular phone immediately detects it and informs Yamazaki Mazak's online support center of the problem by mail. Upon receiving the mail, the support center person in charge connects the center to the customer machine to collect the relevant data. If the user seems to be able to fix the problem, the center person sends the necessary problem-solving procedure. In the case of a major trouble, a maintenance serviceperson will be promptly dispatched to the site carrying the necessary tools with him/her. Most of the time, services of this kind have traditionally been provided free of charge. However, Yamazaki Mazak provides its services on a fee basis. The company recognizes the services as another possibility for business opportunities.

2-1-3 Future prospects

It is expected that in the domestic market, orders related to automobiles and IT will continue growing for some time to come. However, excessive dependence on automobile- and IT-related sales could lead to unstable profitability. There are also volatile factors such as fluctuating crude oil and steel material prices. The challenge should, therefore, be to build up a robust corporate structure that is resilient enough to handle these unstable factors. To this end, it is necessary to make efforts to cut expenses and at the same time develop high value-added products. In overseas markets, sales have been solid in the United States and Europe as well as in East Asia. Overall, this favorable trend is expected to continue for some time in the future. For each company to achieve sales growth, the decisive factor will be how well it can build sales and support setups in overseas markets. A lead in management capability would result in a lead in corporate performance.

2-2 Industrial Robots

2-2-1 Supply and demand trends

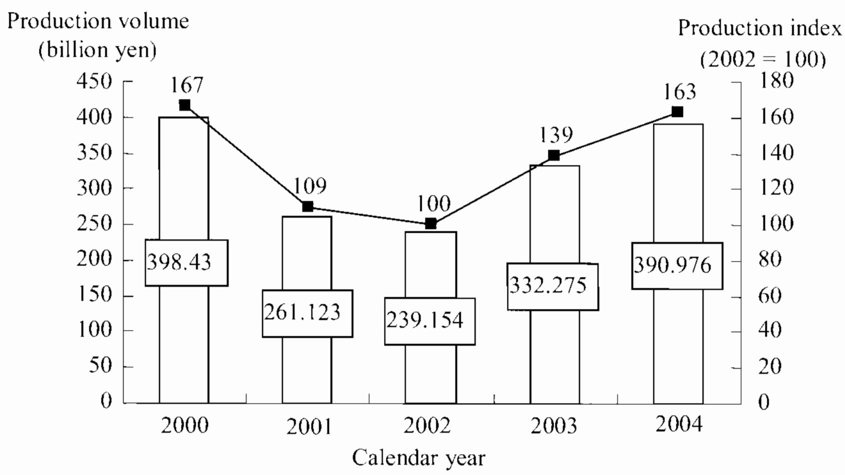
(1) Overview

The production volume of industrial robots in 2004 was ¥391.0 billion, up 17.3% from the previous year, reflecting a steady expansion of the market for playback robots and numerically controlled robots. The production of playback robots and numerically controlled robots increased 20.6% and 15.6% from the previous year, respectively. That of intelligent robots sharply increased, up 52.8% from the previous year, though the production itself was small. The production of sequence robots, however, decreased. In terms of breakdown by use, the production of vertical articulated robots and electronic component mounters expanded successfully.

Exports of industrial robots were ¥84.3 billion, a dramatic 39.3% increase from the previous year, reflecting increased exports to China, South Korea, and Taiwan. Imports of industrial robots went down 17.9%.

(2) Production

The production volume of industrial robots in 2004 was ¥391.0 billion, up ¥58.7 billion from the previous year. The production of industrial vehicles has increased each year since 2002. It is evident that the industrial robot business is no longer stagnant (Diagram 2-2-1).



Source: "Annual Report of Machine Statistics," Ministry of Economy, Trade, and Industry

Diagram 2-2-1 Production volume of industrial robots

Generally, there are two classification methods for industrial robots. One is to classify them by intelligence. According to this method, industrial robots can be classified into sequence robots, playback robots, numerically controlled robots, and intelligent robots. (For the definition of each category, see the relevant JIS standards.) The Ministry of Economy, Trade, and Industry's Annual Report of Machine Statistics shows the trends of industrial robot production using this classification. Diagram 2-2-2 shows the production status of industrial robots in each category of this classification. As shown in the diagram, the production of sequence robots alone decreased by 20.8% from the previous year. Sequence robots are industrial robots of the oldest generation. For this reason, robots of this type accounted for a small 5% of the total production of industrial robots in 2004. On the other hand, the production of intelligent robots increased 52.8% from the previous year. Intelligent robots are the latest generation of industrial robots. Their percentage share of the 2004 total industrial robot production was as low as 2.9%. Playback robots and numerically controlled robots, which are the main players of today's industrial robots, showed steady increases of 20.6% and 15.6% from the previous year, respectively. The production trend data reveal that the composition of industrial robots has been changing, albeit slowly.

In contrast, the Japan Robot Association classifies robots by use and analyzes robot production trends on the basis of this classification. (The Japan Robot Association's survey on the corporate uses of manipulators and robots and the Ministry of Economy, Trade, and Industry's Annual Report of Machine Statistics differ with respect to the coverage and robot definitions. Therefore, their data are not necessarily identical.)

Diagram 2-2-2 Production volume of industrial robots

(Calendar year; billion yen)

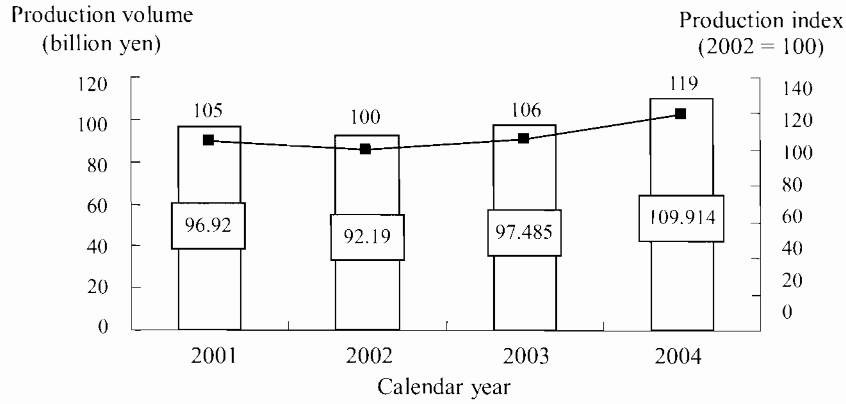
	2000	2001	2002	2003	2004	Growth rate (2004/2003)	Ratio to total production (2004)
Total of industrial robots	398.43	261.223	239.154	332.275	390.976	17.7%	100%
Sequence robots	18.76	15.842	13.518	24.464	19.365	▲20.8%	5%
Playback robots	96.413	95.834	92.016	122.6	147.851	20.6%	3,708%
Numerically controlled robots	238.311	114.082	105.231	143.189	165.574	15.6%	42.3%
Intelligent robots	12.26	7.505	6.828	7.503	11.462	52.8%	2.9%
Parts and peripheral devices	32.686	27.96	21.561	34.519	46.724	35.4%	12.0%

Source: Same as Diagram 2-2-1

In terms of classification by use, vertical articulated robots and electronic component mounters account for the greater part of the production of industrial robots. Vertical articulated robots accounted for 24.6% of the production of industrial robots (excluding peripheral parts) in 2004. Electronic component mounters accounted for 37.2%. Diagrams 2-2-3 and 2-2-4 show the recent trends of production of vertical articulated robots and electronic component mounters. The production of robots of both types hit the bottom in 2002 and then picked up. The volume of production in 2004 was up 66% of the 2002 level for both industrial robots and electronic component mounters.

