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Rebuilding Business Strategies of General Electric Machinery/Semiconductor Manufacturers

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Rebuilding Business Strategies of General Electric Machinery/ Semiconductor Manufacturers

Summary

1. The electronics industry consists of five sectors: electric home appliances ("white goods"), consumer electronics (e.g. digital household appliances), industrial electronics (computers, communications equipment), electronic components/devices, and heavy electric machinery. While the shares of electric home appliances and consumer electronics, both focused on set products, in domestic production have plummeted largely due to the transfer of production facilities overseas, production has increased in electronic components/devices. Of the total electronic machinery production of ¥28 trillion in 2007, electronic components/devices accounted for ¥10.4 trillion (almost 40%) and has been the largest electronics sector since 2002, replacing industrial electronics. Orders placed with Japanese electronic components manufacturers have been rising alongside the growing global demand for electronic products. In addition, there has been considerable impact from the relocation of production facilities overseas by Japanese electronic machinery manufacturers and the development of international division of labor between production processes, as the later processes are separated from the earlier ones, which remain in Japan, and transferred overseas.

2. Data compiled by the Development Bank of Japan indicate that the index of pre-tax profits of 882 domestic manufacturers (FY 1996 = 100) had risen to 280 by FY 2006. However, the index only increased to 149 for the 157 electronics manufacturers, reflecting their below-average performance during the ten years as compared with other manufacturing industries. The time series of profit margin for major manufacturing industries shows a strong recovery in iron & steel from stagnant growth in the 1990s; double-digit growth in precision machinery, general machinery and chemicals; and margins of 8–9% in cement, ceramics & glass and transport equipment. In contrast, electric machinery has suffered the second slowest growth over the years among all industries, next to paper & pulp, falling further behind other industries. It should be noted however that within the electric machinery industry, the electronic components sector enjoys a remarkably large profit margin. Indeed, the profit margin of the electronic components sector has almost constantly exceeded the average for manufacturing industries as a whole, surpassing 10% in FY 2006. Thus, it is important to distinguish between general electric machinery manufacturers, which are heavily dependent on set products, and electronic components manufacturers, when discussing profitability in the electric machinery industry. Identifying the sources of the strong profit-earning capacity of electronic components manufacturers would provide useful insights in considering how to increase the competitiveness of general electric machinery manufacturers.

3. Many electronic components manufacturers have secured wide profit margins by boosting sales overseas, in stark contrast to general electric machinery manufacturers, which, being highly dependent on the domestic market, have seen their profits eroded by intensive competition for market share among themselves. Highly profitable electronic components manufacturers have another aspect in common: they have developed quality products that cannot be challenged by overseas competitors in the global market, starting with proprietary techniques upstream such as materials development and equipment manufacturing. By building modular components around key devices and providing a whole set of specific functions for customers, they have succeeded in streamlining circuit designs and reducing the burden of component mounting, thus adding further value to their products.

4. Demand is expected to grow mainly in Southeast Asian and other emerging economies, where low-end products will account for much of the sales. Merchandise strategies in those mar-

kets therefore require a different perspective than in developed countries. In order to solidify its overseas business base, a general electric machinery manufacturer will have to commit itself to radical consolidation of its production facilities overseas and expansion of local procurement. It will also need to build an optimal production/sales system on a global scale by enhancing its product development and marketing procedures to suit local needs and actively utilizing local human resources. A business model based on the division of labor is becoming predominant in the electronics industry, not only for set products but also for semiconductors, which integrate proprietary control technology. As a result, the typical business model for general electric machinery manufacturers, producing the whole range of products within the group from semiconductors to set products, now finds fewer areas of comparative advantage. As added value becomes concentrated on key devices (e.g. electronic components and materials) and overseas fabrication contractors, particularly in China, expand their activities to the assembly of set products, it is now imperative for general electric machinery manufacturers to distinguish between (1) the business areas in which differentiation is possible by incorporating upstream segments such as materials and manufacturing equipment and (2) the business areas in which technology alone can no longer ensure differentiation due to substantial levels of commoditization, so that they may redevelop business strategies suited for individual areas to increase competitiveness, while mobilizing their limited managerial resources more effectively.

5. With regard to the latter business areas, where branding and designing, as well as business models and product standardization are increasingly crucial factors for differentiation, a general electric machinery manufacturer is required to concentrate managerial resources on development and marketing, taking bold measures to cut back on fabrication activities, including through outsourcing. After focusing its attention on its areas of strength through this “selection and concentration” process, the manufacturer should proceed with massive deployment of managerial resources in any areas where it has found it possible to achieve differentiation by incorporating technologies related to materials and manufacturing equipment. Possible options for a general electric machinery manufacturer include (1) the enhancement of in-house research on technologies related to materials and manufacturing equipment and (2) further development of partnerships with promising materials / manufacturing equipment makers including through joint development, tie-ups and the provision of funds for business investment. Allocating part of its substantial R&D expenses to joint development in the upstream segments of materials and manufacturing equipment to ensure continued growth of domestic facilities as the hub for the development and production of innovative new products incorporating materials technologies will bring medium- to long-term benefits to materials / manufacturing equipment makers as well as to the general electric machinery manufacturer itself.

