Chapter 1 Outlook of the Japanese machine industry and the creation of new industry—promising new markets and new technology, and expected problems with their development and commercialization

In this chapter, we report on the growth potential of the new technology and new markets that the Japanese machine industry considers promising in the future. We also present an outline of the analysis of current problems relating to the commercialization of the new technology and the development of new markets based on our questionnaire survey of 1,000 companies in four categories of machine industry (i.e., general machines, electrical machines and apparatus, transportation apparatus, and precision instruments). This survey was conducted on "2010's New Markets and Commercialization-related Problems" during the period from December 2003 to February 2004.

1.1 Promising new technology and new markets

(1) General condition of the new technology and new markets taken up by the respondent companies

The fields of new technology and new markets taken up by the respondent companies are led by "information, communications, and electronics" (33.5%) and "mechanical and materials" (32.1%), followed by "environment and energy" (18.2%) and "health care, nursing care, biotechnology, and medical services" (15.2%) (Chart omitted). Concerning the internal constituent of each field, "equipment set" (20.9%) was mentioned by many respondents for the "information, communications, and electronics" field and "manufacturing machines" (11.0%) was named in larger numbers for the "mechanical and materials" field.

A classification of these new technology and new markets by industry reveals that while the "health care, nursing care, biotechnology, and pharmaceuticals," "environment and energy," and "mechanical and materials" fields are frequently cited for the general machine industry, "information, communications, and electronics" is frequently cited for the electrical machines and apparatus industry. A close examination of the trends in the electrical machines and apparatus industry in terms of the number of employees shows that the "information, communications, and electronics" field is frequently cited by companies with more than 10,000 employees.

A classification by workforce size reveals that while the "health care, nursing care, biotechnology, and pharmaceuticals" field is frequently mentioned by companies with more than 300 and 10,000 employees or less, the "information, communications, and electronics" field is frequently cited by companies with more than 10,000 employees.

(2) New technology and new markets for 2010 on a global scale—Market size and growth rate

The scales of new technology and new markets that the respondent companies forecast for 2010 on a global basis are ¥30,080,300 million for the "health care, nursing care, biotechnology, and pharmaceuticals" field, ¥3,249,300 million for the "environment and energy" field, ¥27,048,700 million for the "information, communications, and electronics" field, and ¥60,515,000 million for the "mechanical and materials" field (Chart 1-1). The large market size for the mechanical and materials field seems to be attributable to the fact that the forecast for the "information service to vehicles" includes not only equipment, but also services, software, and contents. Incidentally, the market size of the mechanical and materials field, excluding "information service to vehicles," is ¥47,918,000 million.

With regard to the annual growth rates of new technology and new markets on a global scale for 2000 to 2010, Chart 1-1 illustrates that the respondent companies estimate average rates of 3.6% for the "health care, nursing case, biotechnology, and pharmaceuticals" field, 5.6% for the "environment and energy" field, and 8.5% for the "information, communications, and electronics" field. The field of "mechanical and materials" surpasses all of the others with an average rate of 20.7%.

Chart 1-1 Comparison of Global Market Size and Annual Growth Rate for 2010 (Survey results by The Economic Research Institute, Japan Society for the Promotion of Machine Industry [ERI, JSPMI] vs. the Nikkei + Mitsubishi Research Institute)