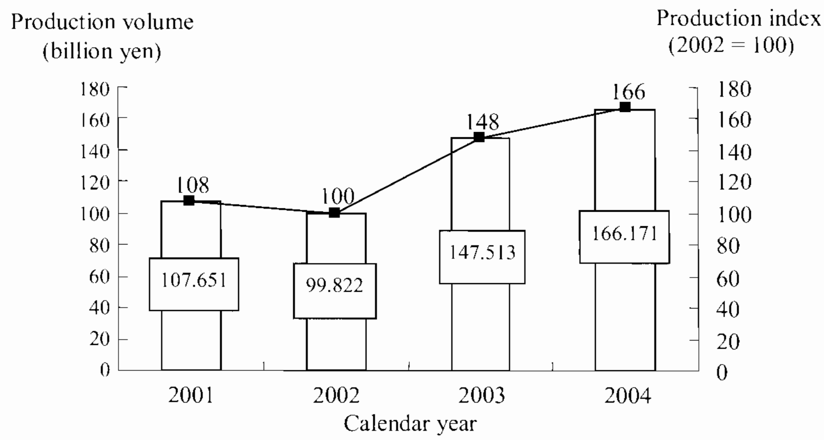
(3) Shipments

Let us take a look at domestic shipments of vertical articulated robots and electronic component mounters. Shipments of vertical articulated robots in 2004 showed a small 5% increase from 2002. This figure is somewhat lower than the percentage increase in the production volume. Domestic shipments of electronic component mounters in 2004 were up a substantial 78% from the 2002 level. This parallels the production increase of 66% during the same period.



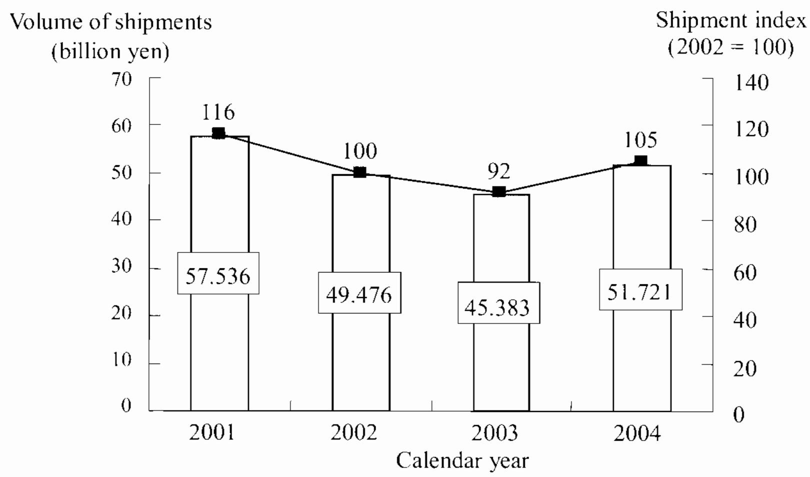
Source: Japan Robot Association

Diagram 2-2-3 Production of vertical articulated robots



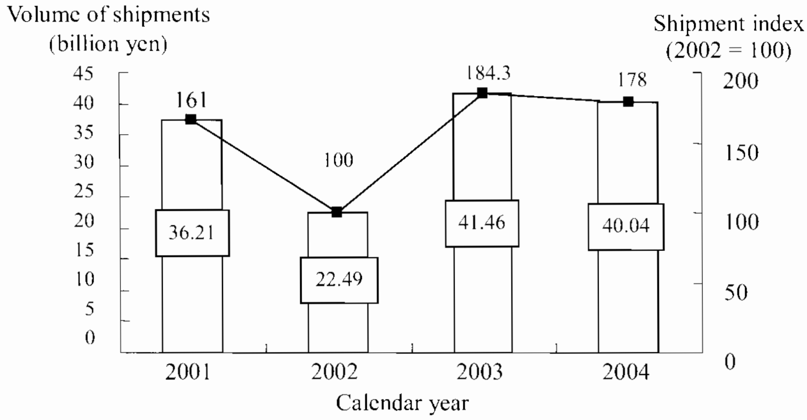
Source: Same as the above

Diagram 2-2-4 Production of electronic component mounters



Source: Same as above

Diagram 2-2-5 Domestic shipments of vertical articulated robots



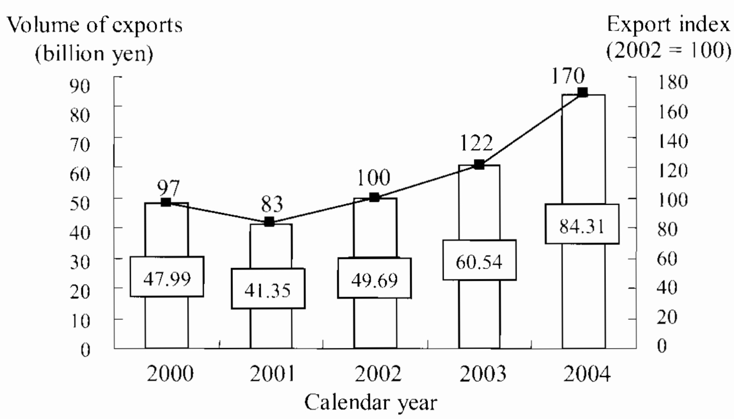
Source: Japan Robot Association

Diagram 2-2-6 Shipments of electronic component mounters

(4) Exports and imports

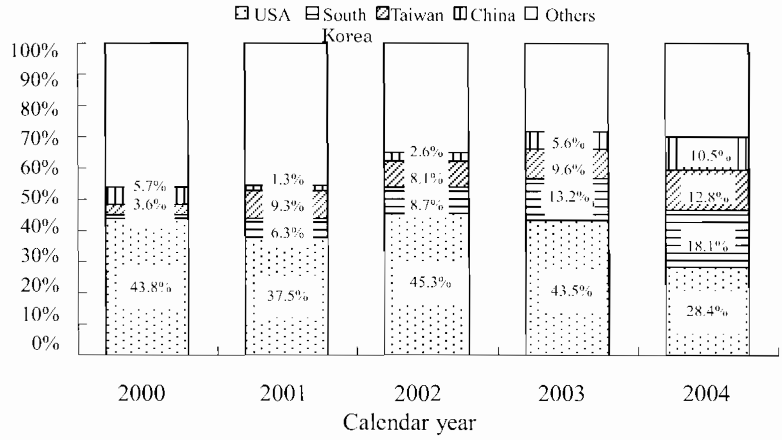
In 2004, the exports of industrial robots reached ¥84.3 billion, representing a substantial 39.3% increase from 2003. Since 2001, exports of industrial robots have been continuously increasing. As a result, 2003 shipments were more than double the level of those in 2001 (Diagram 2-2-7).

Diagram 2-2-8 is the graph showing industrial robot exports to the United States, South Korea, and China as a percentage of total industrial robot exports. In 2000, exports to the United States accounted for 43.8% of Japan's total industrial robot exports. The figure reduced to 28.4% in 2004. In 2000, exports to South Korea, Taiwan, and China as a percentage of total exports were 1%, 3.6%, and 5.7%, respectively. These percentage figures increased dramatically to 18.1%, 12.8%, and 10.5%, respectively, in 2004. The combined share of these three countries amounts to 41.4%, exceeding the share of the United States in 2004. This shows that the United States has switched positions with East Asia (South Korea, China, and Taiwan) when it comes to Japan's exports of industrial robots. Imports of industrial robots were ¥2.2 billion, down 17.9% from the previous year. Since 2001, imports of industrial robots have experienced a declining trend.