6. Even for semiconductors, which are the key part for controlling electronics products, the global trend points to a division of labor between fabless companies specialized in design and software development on the one hand, and foundries specialized in fabrication under contract on the other. In partnership with fabless companies and EDA (electronic design automation) tool vendors across the globe, foundries have built a division of labor mechanism, effectively eroding the traditional advantage of vertical integration ranging from design and development to production. Since withdrawing from the general-purpose DRAM business, many of the Japanese semiconductor manufacturers have focused on application-specific custom products including system LSI (large-scale integration) circuits. In this field, however, they do not have a whole range of products meeting the global standard that can ensure sufficient shipments to warrant the huge investment. Thus, investing hundreds of billions of yen in a state-of-the-art semiconductor manufacturing plant is not likely to deliver sufficient profit to cover the cost. In light of their limited managerial resources, many Japanese semiconductor manufacturers should now put top priority on coordinated enhancement of their product development and marketing capacities within their LSI business. As for fabrica-

tion, they should seek revitalization by leveraging complementary partnerships on a global scale, for example.

7. Until recently, fund managers did not consider semiconductors as a potential target of investment. The current inflow of some investment money into the semiconductor industry indicates that the industry has entered a transition period. Indeed, the volatility of the silicon cycle has diminished, improving the prospects for relatively stable growth. Moreover, the performance of semiconductor manufacturers has come to depend on the success of management, as well as on the superiority of advanced technology in terms of miniaturization and yield. Faced with the changing environment, an increasing number of semiconductor manufacturers are now looking for a new management model. For example, Texas Instruments (U.S.) has introduced a "hybrid model" using both its own fabs and foundries for the production of advanced logic semiconductors. Indeed, the next-generation 32 nanometer (nm) process will be developed in collaboration with foundries. Business strategies are also being reviewed by domestic semiconductor manufacturers. Fujitsu, for instance, will spin off its semiconductor business in March 2008 to expedite substantially the process of business judgment, while allowing for more discretion in management to increase business value.

8. A business model based on the global division of labor is expanding rapidly in the electronics industry, not only for set products such as PCs and digital household appliances, but also for semiconductors, a key component in controlling such products. The common aspect of the two businesses is that product differentiation depends increasingly on the success of management, including branding, designing, strategic partnerships and the establishment of a business model, in addition to the development of cutting-edge technology. In Japan, many of the semiconductor manufacturers as well as general electric machinery manufacturers, largely dependent on set products, trail behind other manufacturers in profitability. In order to find a breakthrough, they require managerial ingenuity to think out of the box and make quick and flexible decisions in response to the three ongoing worldwide developments (i.e. progress in the global division of labor, changing differentiators and expansion of emerging markets led by low-end products).

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Introduction

In the electronics industry, the global division of labor model has been expanding not only for set products such as PCs and digital household appliances but also for semiconductors, a key component in controlling such products. Also, product differentiation depends increasingly on the success of "management," including branding, designing, strategic partnerships and the establishment of a business model, in addition to the development of cutting-edge technology. In Japan, many of the semiconductor manufacturers as well as general electric machinery manufacturers, largely dependent on set products, trail behind other manufacturers in profitability. The common aspect to those two sectors is that manufacturers have not fully responded to the three defining developments in the world market: progress in the global division of labor, changing differentiators and expansion of emerging markets led by low-end products.

With that background, this two-part report considers how general electric machinery and semiconductor manufacturers should rebuild their business strategies. Comparing the profitability of general electric machinery manufacturers with that of leading electronic components/materials manufacturers, Part I shows the importance for general electric machinery manufacturers to clearly distinguish between (1) the areas where the global division of labor should be adopted and (2) the areas where they can obtain a competitive edge by incorporating materials and manufacturing equipment segments, and build a suitable business strategy for each type of area. Taking the example of Taiwan, where growth has been attained through the division of labor model between fabless companies and foundries, Part II recommends measures for the semiconductor industry to regain its competitiveness, with special focus on system LSI (large-scale integration) circuits, which are key devices in many products including digital household appliances.[1]

[1] This report is a revised version of Makoto Shimizu, "Policies to Restore the International Competitiveness of the Japanese Electronic Products Industry," *Annals of the Society for Industrial Studies*, No. 23.

I Policies to Rebuild Business Strategies of General Electric Machinery Manufacturers

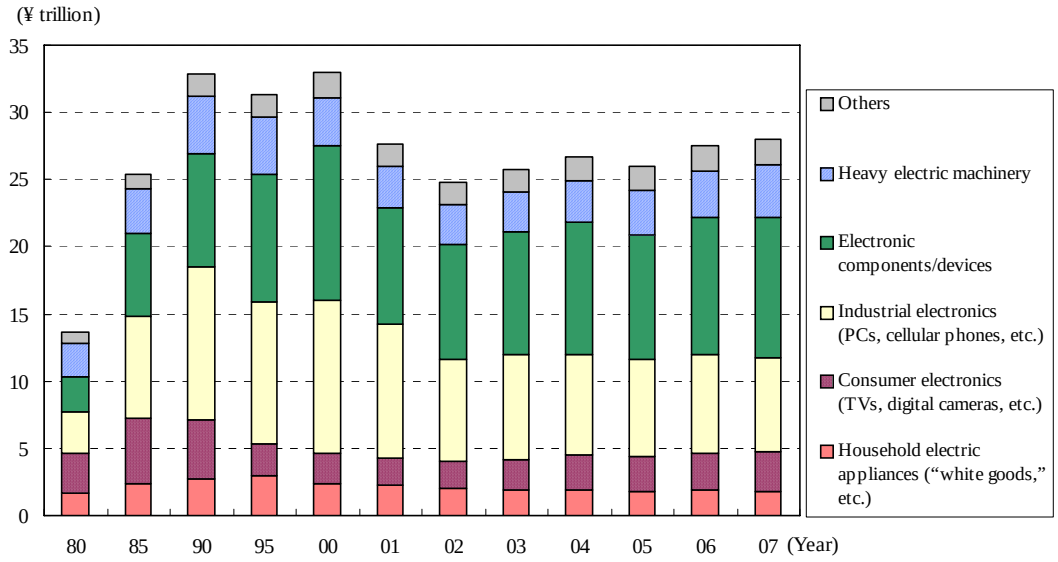
1. Increased Presence of Electronic Components in Electronics Industry