Item	ERI, JSPMI questionnaire survey		Nikkei + Mitsubishi Research Institute		
	2010 (¥100 million)	Annual growth rates (%) for 2000–2010	2000 (¥100 million)	2010 (¥100 million)	Annual growth rates (%) for 2000–2010
Health care, nursing care, biotechnology and pharmaceuticals	**300,803**	**8.6%**	**210,551**	**535,154**	**10.2%**
Home care medical equipment, system	6,000	-5.0%	9,977	73,661	22.1%
Nursing-care equipment	41,748	7.3%	20,625	67,634	12.6%
Diagnostic imaging apparatus	14,000	0.2%	13,661	24,107	5.8%
Ultrasonic diagnostic equipment	3,000	-8.1%	6,964	16,607	9.1%
X-ray diagnostic equipment	7,000	4.4%	4,554	5,357	1.6%
Indoor movable equipment	1,876	9.9%	729	1,858	9.8%
Home diagnostic equipment	2,995	3.4%	2,143	2,786	2.7%
MRI	3,490	5.0%	2,143	2,143	0.0%
Cancer-treatment equipment	785	2.0%	644	776	1.9%
Ethanol	9,593	2.0%	7,870	14,464	6.3%
Bioremediation	2,942	3.0%	2,189	6,359	11.3%
Biopesticide	291	2.0%	239	1,232	17.8%
Genetically modified agricultural produce	80,131	2.0%	65,736	116,607	5.9%
Genetically modified food products	41,423	1.0%	37,500	101,250	10.4%
Biosensor	1,379	5.0%	846	4,924	19.3%
Medical waste disposal	1,745	5.0%	1,071	3,214	11.6%
Artificial organ, artificial tissue	23,192	10.0%	8,941	22,446	9.6%
Osteoporosis (therapeutics)	7,344	10.0%	2,831	4,898	5.6%
AIDS (therapeutics)	4,030	10.0%	1,554	5,571	13.6%
Pharmaceuticals made from cloned animals	13	2.0%	11	629	50.3%
Energy-efficient housing	21,771	5.0%	13,366	38,230	11.1%
Lifestyle-related disease preventative food	4,156	1.0%	3,762	29,194	22.7%
Organic foods	1,500	-6.5%	2,944	10,408	13.5%
Protein by molecule design (artificial enzyme, etc.)	14,000	62.6%	109	–	–
Functional foods for immunodeficiency and nervous system diseases	6,398	46.2%	144	799	18.7%
Environment and energy	**32,493**	**5.6%**	**13,899**	**71,783**	**14.3%**
High-efficiency combustion turbine	6,780	-3.1%	9,286	17,984	6.8%
Recycling-oriented incinerator (gasification melting furnace, etc.)	2,588	0.0%	2,588	9,626	14.0%
Superconducting storage system	8,169	97.0%	9	384	45.1%
Solid-oxide fuel cell (excluding mobile type)	328	10.0%	126	4,473	42.8%
Molten carbonate fuel cell	53	0.0%	53	501	25.2%
Phosphoric-acid fuel cell	460	-4.1%	701	1,869	10.3%
Amorphous solar battery	4,842	12.7%	1,459	19,679	29.7%
Monocrystal solar battery	282	0.0%	282	711	9.7%
Lithium ion battery	2,336	0.0%	2,336	8,169	13.3%
Zinc air battery	436	-5.0%	729	894	2.1%
Lithium polymer battery	154	5.0%	94	786	23.6%
Sodium sulfur battery	12	2.0%	10	229	36.7%
Hydrogen storing alloy	300	5.5%	175	3,557	35.1%
Business and system of treating and measuring endocrine-disrupting chemicals	5,608	20.0%	906	2,679	11.5%
Wastewater treatment using supercritical water	145	0.0%	145	244	5.3%
Information, communications, and electronics	**270,487**	**8.5%**	**119,781**	**545,444**	**16.4%**
Internet-access service	44,464	10.0%	17,143	40,129	8.9%
Online advertising	4,843	10.0%	1,867	38,304	35.3%
Natural language processing software	1,800	5.9%	1,015	6,514	20.4%
Character and image recognition software	9,886	10.0%	3,811	11,709	11.9%
Voice recognition and synthetic software	2,366	20.0%	382	2,405	20.2%
Super-slim TV (excluding PDP)	65,495	20.0%	10,578	109,821	26.4%
Panel computer	40,000	75.6%	144	2,036	30.4%
Magnetic optical disk (MO)	8,900	27.8%	764	5,114	20.9%
Next generation super-memory	55,000	14.4%	14,321	57,268	14.9%
Magnetic material for super dense storage	2,000	-28.9%	60,401	201,429	12.8%
Optical fiber	28,115	13.5%	7,929	53,571	21.1%
Post-silicon elemental material (diamond, cubic boron nitride, GaAs, etc.)	2,617	7.0%	1,329	13,714	26.3%
Organic EL	5,000	48.3%	97	3,429	42.8%
Mechanical and materials	**605,150**	**20.7%**	**91,991**	**365,411**	**14.8%**
Note: Total excluding "information service to vehicles"	**479,180**	**18.1%**	**90,801**	**363,268**	**14.9%**
Semiconductor manufacturing equipment	176,995	20.0%	28,586	81,107	11.0%
Thin-film manufacturing equipment (excluding the equipment for semiconductors)	2,091	4.6%	1,339	3,750	10.8%
Laser processing machine	3,063	0.4%	2,946	7,768	10.2%
SOR equipment (for MEMS, etc. LSI has limited possibilities.)	1,691	10.0%	652	2,079	12.3%
Ultraprecision processing machine using electron beam, ion beam, etc. (excluding the one for semiconductors)	738	7.0%	375	2,544	21.1%
Ultraprecision positioning device	5,485	20.4%	857	964	1.2%
Nanometer-level inspection and measurement instrument	2,000	25.6%	204	964	16.8%
Superconducting generator	6,000	110.2%	4	27	22.5%
Robot (general)	19,618	3.0%	14,598	26,569	6.2%
Manufacturing industry robot	17,743	5.0%	10,893	20,536	6.5%
Domestic robot	200	7.4%	98	4,573	46.9%
Robots for critical works	735	5.0%	451	1,459	12.4%
Micromachine	5,020	5.0%	3,082	11,727	14.3%
Direct-injection engine car	15,033	5.4%	8,893	58,714	20.8%
Fuel-cell-powered vehicle (See Note 4)	74,111	101.7%	66	74,111	101.7%
Natural-gas-powered car	17,943	35.1%	886	9,464	26.7%
Secondary battery car	78	-6.7%	156	7,500	47.3%
TSL and other high-speed vessels	23,733	10.0%	9,150	36,286	14.8%
Fiberglass-reinforced plastic	13,115	10.0%	5,056	7,836	4.5%
Super fiber	1,324	5.0%	813	2,019	9.5%
Shape-memory fiber	463	8.0%	214	536	9.6%
Heat-recovery thermoelectric element	37,000	114.6%	18	144	23.2%
Shape-memory alloy	5,000	44.4%	126	126	0.0%
Automatic physical distribution system	50,000	43.6%	1,336	2,464	6.3%
Information service to vehicles	200,000	66.9%	1,190	2,143	6.1%