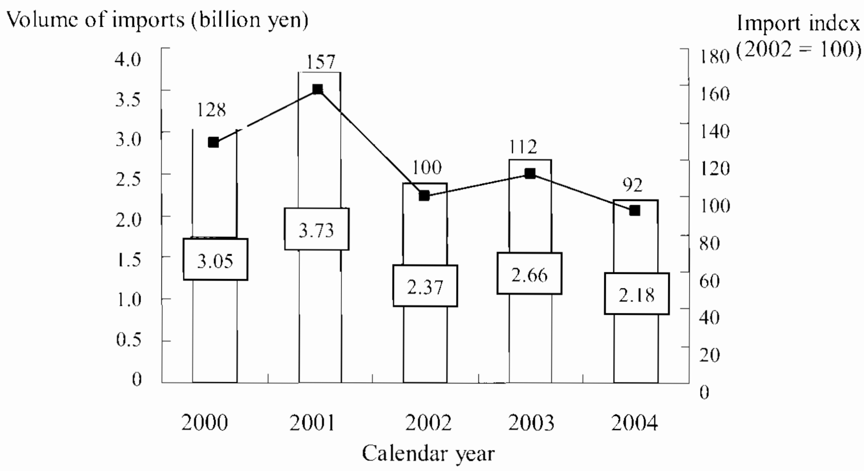
Source: Trade Statistics, Ministry of Finance

Diagram 2-2-7 Exports of industrial robots



Source: Same as Diagram 2-2-7

Diagram 2-2-8 Exports of industrial robots to major countries



Source: Same as Diagram 2-2-7

Diagram 2-2-9 Imports of industrial robots

2-2-2 Business performance and industry trends

(1) Business performance

Diagram 2-2-10 shows the business performance of some major companies in the industrial robot industry. This article focuses on the business performance of major companies in the markets for vertical articulated robots, electronic component mounters, and peripheral parts for robots. Panasonic Factory Solutions Co. Ltd. (PFSC) and Matsushita Welding Systems Company are subsidiaries of Matsushita Electric Industrial. PFSC mainly manufactures electronic component mounters. Matsushita Welding Systems mainly manufactures vertical articulated robots.

Each company did better in 2004 than it did in 2003 in terms of both sales and operating profit. Let us begin our review with vertical articulated robots. In 2004, demand was strong for arc welding robots, spot welding robots, and painting robots in the automobile-related industries in Japan, the United States, Europe, and Asia. Yasukawa Electric Corp. reported a 25.6% increase in sales and 38.3% increase in operating profit from the previous year. Also, FANUC Ltd. reported a 13.1% increase in sales from the previous year. In Kawasaki Heavy Industries, industrial robots, together with motorcycles and others, are classified into the category of general-purpose machine business. It is, therefore, impossible to obtain accurate data about sales and operating profit specifically from industrial robots. The company's general-purpose machine business as a whole enjoyed increased sales and operating profit. In particular, the operating profit increased to as high as 130.4% of the previous year. In addition, the company's financial report states that 2004 saw an increase in sales from industrial robots as well. It can therefore be said that Kawasaki Heavy Industries' industrial robot business went well in 2004.

Diagram 2-2-10 Consolidated statements of major manufacturers of industrial robots

(Consolidated results, Unit: billion yen, Digits less than 100 million were rounded.)

	2003		2004		Growth rate (2004/2003)	
	Sales	Operating profit	Sales	Operating profit	Sales	Operating profit
Matsushita Electric Industrial						
PFSC Matsushita Welding Systems Others	948.7	14.7	1,027.1	38.3	8.3%	160.5%
Vertical articulated robots						
Yasukawa Electric Robotics Automation	85.1	5.3	107.8	7.3	26.6%	38.3%
FANUC Robot division (Annual report)	136.7	89.9	154.6	124.7	13.1%	38.7%
Kawasaki Heavy Industries General-purpose machine business	322.3	7.2	343.5	16.7	6.6%	130.4%
Electronic component mounters						
Fuji Machine Mfg. Electronic component assembly business	38.9	1.8	47.0	3.6	20.6%	95.8%
Yamaha Motor Others	92.8	10.1	156.0	11.5	68.1%	13.8%
Peripheral parts for robots						
Komatsu Engineering Profit-and-loss statement	11.0	0.5	13.1	0.9	19.6%	80.0%
Toyoda Machine Works Machine tool business	73.7	0.5	89.1	6.5	20.9%	1200%

Note 1: The name under each company name is the name of the company's relevant business unit.

Note 2: Sales include inter-segment sales.

Note 3: FANUC data was taken from its annual report and Komatsu Engineering data was obtained from its profit-and-loss statement. FANUC's operating profit was represented by its pretax profit.

Source: Each company's annual securities reports, flash reports, and profit-and-loss statements.

In the area of electronic component mounters, let us focus on Fuji Machine Mfg. and Yamaha Motor. 2004 saw a recovery of the demand for digital appliances such as PCs and cellular phones. Reflecting this trend, the demand for electronic component mounters has been expanding, particularly among Chinese and Taiwanese ODMs and EMS's. Against this background, Fuji Machine Mfg. increased sales and operating profit from its electronic parts assembly business by 20.6% and 95.8%, respectively, from the previous year. Yamaha Motor's operating profit from its industrial robot business was consolidated with profit from other lines of business. Since the consolidated profit was up 13.8% from the previous year, it is presumed that operating profit from industrial robots was on the increase.

In the arca of peripheral parts for robots, let us focus on Komatsu Engineering and Toyoda Machine Works. Komatsu Engineering experienced a 19.6% increase in sales and a substantial 60.5% increase in operating profit from the previous year. Toyoda Machine Works recorded a 20.9% increase in sales and a massive 1,200% increase in operating profit from the previous year.

In 2004, each company in the industrial robot industry enjoyed satisfactory operating results.

(2) Innovation and management environment

Let us now take a look at innovation and research and development efforts in the industrial robot industry. Yasukawa Electric has been developing welding robots for the automobile industry, orthogonal double-arm robots for large glass substrate used in the liquid-crystal industry, and semiconductor wafer conveying robots for the semiconductor industry. FANUC focuses its development efforts on intelligent robots and sophisticated robot programming functions. In addition, thc company is expanding its line of material handling robots. Fuji Machine Mfg. is making efforts to develop an clectronic component mounter capable of satisfying both productivity and high-mix low-volume production. Yamaha Motor aims at dcvcloping a medium-sized electronic component mountcrs (medium-sized multifunctional mounters) on thc basis of its own small engine technology.

Diagram 2-2-11 R&D efforts of individual companies

Company name	Description of development effort
Yasukawa Electric	Robots for automobile, liquid crystal, and semiconductor markets
FANUC	Automatic robot programming functions
Fuji Machine Mfg.	Automatic equipment and systcms
Yamaha Motor	Industrial robots based on small cnginc technology

Source: Annual securities reports

Now let us turn to the business management environment. The business of industrial robots bears heavily on the government's policy. For example, the Ministry of Economy, Trade, and Industry plans to promote the business of next-generation robots by positioning it as part of the ministry's New Industry Promotion Strategy. The ministry made technology maps for industrial robots and next-generation robots as well.