The electronics industry consists of five sectors: electric home appliances ("white goods"), consumer electronics (e.g. digital household appliances), industrial electronics (computers, communications equipment), electronic components/devices, and heavy electric machinery. Taken together, the electric home appliance and consumer electronics sectors (i.e. producers of set products) accounted for as much as one third of domestic production in 1980. The share has plummeted since then, however, largely due to the relocation of production facilities overseas (Figure 1). In contrast, production has been on the rise in the electronic component/device sector. Of the total electronic machinery production of ¥28 trillion in 2007, electronic components/devices accounted for ¥10.4 trillion (almost 40%), and has been the largest electronics sector since 2002, replacing industrial electronics.

Figure 2 compares the values of electric machinery exports and imports between FYs 1985 and 2006. In just over 20 years, the share of electronic components and devices in total exports rose substantially, while imports recorded over an eight-fold increase, from ¥1.2 trillion to ¥10.1 trillion, with most of the increment due to electronic components and devices (Figure 1). The active external trade in electronic components and devices in both directions has been driven by the growth in orders placed with Japanese electronic components manufacturers alongside the expansion of global demand for electronic products. In addition, there has been considerable impact from the relocation of production facilities overseas by Japanese electronic machinery manufacturers and the development of international division of labor between production processes, as the later processes are separated from the earlier ones, which remain in Japan, and transferred overseas.

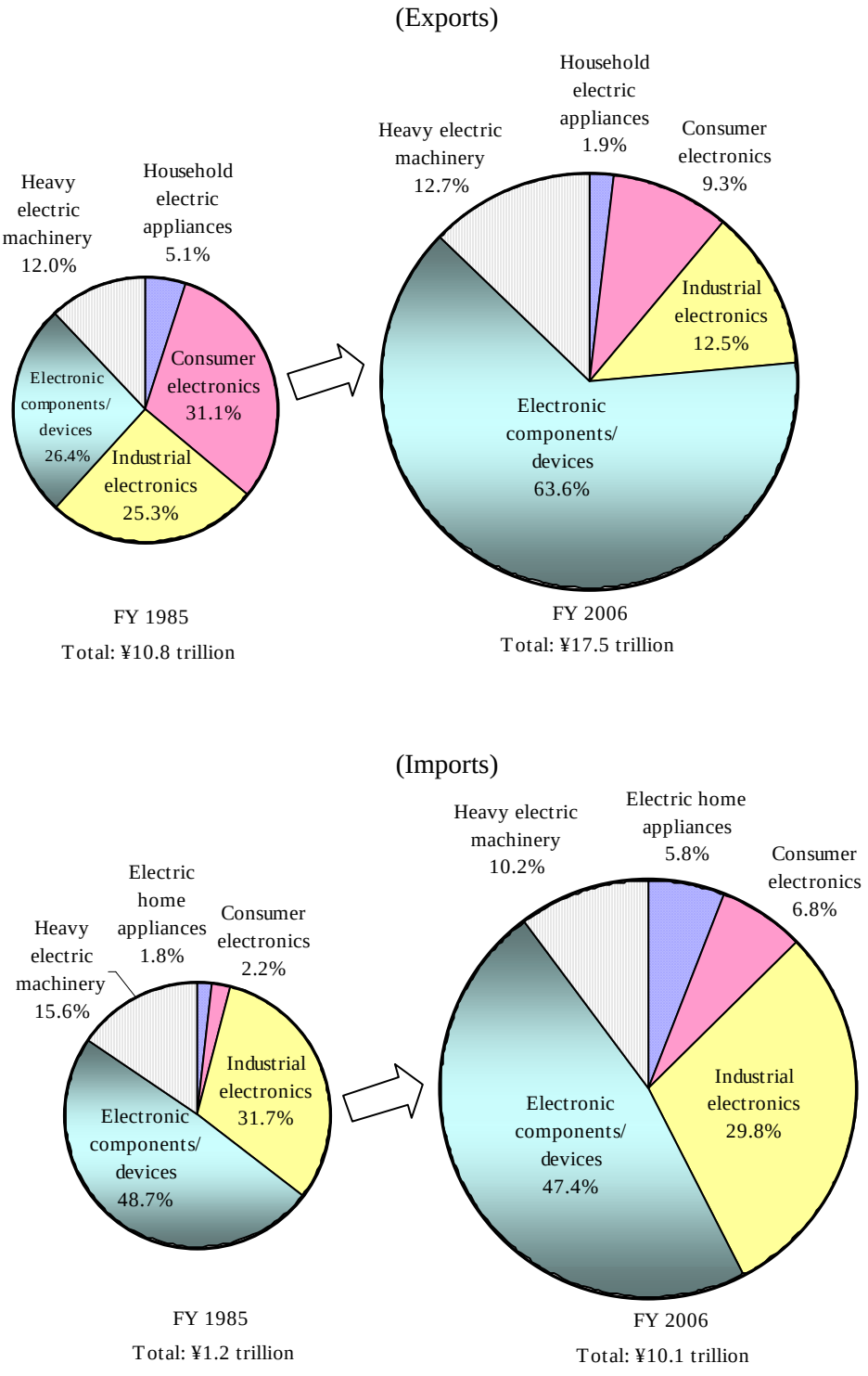
By destination (FY 2006), Asia other than China accounts for almost half (46%) of Japanese exports, followed by China (20%), Europe (15%) and the U.S. (14%). Although a large part of the exports still go to those countries where Japanese manufacturers established their first offshore production facilities, such as Malaysia and Thailand, the share of China has been rising in recent years, attesting to the country's increased importance as a destination for Japanese electronic component exports.