Note 1: Prepared on the basis of the subject items replied to in the questionnaire survey conducted by The Economic Research Institute, Japan Society for the Promotion of Machine Industry

Note 2: The global market sizes for 2000 and 2010 estimated by the Nikkei and Mitsubishi Research Institute have been recalculated at the $1 = ¥100 exchange rate. The original data was based on an exchange rate of $1 = ¥140.

Note 3: Concerning the value of the 2010 global market mentioned by The Economic Research Institute, Japan Society for the Promotion of Machine Industry, those for the items for which only the growth rates were answered were calculated backward from the market sizes estimated by the Nikkei and Mitsubishi Research Institute.

Note 4: As for the fuel-cell-powered vehicle, because there were very few answers and the values were abnormal, we used the original data of the Nikkei and Mitsubishi Research Institute without modification.

(3) Timing of commercializing new technology and developing new markets

i) Global market

(a) Starting to bring the market into bloom

The timing of commercializing new technology and developing new markets is generally classified into the three major stages of "commercialization," "starting to bring the market into bloom," and "starting full-scale growth." We chose the last two stages of "starting to bring the market into bloom" and "starting full-scale growth," and asked about the "global market" and "domestic market" in our questionnaire.

First, concerning the timing of starting to bring the market into bloom on a global scale, Chart 1-2 shows those just coming into bloom in "2004" (10.5%) and "2005" (9.1%). "2000 or earlier" (9.0%) are mentioned by many companies, though "no response" is the most common reply with 52.2%. Although we asked the respondent companies to reply objectively as to the timing of commercialization, the replies seem to reflect their own inclinations somewhat.