Many local areas have initiatives to promote the industrial robot industry. In February 2003, the Ogaki area, Gifu prefecture, was designated as a state-of-the-art robotics medication cluster by the Ministry of Education, Culture, Sports, Science and Technology. In November 2003, Fukuoka city and Kita Kyushu city were designated as special areas for robot dcvclopment and demonstration experiment. These policies focus on the so-called next-generation robots. According to the definition given in the 2005 interim report of the Robot Policy Study Group of the Ministry of Economy, Trade, and Industry, a next-generation robot is either a next-generation industrial robot capable of replacing, or cooperating with, humans in a high-mix variable-volume production shop floor, or a service robot capable of offering services related to various uses, such as cleaning, security service, welfare, life support, and amusement, through coexistence with humans. Therefore, traditional vertical articulated robots and electronic component mounters are excluded from this category. However, next-generation robots will be built on the existing technology of industrial robots. In addition, existing industrial robot manufacturers are embarking on the development of next-generation robots. For these reasons, the above-mentioned policies would have a big impact on the industrial robot industry.

(3) Future prospects and challenges

People of the baby-boomer generation are retiring in stages. This is a major factor that must be considered in relation to the future of industrial robots. The idea is that industrial robots and next-generation robots could fill the vacancy to be generated by the mass retirement of people in the baby-boomer generation. Robots of this kind would be used not only as industry-derived labor power but also for labor for home services and other nonindustrial areas. For example, A Survey of Technological Strategy for Creating Robotic Society for the 21st Century (Japan Robot Association, 2001) and Report on the Next -Generation Robot Vision (Ministry of Economy, Trade, and Industry, 2004) forecast future demand for industrial robots and next-generation robots as summarized below:

Diagram 2-2-12 Forecast of future demand for robots (2010-2025)

Unit: billion yen

	Japan Robot Association		Next-Generation Robot Vision Committee
Area	201	202.5	202.5
Manufacturing industry	853	1,415	-
Biotechnology industry	90	360	-
Public sector	290	990	549
Medical and welfare areas	260	1,100	931
Living	1,100	4,100	3,306
Application software	-	-	2,245
Education industry	-	-	42
Used goods selling	-	-	96
Total	2,593	8167.5	7,169

Source: "A Survey of Technological Strategy for Creating Robotic Society for the 21st Century," Japan Robot Association, 2001, and "Report on the Next-Generation Robot Vision," Ministry of Economy, Trade, and Industry, 2004

The diagram suggests that the market for robots will grow under the influence of the coming mass retirement of the baby-boomer generation and the accelerating decrease in number of children. However, this forecast assumes that it would be possible to use industrial robots in more complex processes than those at present and that it would be possible to use next-generation robots in nonindustrial areas such as houses. In view of this, the challenge to each industrial robot manufacturer is to proactively focus their R&D and innovation efforts in relation to next-generation, as well as industrial robot.

2-3 Electronic Device Manufacturing Equipment

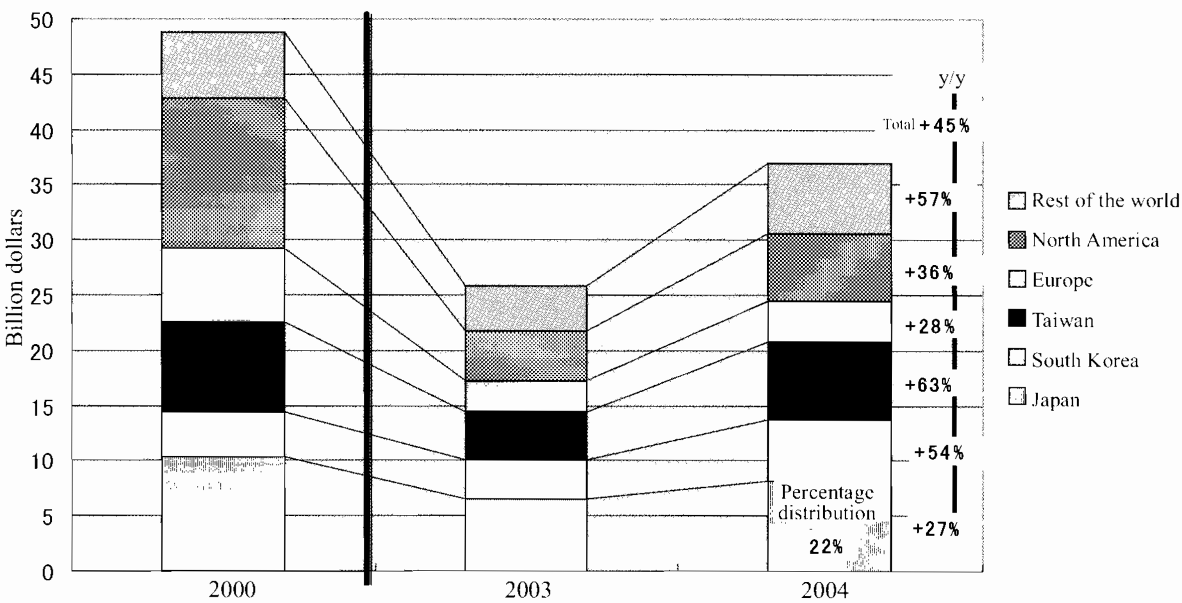
2-3-1 Supply and demand trends

(1) Overview

Electronic device manufacturing equipment includes microfabrication and testing equipment to make semiconductors and flat panel displays (FPD), which are the two main items. At present, the mainstream products are semiconductor manufacturing equipment. (FPD manufacturing equipment will be discussed later.)

In FY 2004 (April 2004 to March 2005), the world market for semiconductor manufacturing equipment reached $37.3 billion (about ¥4 trillion), up 45% from the previous year. While the market showed a mild upswing in 2003, it achieved a much rapider recovery in 2004 (Diagram 2-3-1).

In Asia, the Taiwanese, Chinese, South Korean, and other markets increased by more than 50%, but the growth of the Japanese market was limited to a moderate 27% increase (dollar basis). This means that in 2003 the Japanese market achieved the world's fastest growth and the rest of the world market caught up with Japan rapidly in 2004. The North American and European markets achieved a solid recovery as well. It must be noted here that Asian countries other than Japan have become central players in this hi-tech equipment market, too, accounting for 51% of the world market including the United States, Europe, and Japan. It is expected that the Asian market will expand more and that, with the exception of very special niche fields, it will be impossible to counter this trend.