Figure 1. Domestic Production of Electric Machinery by Sector



Sources: Ministry of Economy, Trade and Industry, "Machinery Statistics"; Japan Electric Machine Industry Association; Japan Electronics and Information Technology Industries Association; Association for Electric Home Appliances, "Electric Home Appliance Industry Handbook."

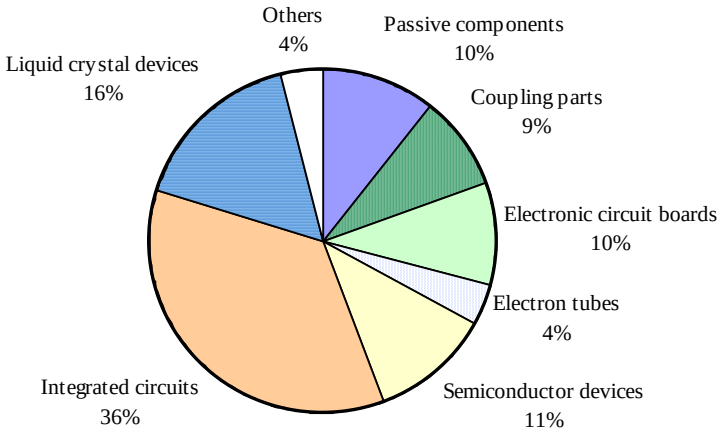
Figure 2. Exports and Imports of Electric Machinery



Sources: Japan Electric Machine Industry Association; Japan Electronics and Information Technology Industries Association.

A wide variety of electronic components and devices are produced nowadays. Whereas the production of electronic devices, including integrated circuits, liquid crystal devices, semiconductor devices and electron tubes, exceeds ¥6 trillion, the market for general electronic components, including passive components such as resistors and capacitors, and coupling parts such as connectors and switches, amounts to almost ¥3 trillion in total (Figure 3). Although average unit prices for resistors and capacitors are very low at around ¥1, they play a crucial role in controlling currents and suppressing electrical noise. A single digital household appliance or cellular phone requires dozens or hundreds of those components, so production is steadily increasing.

Figure 3. Composition of Domestic Production of Electronic Components and Devices (FY 2006)



Total: ¥10,190.5 billion

<Cf.> Production (FY 2006) and major products for each item

Passive components (¥1.1 trillion): resistors, condensers
Coupling parts (¥0.9 trillion): connectors, switches
Electronic circuit boards (¥1 trillion): printed control panels
Electron tubes (¥0.4 trillion): microwave tubes, vacuum tubes
Semiconductor devices (¥1.1 trillion): transistors, light-emitting diodes, etc.
Integrated circuits (¥3.6 trillion): memory, microcontrollers
Liquid crystal devices (¥1.7 trillion): liquid crystal elements

Source: Japan Electronics and Information Technology Industries Association.

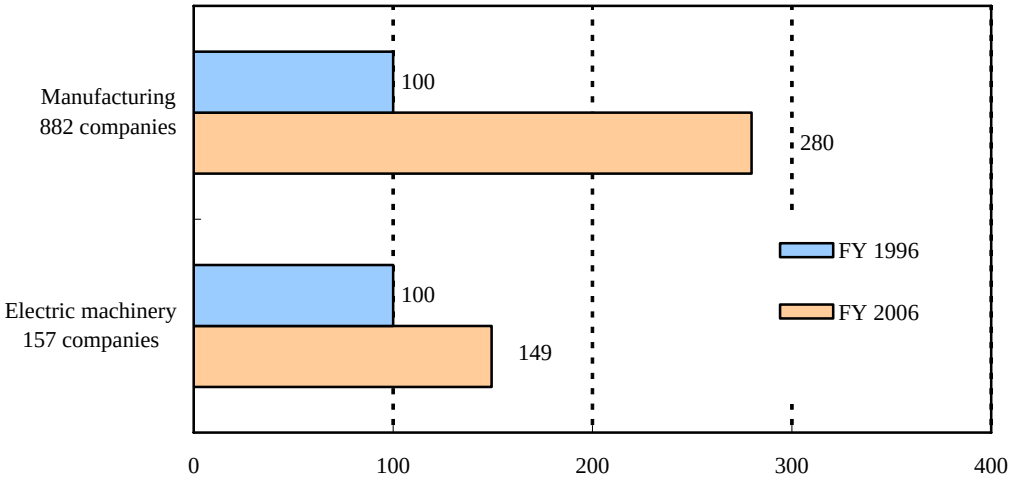
2. Stagnant General Electronic Manufacturers and Booming Electronic Components Manufacturers: Sources of Profitability for Electronic Components Manufacturers

Electronic components manufacturers lead the whole electronics industry in corporate performance. Data compiled by the Development Bank of Japan indicate that the index of pre-tax profits of 882 domestic manufacturers (FY 1996 = 100) had risen to 280 by FY 2006 (Figure 4). Apparently, Japanese manufacturers have increased their sales by absorbing global demand, particularly in emerging economies, and have built a corporate structure that directly links the expansion of sales with profits. However, the index was only 149 for the 157 electric machinery manufacturers in FY 2006, reflecting below-average performance during the ten years as compared with other manufacturing industries.