A close examination of these timings (Chart omitted) shows that, by classification of industry, general machine companies name "2004" and "2010 or later" more than others.

With regard to the workforce size, companies with more than 10,000 employees mention "2000 or earlier" more frequently than others. And in terms of classification by the field of new technology and new markets, "2004" and "2008" are named by many companies with regard to the health care, nursing care, biotechnology, and pharmaceuticals fields.

Chart 1-2 Timing of Commercializing New Technology and Developing New Markets (Global Market)

(Upper row: % / Lower row: Number of answers)

	2000 or earlier	2001	2002	2003	2004	2005	
Timing of starting to bring the market into bloom	9.0 31	0.9 3	1.5 5	1.2 4	10.5 36	8.5 29	
Timing of starting full-scale growth	5.0 17	1.2 4	1.5 5	2.0 7	2.0 7	3.8 13	
	2006	2007	2008	2009	2010 and later	No response	Total
Timing of starting to bring the market into bloom	3.8 13	1.5 5	6.1 21	0.0 0	5.0 17	52.2 179	100.0 343
Timing of starting full-scale growth	4.7 16	1.5 5	9.0 31	0.3 1	19.2 66	49.9 171	100.0 343

(b) Full-scale market development

Regarding the timing of the full-scale starting of market development on a global basis, Chart 1-2 reveals that, although "no response" is the most common reply with 61.8%, as in the case of starting to bring the market into bloom, the majority of respondent companies name "2010 or later" (19.2%), followed by "2008" (9.0%).

A close look at these timings (Chart omitted) reveals that by classification of industry, "2010 or later" is mentioned more frequently than others for the general machine industry, and by workforce size, companies with more than 300 and 10,000 or less employees. As for others, electrical machine and apparatus companies with more than 10,000 employees most frequently mention "2003."

Finally, in terms of classification by new technology and new markets, health care, nursing care, biotechnology, and pharmaceuticals outnumber other fields for "2010 or later."

ii) Japanese market

(a) Starting to bring the market into bloom

Concerning the timing of starting to bring the market into bloom, Chart 2.3 illustrates that there are many companies that consider that the market already bloomed in "2000 or earlier" (11.7%) or will blossom soon in "2004" (14.0%) or "2005" (9.0%), though the number of "no response" (43.1%) answers is significant. Although we asked the respondent companies to answer objectively regarding the timing of market opening, as in the case for the global market, the responses seem to reflect their own inclinations somewhat.

Upon close examination of these timings (Chart omitted), it can be observed that, by classification of industry, "2004," which outnumbers others, is found more for the general machine industry, and "2003" is mentioned more by electrical machinery and apparatus companies with 10,000 employees or less. With regard to workforce size, companies with more than 10,000 employees outnumber other groups in mentioning "2000 or earlier."

Lastly, by field of new technology and new markets, while "2004" is high for the mechanical and materials field, as for the environment and energy field, "2000 or earlier" and "2008" are high.

Chart 1-3 Timing of Commercializing New Technology and Developing New Markets (Domestic Market)

(Upper row: % / Lower row: Number of answers)

	2000 or earlier	2001	2002	2003	2004	2005	
Timing of starting to bring the market into bloom	11.7 40	1.2 4	2.3 8	3.8 13	14.0 48	9.0 31	
Timing of starting full-scale growth	5.8 20	0.6 2	2.3 8	3.5 12	3.2 11	7.6 26	
	2006	2007	2008	2009	2010 and later	No response	Total
Timing of starting to bring the market into bloom	5.8 20	1.2 4	3.8 13	0.0 0	4.1 14	43.1 148	100.0 343
Timing of starting full-scale growth	6.1 21	6.1 21	9.9 34	0.6 2	16.0 55	38.2 131	100.0 343

(b) Full-scale market development

It is evident from Chart 1-3, which shows the timing of the full-scale start of market development at home, that the largest number of respondent companies name "2010 or later" (16.0%) as the timing, followed by "2008" (9.9%) and "2005" (7.6%), though "no response" is very common, with 38.2%, as in the case of the start of bringing the market into bloom.