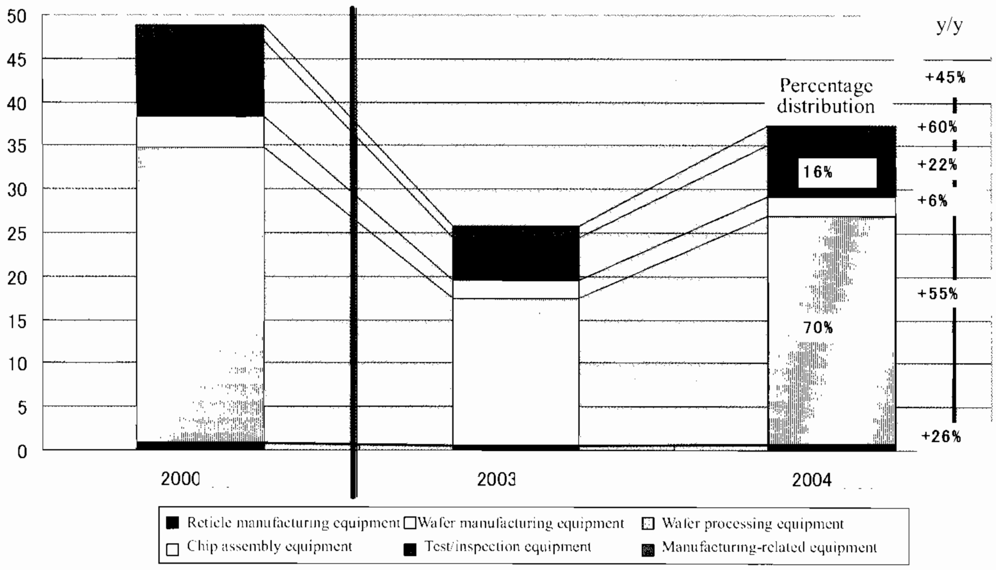
Source: Joint statistics by Semiconductor Equipment and Materials International (SEMI) and Semiconductor Equipment Association of Japan (SEAJ)

Diagram 2-3-1 World's regional markets for semiconductor manufacturing equipment

Let us have a look at today's market trends by type of equipment. Sales of front-end wafer processing equipment, which forms semiconductor IC devices and circuits on a silicone wafer, were $26.2 billion (70% of total sales), up 55% from the year earlier. Other manufacturing-related equipment including conveyers achieved a high growth, though the volume of sales was small (Diagram 2-3-2).

The growth of sales of post-process chip assembly equipment, which cuts out chips from completed ICs (dies) and mounts them on a package, was limited to a 6% increase from the year-earlier level. Sales of test/inspection equipment used at various levels of the process were up 22% from the previous year, chalking up $5.9 billion (16% of total sales). There exists equipment to make wafers but its sales are small. Reticle manufacturing equipment will be discussed later.

Sales of FPD panel manufacturing equipment were also satisfactory (to be discussed later).



Source: Same as Diagram 2-3-1

Diagram 2-3-2 World sales of semiconductor manufacturing equipment by type

Diagram 2-3-3 Order trends of Japanese semiconductor manufacturing equipment

(Unit: million yen)

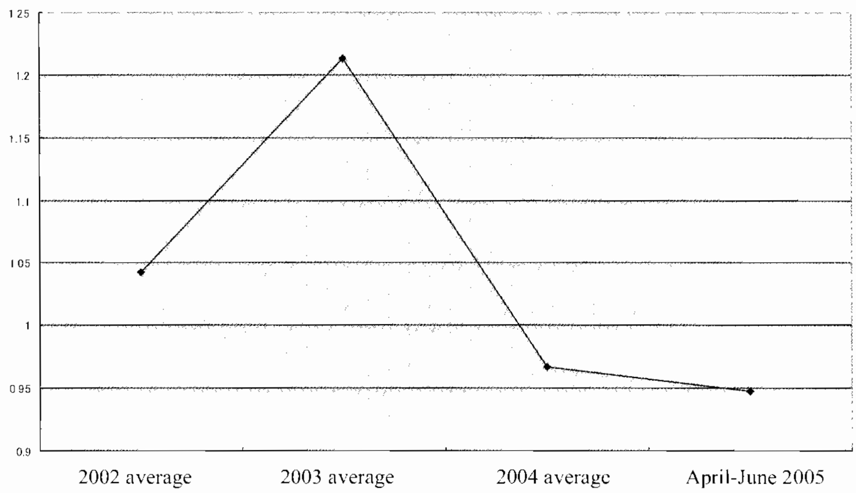
	FY2003	FY2004	Increase/ decrease from previous year	April-June 2004	April-June 2005	Increase/ decrease from same period previous year
Total for the following items	1,415,409	1,554,253	110%	472,846	320,305	68%
Reticle manufacturing equipment	22,733	25,526	112%	5,671	4,154	73%
Wafer manufacturing equipment	11,182	13,026	116%	4,871	3,949	81%
Wafer processing equipment	917,356	1,028,049	112%	288,576	196,306	68%
Chip assembly equipment	99,605	95,790	96%	39,841	20,423	51%
Test/inspection equipment	308,187	326,348	106%	117,386	83,948	72%
Manufacturing-related equipment	56,346	65,514	116%	16,501	11,522	70%

Source: Semiconductor Equipment Association of Japan (SEAJ)

(2) Orders

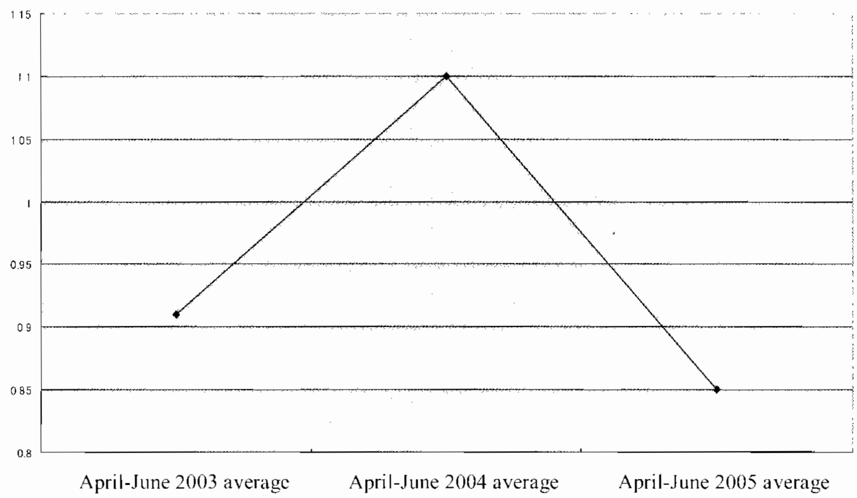
In 2004, orders of Japanese semiconductor manufacturing equipment increased in all the categories except chip assembly equipment. Total orders were up 10% from the year earlier as well. The rate of recovery in 2003 was very high although recovery in 2004 decelerated (Diagram 2-3-3). In particular, order volume slowed down further in the latter half of 2004. In the first quarter of 2005, order volume was down more than 30% from the same period of the previous year (Diagram 2-3-3). This trend of slowing down can be forecast by using the BB (book-to-bill) ratio (Diagram 2-3-4). As early as 2004, the ratio was less than 1 and dipped further in the first quarter of 2005. It is therefore expected that this trend of slowing down will continue for some time to come.

Order volume of equipment made in North America slowed down as well—this is a global trend. The BB ratio of North American equipment was above 1 in the first quarter of 2004, but fell below 1 to 0.85, a level lower than that of Japanese equipment (about 0.95) in the first quarter of 2005 (Diagram 2-3-5).



Source: Semiconductor Equipment Association of Japan (SEAJ)

Diagram 2-3-4 BB (book-to-bill) ratio of Japanese equipment



Source: Same as above

Diagram 2-3-5 BB (book-to-bill) ratio of North American equipment

(3) Sales

In 2004, sales of Japanese semiconductor manufacturing equipment were slightly below ¥1,600 billion, up 37% from the year-earlier level, achieving a substantial recovery as in the previous year (Diagram 2-3-6). If the yen appreciation is taken into consideration, the 37% increase on a yen basis translates into about 41% increase on a dollar basis. This was slightly below the 45% growth (dollar basis) of the world market for semiconductor manufacturing equipment.