Figure 5 shows the time series of profit margin for major manufacturing industries. It indicates a strong recovery in iron & steel from the stagnant growth in the 1990s, double-digit growth in precision machinery, general machinery and chemicals, and margins of 8–9% in cement, ceramics & glass and transport equipment. In contrast, electric machinery has suffered the second slowest growth over the years among all industries, next to paper & pulp, falling further behind other industries. It should be noted however that within the electric machinery industry, the electronic component sector enjoys a remarkably large profit margin. Indeed, the profit margin of the electronic component sector has almost constantly exceeded the average for manufacturing industries as a whole, surpassing 10% in FY 2006.

Eleven major electronic components manufacturers, including Kyocera, Nidec, Murata Manufacturing, Ibiden, Rohm and Taiyo Yuden, each recorded a double-digit operating profit margin in FY 2006, substantially exceeding the average margin (5.9%) for the nine major general electric machinery manufacturers (Figure 6). Thus, the low profit margin for the electric machinery industry as described above is largely attributable to the general manufacturers, and so a distinction should be made between general electric machinery manufacturers, heavily dependent on set products, and electronic components manufacturers, rather than discussing is-

Figure 4. Growth of Profit Margin for Domestic Manufacturing and Electric Machinery in the Last 10 Years

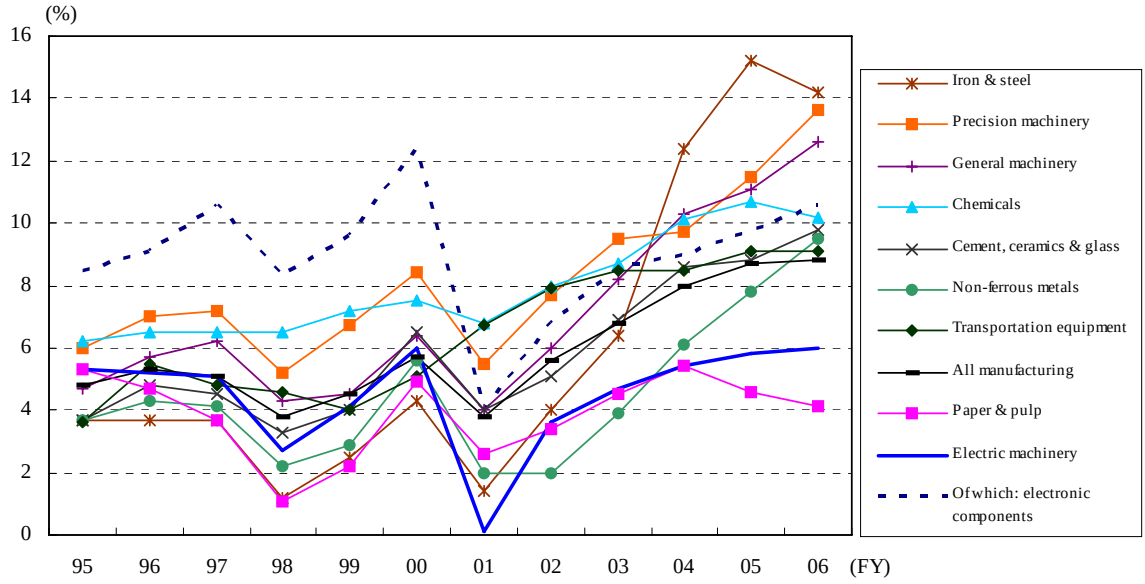


Source: DBJ ed., "Handbook of Industrial Financial Data (2007)."

sues in the electronics industry as a whole. Identifying the sources of the strong profit-earning capacity of electronic components manufacturers would provide useful insights on ways to increase the competitiveness of general electric machinery manufacturers.

The following sections analyze the strengths of Japanese electronic components manufacturers from two aspects: high overseas sales ratio and production process integrating the upstream segments of materials and manufacturing equipment.

Figure 5. Time Series of Operating Profit Margin in Domestic Manufacturing Industries



Source: DBJ ed., "Handbook of Industrial Financial Data (2007)."

Figure 6. Sales, Operating Profit, Overseas Sales Ratio and Major Products of Selected Electronic Components Manufacturers

	(¥billion)	Sales	Change y/y	Operating profit	Change y/y	Profit margin	Overseas sales ratio	Major products
Kyocera	FY 2005	1,173.5	0.0%	99.7	2.1%	8.5%	60.2%	Fine ceramic components,
	FY 2006	1,283.9	9.4%	135.1	35.5%	10.5%	61.3%	SC package components
TDK	FY 2005	795.2	20.9%	60.5	1.2%	7.6%	78.2%	Heads for HDD
	FY 2006	862.0	8.4%	79.6	31.5%	9.2%	80.1%	
Nidec	FY 2005	536.9	10.5%	53.4	-0.4%	10.0%	69.1%	Motors
	FY 2006	629.7	17.3%	64.0	19.8%	10.2%	69.1%	
Alps Electric	FY 2005	709.6	10.3%	45.5	46.3%	6.4%	76.7%	Switches, connectors,
	FY 2006	708.1	-0.2%	22.1	-51.4%	3.1%	74.8%	in-vehicle electric components
Murata	FY 2005	490.8	15.6%	89.8	29.2%	18.3%	72.5%	Ceramic filters,
Manufacturing	FY 2006	566.8	15.5%	113.4	26.3%	20.0%	74.5%	ceramic capacitors
Ibiden	FY 2005	319.0	28.8%	43.6	116.9%	13.7%	62.1%	Printed circuit boards,
	FY 2006	398.6	25.0%	69.0	58.3%	17.3%	66.5%	ceramics-related products
Hosiden	FY 2005	218.0	-12.4%	4.5	-51.5%	2.1%	44.1%	Connectors, switches
	FY 2006	312.8	43.5%	9.0	102.1%	2.9%	32.2%	
Rohm	FY 2005	387.8	5.1%	68.3	-10.2%	17.6%	59.7%	Custom LSIs
	FY 2006	395.1	1.9%	69.5	1.7%	17.6%	61.1%	
Mitsumi Electric	FY 2005	236.7	-0.9%	5.2	12.8%	2.2%	60.0%	Switches, coils, high-frequency
	FY 2006	281.9	19.1%	26.7	413.4%	9.5%	48.5%	devices, power supply ICs
Taiyo Yuden	FY 2005	186.5	8.3%	6.7	225.6%	3.6%	69.6%	Ceramic capacitors, ferrite,
	FY 2006	221.2	18.6%	22.0	229.0%	10.0%	70.5%	power supply/high-frequency modules
Nippon Chemi-Con	FY 2005	120.9	14.4%	6.1	29.9%	5.1%	60.4%	Aluminum electrolytic capacitors,
	FY 2006	135.1	11.7%	9.4	53.9%	7.0%	68.0%	Aluminum electrode foils, rubber packings
Total for 9 major general electric machinery manufacturers	FY 2005	50,732.9	4.1%	1,695.6	14.7%	3.3%	45.0%	
	FY 2006	53,719.9	5.9%	1,693.4	-0.1%	3.2%	47.3%	