Close investigation of these timings (Chart omitted) reveals that "2007" is mentioned most frequently for the electrical machine and apparatus industry, and this trend is especially noteworthy in companies with more than 10,000 employees. By workforce size, companies with more than 10,000 employees mention "2000 or earlier" and "2003" more often than other timings.

Lastly, in terms of the field of new technology and new markets, while the health care, nursing care, biotechnology, and pharmaceuticals fields outnumber others for "2010 or later," in the field of information, communications, and electronics, "2007" outnumbers other timings.

1.2 Commercialization

(1) Timing of commercializing new technology and developing new markets

Chart 1-4 presents the timing of the commercialization and development that the respondent companies plan to carry out in regard to promising new technology and new markets. Although "no response" was frequently given (43.3%), many companies have already implemented commercialization during or before 2000; this is followed by companies that plan to carry out commercialization during the coming year "2004" (9.3%).

Chart 1-4 Approximate Timing of Commercialization

(Upper row: % / Lower row: Number of answers)

2000 or earlier	2001	2002	2003	2004	2005	
21.0 72	0.9 3	2.3 8	3.5 12	9.3 32	5.5 19	
2006	2007	2008	2009	2010 and later	No response	Total
4.1 14	1.7 6	1.5 5	0.0 0	5.8 20	44.3 152	100.0 343

(2) Judgment criterion for the timing of commercializing new technology and developing new markets

The judgment criterion adopted by respondent companies for commercializing new technology and developing new markets is presented in Chart 1-5. Excepting the reply of "no response" (58.3%), which outnumbers all others, the most frequent replies are "at the time of domestic commercialization" (18.4%), followed by "at the time of starting to bring the domestic market into bloom" (12.8%) and "at the time of starting to bring the foreign market into bloom (5.8%). It is evident from the chart that although many companies set the domestic market, rather than the foreign market, as the judgment criterion, some companies attach a certain amount of importance to the foreign market.

Upon close examination of these timings, it is evident (Charts omitted) that, by classification of industry, the judgment criterion centered around "at the time of the domestic commercialization of product" and "at the time of starting to bring the domestic market into bloom" is cited more than others by electrical machine and apparatus companies, and by classification of the workforce size, by companies with more than 10,000 employees. This trend is particularly noteworthy for electrical machine and apparatus companies with more than 10,000 employees. As for the others, general machine companies name "at the time of starting to bring the foreign market into bloom" more frequently than others.

Lastly, with regard to the classification of new technology and new markets, while "at the time of starting to bring the domestic market into bloom" is mentioned more frequently for the information, communications, and electronics field, "at the time of the domestic commercialization of the product" is mentioned more frequently for the environment and energy field.

Chart 1-5 Criterion for Judging the Timing of Commercializing New Technology and Developing New Markets

(Upper row: % / Lower row: Number of answers)

Timing of the domestic commercialization of the product	Timing of starting to bring the domestic market into bloom	Timing of starting domestic full-scale growth	Timing of the commercialization of the product in foreign markets	Timing of starting the opening of foreign markets	Timing of starting the full-scale growth of foreign markets	No response	Total
18.4	12.8	3.8	0.9	5.8	0.0	58.3	100.0
63	44	13	3	20	0	200	343

(3) Items that restricted the study of commercialization timing

Chart 2-6 presents the items that the respondent companies consider to have most tightly restricted their decisions regarding the commercialization of new technology and the development of new markets. Excepting "no response" replies (70.6%), the highest percentage is recorded for "in-house/technology" (20.1%), followed by "company's competition strategy" (11.4%), "in-house/humans" (9.0%), and "in-house/money" (8.2%). It is clear from these answers that the greatest restriction is of an internal nature rather than an external one. In addition to the above-mentioned items, "intermediate/peripheral business" (5.8%) was also cited frequently enough to be noteworthy. Our follow-up survey on this "intermediate/peripheral business" found that there are many respondent companies that refer it generally in connection with their handling of the changes in the trade environment.