The world market share of Japanese equipment recovered to 41% in 2003 but was limited to 40% in 2004. While the world market share of Japanese semiconductor manufacturers has been tapering, Japanese semiconductor manufacturing equipment makers are enjoying the lion's share with a favorable competitive edge. The challenge lies in their future (to be discussed later).

Sales of Japanese processing equipment were about ¥1,036 billion, up 41% from the year-earlier level. In particular, "other processing equipment" fared well, up 54% from the previous year. This category includes wafer-level test evaluation equipment (different from testers and other test/inspection equipment), resist processing equipment (coaters, developers), cleaners, dryers, and heat treatment equipment. Sales of testers also showed a robust recovery, 35 to 40% increase from the year earlier (Diagram 2-3-6).

Though recovery was relatively slow with chip assembly equipment, the sales reached the ¥100 billion level, up 16% from the year-earlier level. Sales of wafer manufacturing equipment showed a slight increase, though were small in terms of amount. Sales of reticle manufacturing equipment were down about 20%.

Though slow in 2004, sales of wafer and reticle manufacturing equipments were both substantially above the year 2000 levels. In contrast, shipments of processing equipment, which picked up in 2003 and 2004, are still below the level of the year 2000 (see the diagram below)

Diagram 2-3-6 Sales of Japanese semiconductor manufacturing equipment

(Unit: million yen)

	2000	2003	2004	y/y	Percentage distribution 2004
Total for the following items	1,804,504	1,167,134	1,598,140	137%	100%
Reticle manufacturing equipment	18,286	26,331	20,761	79%	1%
Wafer manufacturing equipment	9,966	11,189	11,827	106%	1%
Wafer processing equipment	1,172,746	736,162	1,035,836	141%	65%
Exposure/lithography equipment	329,256	183,370	230,088	125%	14%
Etcher	173,935	103,287	148,141	143%	9%
Thin film deposition equipment	114,352	100,996	120,634	119%	8%
Other processing equipment	555,203	348,509	536,973	154%	34%
Chip assembly equipment	167,677	86,306	100,413	116%	6%
Test/inspection equipment	374,953	267,462	361,039	135%	23%
Tester	219,061	178,121	249,530	140%	16%
Other test/inspection equipment	155,892	89,341	111,509	125%	7%
Manufacturing-related equipment	60,876	39,684	68,264	172%	4%

Source: Semiconductor Equipment Association of Japan (SEAJ)

Sales of Japanese FPD (liquid-crystal [LCD] and organic EL) panel manufacturing equipment chalked up more than ¥560 billion, up 57% from the previous year, marking a continuation of dramatic growth (Diagram 2-3-7).

In this field, the leading player was LCD panel equipment—pattern formation processing equipment in particular. Organic EL equipment remains a future possibility. Pattern formation processing equipment for LCD panels, like equipment for semiconductors, comprises exposure equipment, etchers, and thin-film deposition (CVD) equipment. Pattern formation processing equipment for LCD panels has been mostly developed on the basis of semiconductor manufacturing technology. It is expected that future development will continue to evolve from semiconductor manufacturing equipment.

Diagram 2-3-7 Sales of Japanese FPD manufacturing equipment

(Unit: million yen)

	2000	2003	2004	y/y
Total for the following items	274,627	357,462	561,428	157%
LCD panel design equipment	-	-	-	-
Reticle manufacturing equipment	100	239	156	65%
Glass substrate manufacturing equipment	3,197	2,899	4,705	162%
Pattern formation processing equipment	224,064	244,872	417,735	171%
Color filter manufacturing equipment	4,399	53,410	64,704	121%
Panel processing equipment	22,382	24,538	29,463	120%
Test/inspection equipment	10,843	5,736	9,326	163%
LCD panel manufacturing-related equipment	9,642	17,165	31,493	183%
Organic EL manufacturing equipment	-	8,603	3,846	45%

Source: Semiconductor Equipment Association of Japan (SEAJ)

(4) Exports and imports

In 2004, exports of Japanese semiconductor manufacturing equipment, or more precisely, exports to overseas markets by Japanese semiconductor equipment manufacturers*, were about ¥1,017 billion, up 55% from the previous year. With this, 2004 became another year of rapid recovery, the result still remained at the level of the year 2000 (Diagram 2-3-8).

Imports, or more precisely, shipments to Japan by foreign equipment manufacturers, were up 38% from the year-earlier level, reaching about ¥210 billion.

When it comes to trade balance between the exports and the imports of semiconductor manufacturing equipment, the exports are definitely larger than the imports, resulting in a continuation of an overwhelming export surplus.

Exports increased fairly rapidly. This was because in 2004 the growth rate of the Japanese market for semiconductor manufacturing equipment slowed down and at the same time the yen appreciated by 3 to 5%, resulting in a substantially reduced rate of domestic demand expansion (less than 24% on a yen basis), compared to the previous year.

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* Most electronic device manufacturing equipment is industrial precision instruments requiring delicate assembling and fine-tuning. They must undergo assembly and inspection at least once in Japan before shipment. The volume of overseas production is therefore miniscule. Most of the time, overseas shipments are done as exports. Much the same goes for North American equipment. It is manufactured in North America and then exported.

The high increase in the imports gives some misgivings. Specifically, exposure equipment is a possible problem. No misgivings are felt with testers. The imports of testers showed the fastest growth. Traditionally, exports of exposure equipment and testers have overwhelmed imports, which have been very small. But exports of exposure equipment remained below the level of the year 2000 while tester exports exceeded the level of that year by a large margin. The problem is that exports have been slow to increase while imports have been expanding rapidly. (This will be discussed later.) Imports of etchers increased at a high pace but remained at a very low level compared with the year 2000. This can be interpreted as a limited rebound of imports.

Diagram 2-3-8 Exports and imports of Japanese semiconductor manufacturing equipment

Exports to overseas markets by Japanese semiconductor equipment manufacturers (≒ exports)

(Unit: million yen)

	2000	2003	2004	y/y
Total for the following items	1,081,636	656,875	1,017,154	155%
Design equipment	-	-		-
Reticle manufacturing equipment	10,961	16,265	11,824	73%
Wafer manufacturing equipment	1,327	925	683	74%
Wafer processing equipment	740,575	409,363	664,930	162%
Exposure/lithography equipment	215,390	92,863	133,585	144%
Etcher	112,389	64,357	104,151	162%
Thin film deposition equipment	60,753	52,369	71,167	136%
Other processing equipment	352,043	199,774	356,007	178%
Chip assembly equipment	89,566	53,492	65,346	122%
Test/inspection equipment	226,999	167,279	255,050	152%
Tester	123,287	110,926	179,273	162%
Other test/inspection equipment	103,712	56,353	75,777	134%
Manufacturing-related equipment	12,208	9,551	19,321	202%

Imports to Japan by foreign semiconductor equipment manufacturers (≒ imports) (Unit: million yen)

	2000	2003	2004	y/y
Total for the following items	292,425	153,172	210,831	138%
Design equipment	2,738	1,484	1,696	114%
Reticle manufacturing equipment	4,553	10,805	7,517	70%
Wafer manufacturing equipment	1,936	3,133	3,497	112%
Wafer processing equipment	267,272	128,332	176,873	138%
Exposure/lithography equipment	1,638	509	1,054	207%
Etcher	41,640	7,744	14,120	182%
Thin film deposition equipment	105,617	55,221	66,237	120%
Other processing equipment	118,377	64,858	95,462	147%
Chip assembly equipment	1,324	224	274	122%
Test/inspection equipment	14,540	9,194	20,974	228%
Tester	12,871	7,631	19,078	250%
Other test/inspection equipment	1,669	1,563	1,896	121%
Manufacturing-related equipment	62	0	0	-

Source: Semiconductor Equipment Association of Japan (SEAJ)

2-3-2 Business conditions and industry trends

(1) Business conditions

When it comes to corporate rankings in terms of sales, Allied Materials (AMAT) in the United States is the runaway leader, followed by Tokyo Electron. A few Japanese companies are included in the top ten companies. ASML Holding N.V. (ASML), a Dutch company, is the only European company included in the top ten. The rest are American and Japanese companies. A number of Asian start-up companies with interesting technologies of their own have come to emerge. However, most of their product lines are still limited to replacement parts (Diagram 2-3-9).