Sources: Corporate data.

2.1 High Overseas Sales Ratio

Demand for flat-panel TVs, PCs and cellular phones has been accelerating, thanks specifically to the expansion of overseas markets. Global demand for liquid crystal display (LCD) TVs (display size of 10 inches or more) is expected to increase from 21.2 million units in 2005 to 155 million units in 2012. However, the share of the Japanese market will fall from 19% in 2005 to less than 7% in 2012, while Western Europe and the U.S. will account for 44% of the global market between them, and China for 19% (Figure 7).[2]

PCs and cellular phones will also continue to see their markets expand in terms of volume, led by the BRICs and other emerging economies (Figure 8). Cellular phone subscribers in India rose from 98.78 million in March 2006 to over 200 million in August 2007, which means that more than the total number of Japanese subscribers became cellular phone users in India in less than one and a half years (Figure 9). Even if we adopt a conservative estimate of 1.1 billion for the population of India, less than 20% have cellular phones, so there is further potential for market expansion.

Since low-end products are the mainstay for emerging markets, however, a substantial increase in volume will not easily translate into a corresponding increase in value. Indeed, the strong demand in India is driven by low-end products priced at R2,000–3,000 (about ¥5,600–8,400). Nokia dominates the market, followed by Samsung Electronics. The set products of Japanese manufacturers, although highly appreciated for their quality, cannot easily attract customers due to their high prices. Meanwhile, bulk orders have been placed with Japanese manufacturers for electronic components to be used in set products.

Figure 10 shows the performance of the nine general electric machinery manufacturers and 11 major electronic components manufacturers. The horizontal and vertical axes indicate the overseas sales ratio and operating profit margin, respectively. Many of the electronic components manufacturers secure a large profit margin by increasing sales overseas, whereas the general manufacturers, being heavily dependent on the domestic market, have thin profit margins due to the intense competition for market share among themselves. Thus, Japanese electronic components manufacturers continue to show strong performance even after the core market has moved overseas and foreign companies such as Nokia, Dell and Samsung Electronics have come to enjoy substantial market share in set products.

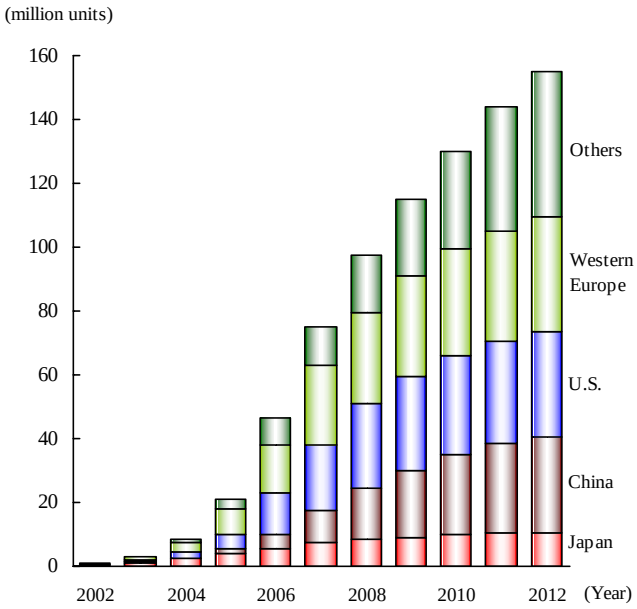
The overseas production ratio in electric machinery (23.1%) has remained almost flat in recent years with some fluctuations (Figure 11). In contrast, carmakers and other transport equipment manufacturers have successfully benefited from the expansion of global demand by rapidly accelerating overseas production since 2000. The general electric machinery manufacturers, which depend on the domestic market for most of their sales, are no match for carmakers in profitability, in both the Euro-American and Asian markets (Figure 12).

As compared with the average for all manufacturing industries, the overseas affiliates of Japanese electric machinery manufacturers sell less of their products in the local markets and export more of their products (19%) to Japan (Figure 13). This ratio rises to 32% if we focus on the affiliates in Asia. The stagnant sales overseas is because most of those affiliates were originally established as production bases for export to Japan and third-country markets, thus delaying product development and marketing in response to local needs.