It is evident from a close examination of these timings (Chart omitted) that internal problems such as "in-house/technology," "company's competitive strategy," "in-house/humans," and "in-house/money" are mentioned more frequently by the electrical machine and apparatus industry and, in terms of the workforce size, by companies with more than 10,000 employees. The trend of in-house-related problems cited by the electrical machine and apparatus industry, in particular, is remarkable for companies with more than10,000 employees. These companies also cite the "intermediate/peripheral business" frequently.

Lastly, with regard to the classification of new technology and new markets, "in-house/technology," "company's competitive strategy," and "intermediate/peripheral business" are cited frequently for the information, communications, and electronics field.

Chart 1-6 Items that were found to be restrictive for the study of commercialization (Multiple answers)

(Upper row: % / Lower row: Number of answers)

In-house/ humans	In-house/ goods	In-house/ money	In-house/ technology	In-house/ peripheral business	In-house/ regulation and infrastructure	Company's competition strategy	In-house /other
9.0	0.6	8.2	20.1	2.9	0.9	11.4	0.3
31	2	28	69	10	3	39	1
Intermediate/humans	Intermediate/goods	Intermediate/money	Intermediate/ technology	Intermediate/peripheral business	Intermediate/ regulation and infrastructure	Intermediate/other	Outside the company/ humans
0.9	0.6	0.9	3.5	5.8	1.2	0.0	0.0
3	2	3	12	20	4	0	0

Outside the company/ goods	Outside the company/money	Outside the company/ technology	Outside the company/ peripheral business	Outside the company/ regulation and infrastructure	Outside the company/ other	Other	No response	Total
1.5	0.6	1.7	2.6	2.6	0.3	1.2	70.6	100.0
5	2	6	9	9	1	4	242	343

1.3 Conclusion

The following is a summary of the contents of the analysis described in this Chapter:

(1) Promising categories of markets and the timing of commercialization

- The main categories of markets that the respondent companies consider to be promising are "information, communications, and electronics" and "mechanical and materials." It is characteristic that "equipment set" is mentioned more for the information, communications, and electronics field, and "manufacturing machines" for the mechanical and materials field.
- Concerning the sizes of new technology and new markets on a global basis for 2010, the respondent companies expect, in comparison with other fields, a larger market size and higher growth rate for the mechanical and materials field.
- Concerning the distribution of the timing of commercialization, already-started "2000 or earlier" and the upcoming years "2004" and "2005" are cited frequently for both the global market and the domestic market in regard to bringing the markets into bloom. As for the timing of the full-scale start, too, "2010 or later" is cited frequently for both the global market and the domestic market. Although we asked the respondent companies to answer objectively about the timing of commercialization, the answers seem to reflect their own inclinations somewhat.

(2) Timing of commercializing a company's new business and the problems related to the study of commercialization

- The largest number of companies commercialized their new business in "2000 or earlier," and companies that are considering commercialization in the coming year "2004" come next.
- In terms of deciding the timing for commercializing new technology and developing new markets, many companies mentioned domestic factors such as "at the time of the domestic commercialization of the product" and "at the time of starting to bring the domestic market into bloom" as standards. However, some companies mention "at the time of starting to bring the foreign market into bloom" as the criterion for deciding the timing of commercializing new technology and developing new markets. Therefore, it can be said from these findings that the domestic market is not the only factor—the foreign market is also taken into consideration to a certain extent when Japanese companies consider the timing of commercializing their new business.
  → Regarding new technology and new markets, "at the time of starting domestic commercialization" is frequently cited for the information, communications, and electronics field, and "at the time of the domestic commercialization of the product" is cited frequently for the environment and energy field.
- The greatest restrictions that the respondent companies cited as encountering in the course of studying the timing of commercializing the new business and developing new markets are found "in-house."
  → "Humans," "goods," "technology," and "company's competition strategy."
  → With regard to the category of new technology and new markets, restrictions attributable to in-house problems ("in-house/technology" and "company's competition strategy") and "intermediate/peripheral business" are frequently found for the information, communications, and electronics field.