Advantest (testers) and Hitachi High Technologies (processing equipment) have advanced in ranking in terms of semiconductor manufacturing equipment sales. On the other hand, Nikon and Canon have been gradually lowering in the field of exposure equipment, which once was called Japan's monopoly. In contrast, the Dutch exposure equipment manufacturer ASML, which was formerly just a company ranking below tenth, is now the world's largest exposure equipment manufacturer. Canon and others reported more sales than those shown in the diagram below, because they included sales from exposure equipment for LCD panels. If a manufacturer expands its lines of business horizontally while maintaining its core business of semiconductor manufacturing equipment, it can be said that the company takes an aggressive business expansion approach. However, even if the company manages to maintain sales from equipment for LCD panels, it cannot be regarded as a successful semiconductor equipment manufacturer when it fails to prevent semiconductor equipment sales from declining.

Diagram 2-3-9 World's sales ranking of semiconductor equipment manufacturers

(Unit: million dollars)

Ranking in 2004	Ranking in previous year		Revenue in 2004
1	1	Applied Materials Inc. (USA)	7,552
2	2	Tokyo Electron Limited (Japan)	4,742
3	3	ASML Holding N.V. (Netherlands)	3,022
4	6	Advantest Corporation (Japan)	2,176
5	4	KLA-Tencor Corporation (USA)	1,892
6	5	Nikon Corporation (Japan)	1,411
7	9	Lam Research Corporation (USA)	1,360
8	7	Novellus Systems, Inc. (USA)	1,337
9	8	Hitachi High-Technologies Corporation (Japan)	1,315
10	11	Canon Inc. (Japan)	1,284

Source: VLSI Research, Inc., 2005. Only equipment for semiconductors is included. No equipment for FPD is included.
Note: Rankings can widely vary depending on the data used. It is necessary to be careful with respect to data reliability.

In 2004, Japanese semiconductor manufacturing equipment had a 40% (dollar basis) share of the world market in terms of sales, as described above. This is almost the same as 41% in 2003. That is to say, the share of Japanese semiconductor manufacturing equipment has stabilized at a high level (Diagram 2-3-10).

However, there are some misgivings with respect to the structure of the share. The share of processing equipment, the core of semiconductor manufacturing equipment, was reduced to 37% in 2004 from 39% in 2003. The total share of semiconductor equipment was maintained chiefly because the share of testers and other test/inspection equipment increased.

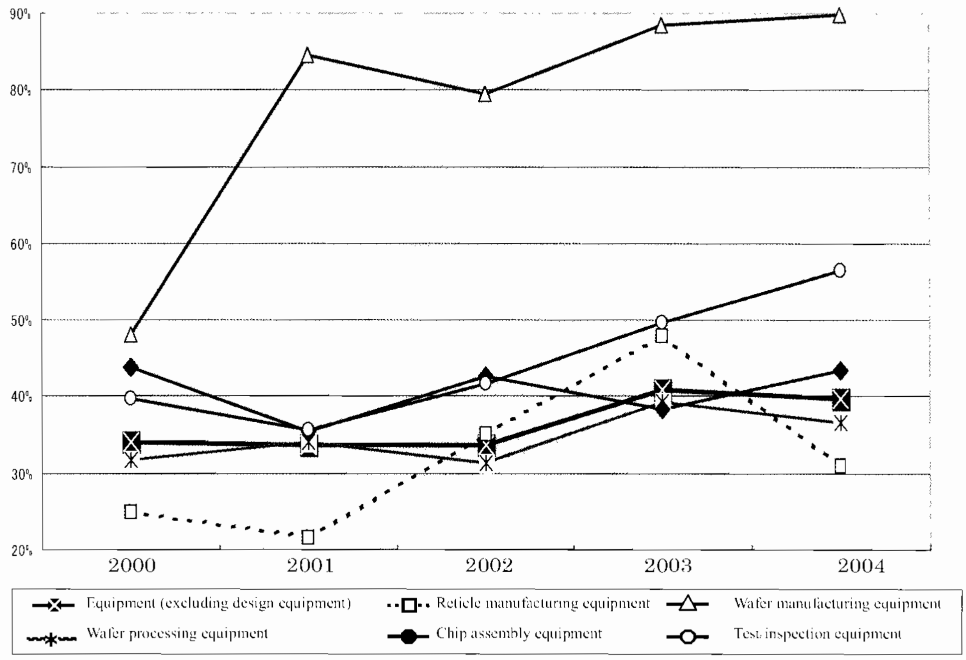


Diagram 2-3-10 Share in world market of Japanese semiconductor manufacturing equipment (dollar basis) in terms of the value of sales (including the Japanese market)

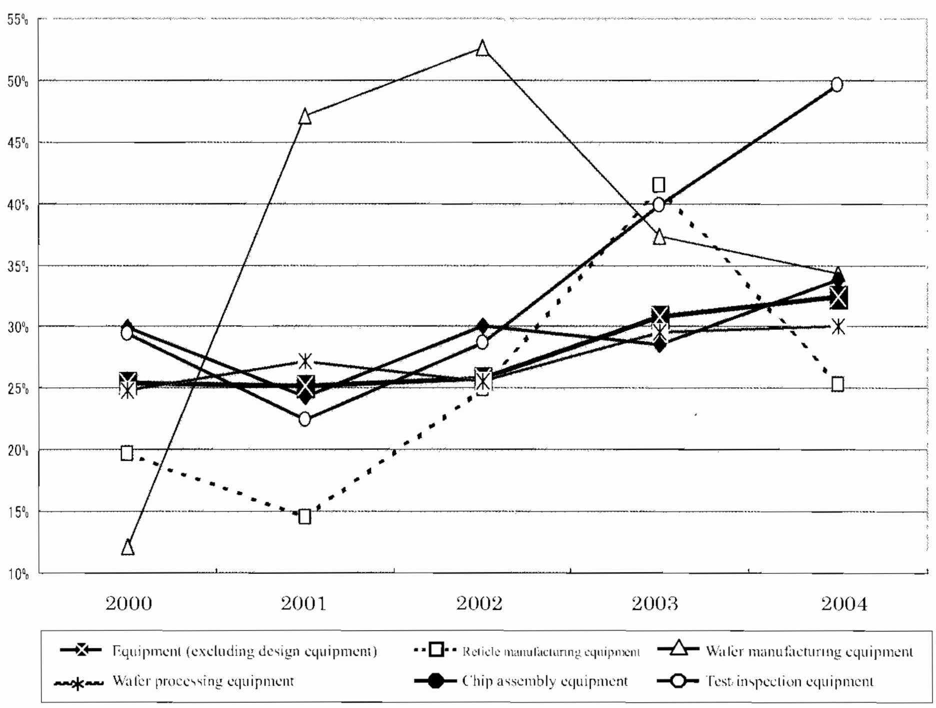


Diagram 2-3-11 Share in overseas markets of Japanese semiconductor manufacturing equipment (dollar basis) in terms of the value of sales (excluding the Japanese market)