Demand is expected to grow mainly in emerging economies, where low-end products will account for much of the sales. Merchandise strategies in those markets therefore require a different approach than in developed countries or Southeast Asia. In order to solidify its overseas business base, a general electric machinery manufacturer must radically consolidate its production facilities overseas and expand local procurement. It will also need to build an optimal production/sales system on a global scale by enhancing its product development and marketing processes to suit local needs and by actively utilizing local human resources.

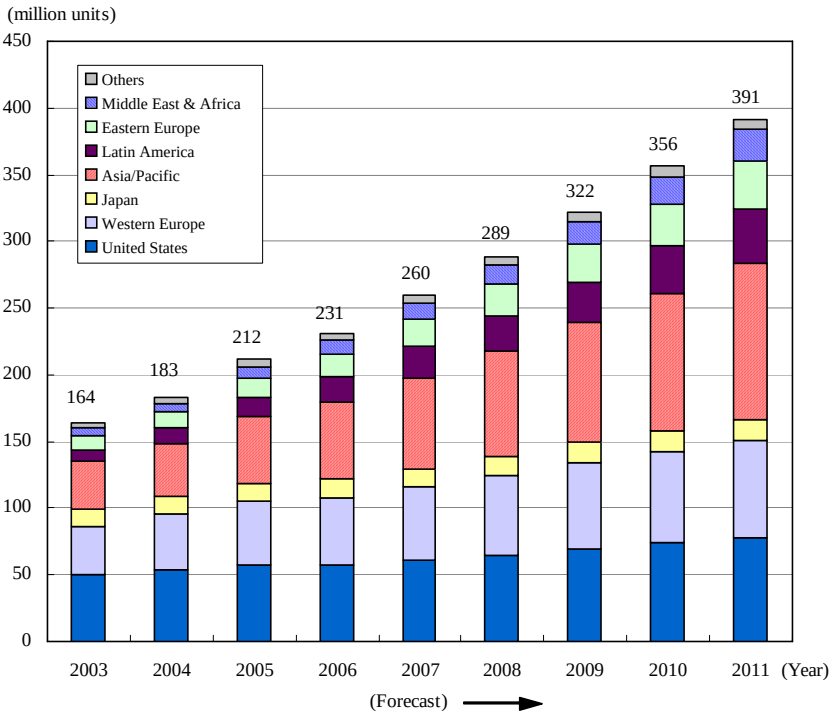
[2] See Japan Electronics and Information Technology Industries Association, "Forecast of Global Demand for Selected Audio-Visual Products."

Figure 7. Trend of World Demand for Liquid Crystal TVs by Region



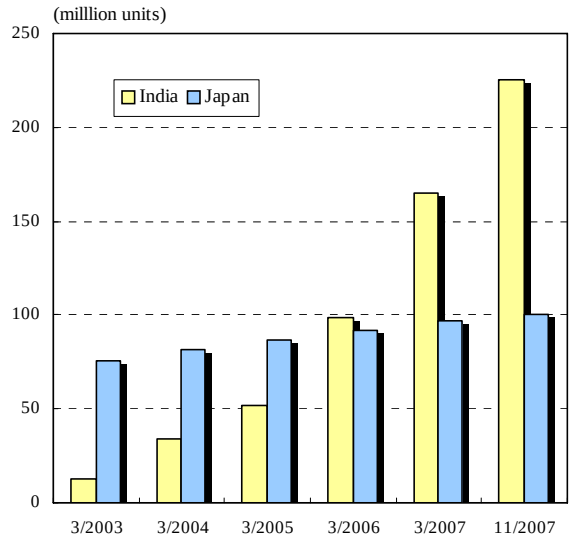
Source: Japan Electronics and Information Technology Industries Association, "Forecast of Global Demand for Selected Audio-Visual Products."

Figure 8. World PC Shipments



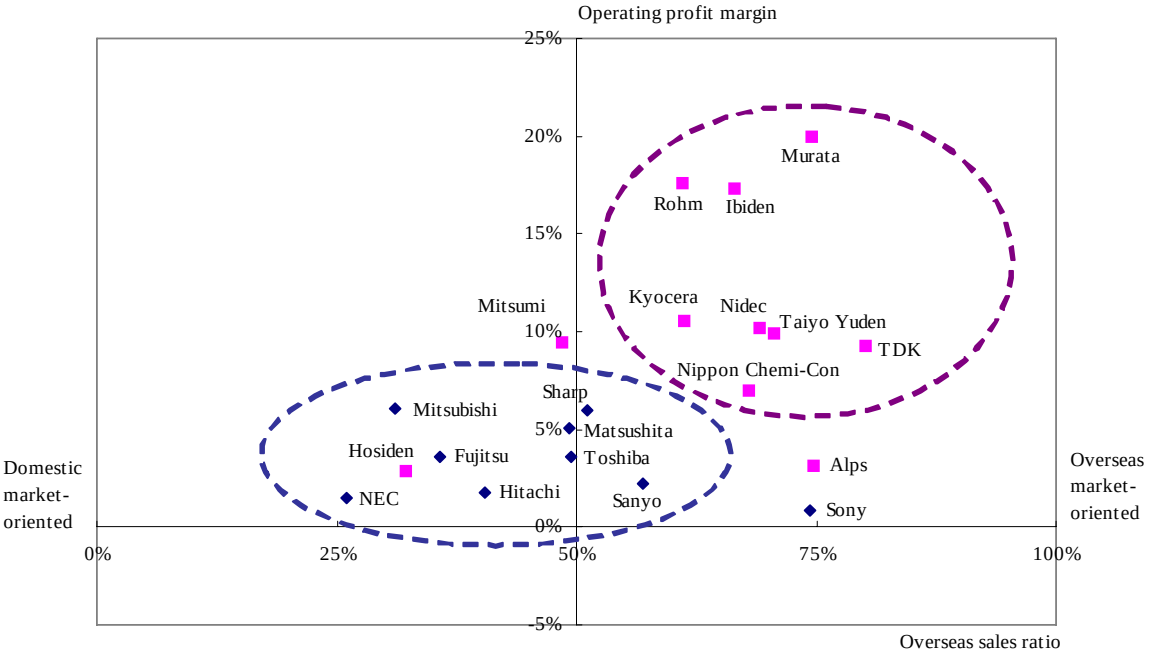
Source: Gartner, "Forecast: PCs, Worldwide," September 2007, GJ08001.