A closer look at the decreased share of processing equipment shows that exposure equipment and etchers suffered a sharp decline in terms of market share. In 2004, the world market shares of Japanese exposure equipment and etchers increased, but the rate of increase definitely lagged behind the rate of recovery of the world market. For some types of etchers, Japanese products have not fared well traditionally. Though their market share in 2004 was down from the previous year, it was still above the level of the year 2000. Exposure equipment is a serious problem. Their share in 2004 was far below the level of the year 2000 (about 50%). What is even worse is that the share was down nearly as low as the lowest ever share recorded in 2002 (about 40%).

The market share is not the only problem with exposure equipment. Exposure equipment plays a pivotal role in processing equipment. Since it is technologically sophisticated equipment, developing and manufacturing new-generation models tends to get increasingly costly generation by generation in terms of money and human resources. Unless sales increase steadily, adequate funds cannot be generated to develop and manufacture next-generation models. This would make it difficult for exposure equipment to exist as a business on its own.

Competition is a relative thing. In the case of exposure equipment, competition is not global. Instead, there is only one competitor, ASML. The company holds 60% of the world's exposure equipment market, the remaining 40% being shared by two Japanese companies, Nikon and Canon. From this aspect, too, the problem of exposure equipment should be considered seriously.

The world market share of Japanese semiconductor manufacturing equipment is influenced, to a greater or lesser extent, by domestic semiconductor equipment investment (Japanese market for semiconductor manufacturing equipment). To eliminate this factor, we took a look at the share of Japanese equipment in overseas markets (excluding Japan), which also confirmed what we have discussed above. That is, the overseas market share of Japanese equipment has leveled off, remaining at a relatively high level; the share of testers and other test/inspection equipment has increased; the total share of processing equipment has leveled off, but the share of exposure equipment has dropped sharply; and the share of etchers has declined but only moderately (Diagram 2-3-11).

(2) Management challenges

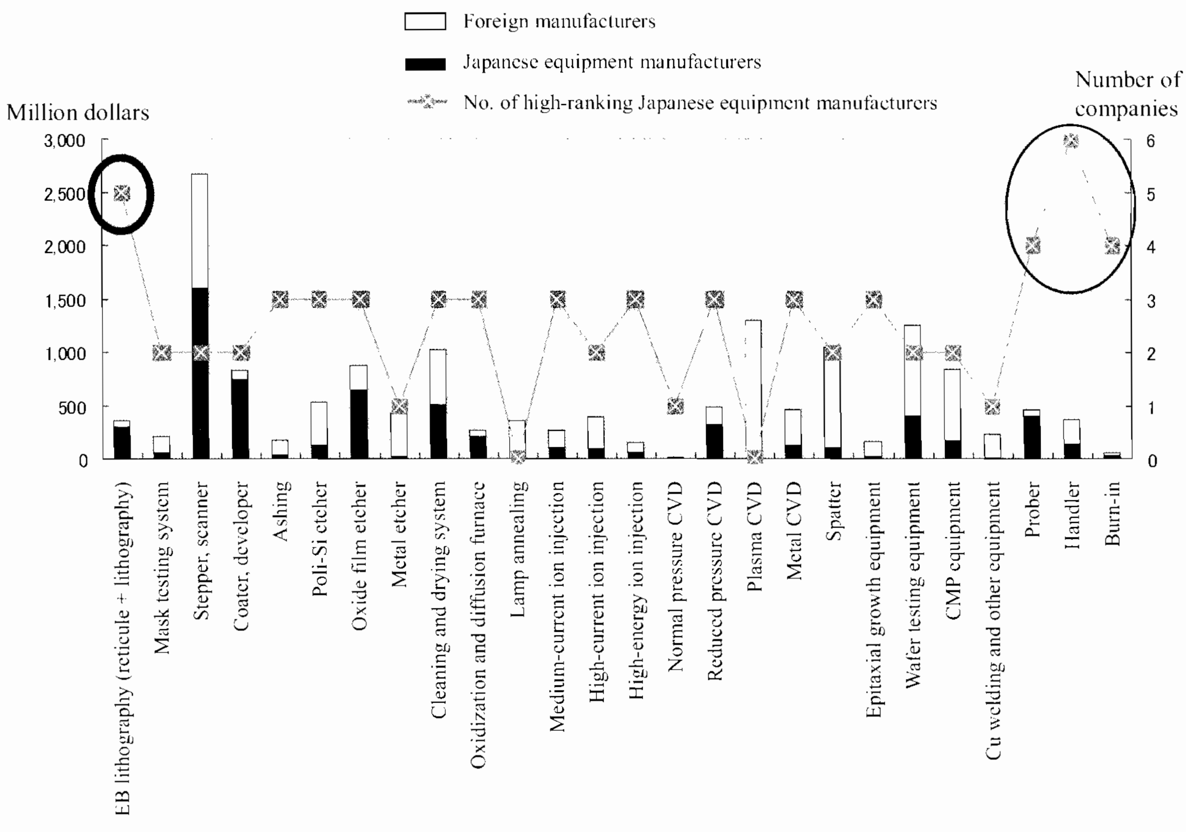
Generally speaking, compared with the level in the late 1990s, the competitive edge of Japanese semiconductor manufacturing equipment started recovering in 2003 and was maintained in 2004. As discussed earlier, however, business conditions vary with types of equipment. For example, testers fared well but exposure equipment has been experiencing aggravating problems.

In the field of electron-beam (EB) lithography equipment, while Japanese companies have technologically competent human resources, they are faced with management difficulties. If combined, Japanese companies maintain a large world market share. However, even the size of the world market as a whole is small. In this small arena, competition is taking place, involving as many as four Japanese companies in addition to foreign companies. This makes it difficult for them to generate enough revenue to develop next-generation models (Diagram 2-3-12).

This is yet another global-scale problem. The world's semiconductor industry is experiencing the slowing down of growth and the changing of structure. While in 2004 the world semiconductor market regained the peak size experienced in the year 2000, it is, however, unlikely that the industry will maintain stable growth as it has enjoyed in the past (see the relevant chapter of this book.) In 2004, the world market for semiconductor equipment picked up but to 76% of the level of the year 2000. Basically, there are surplus stocks of semiconductor equipment globally and equipment investment tends to be curbed in terms of the percentage to sales.

In the field of semiconductor manufacturing, as in the field of exposure equipment, the growing cost of developing and manufacturing next-generation models will lead to financial difficulty without a certain level of sales expansion.

In contrast, FPD manufacturing equipment is experiencing rapid growth, but it is forecast that their market will still remain considerably small compared with the market for semiconductor manufacturing equipment. This would inevitably translate into more intense survival competition.



* Assembling equipment and testers are excluded.

Source: Semiconductor Manufacturing Equipment Databook 2004, Electronics Journal

Diagram 2-3-12

No. of high-ranking Japanese equipment manufacturers by product type (competition)