Figure 9. Trend of Cellular Phone Subscribers in India



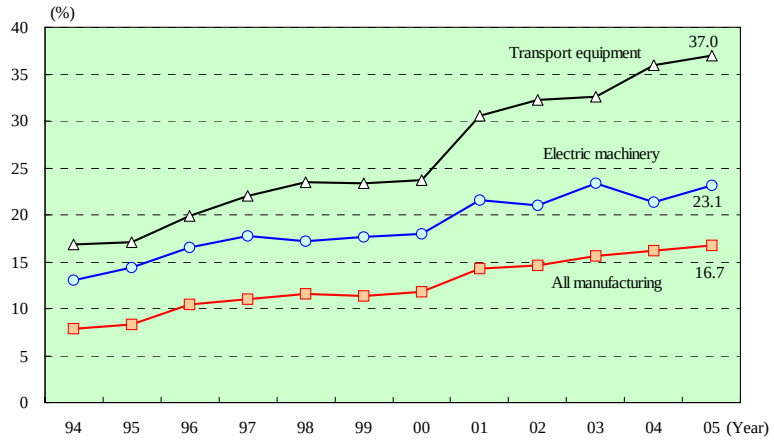
Source: Telecom Regulatory Authority of India (TRAI).

Figure 10. Overseas Sales Ratio and Operating Profit Margin of General Electric Machinery Manufacturers and Selected Electronic Components Manufacturers



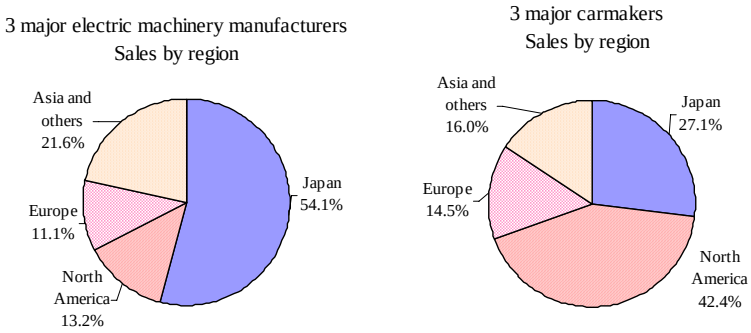
Sources: Corporate financial statements.

Figure 11. Overseas Production Ratio of Electric Machinery and Transport Equipment



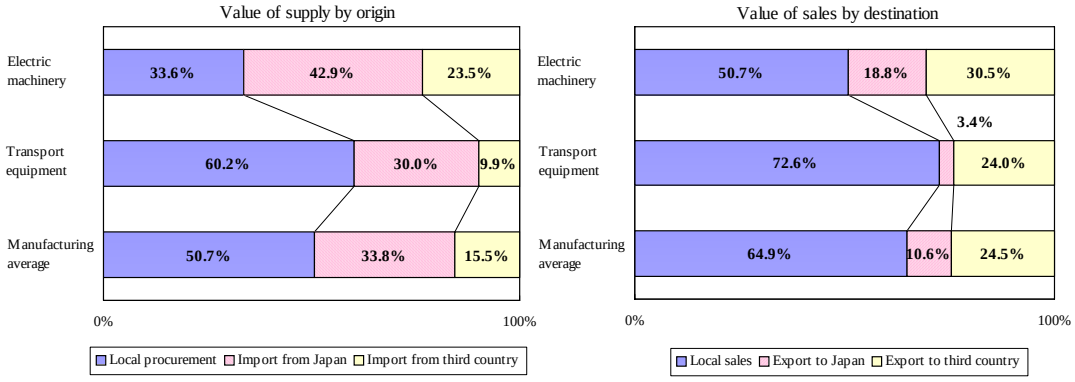
Notes: Overseas production ratio = sales of overseas affiliates/(sales of overseas affiliates + sales of domestic manufacturers) × 100. "Electric machinery" includes "information and communications equipment."
Source: Ministry of Economy, Trade and Industry, "Basic Survey of Overseas Business Activities."

Figure 12. Sales of 3 Major General Electric Machinery and Car Manufacturers by Region (FY 2006)



Note: Electric machinery manufacturers include Hitachi, Toshiba and Matsushita. Carmakers include Toyota, Nissan and Honda.
Sources: Compiled by DBJ from corporate financial reports.

Figure 13. Origin and Destination of Products for Overseas Affiliates of Japanese Electric Machinery Manufacturers



Note: Electric machinery includes information and communications equipment. Data are for FY 2005.
Source: Ministry of Economy, Trade and Industry, "Basic Survey of Overseas Business Activities."

2.2 Continuous Production from Materials and Manufacturing Equipment

Another common feature of highly profitable electronic components manufacturers is that they have developed quality products that cannot be challenged by overseas competitors in the global market, starting with proprietary techniques upstream such as materials development and equipment manufacturing.

The performance of electronic components ultimately depends on the quality of materials. Thus, the quality of aluminum, tantalum and ceramics determines the performance of a capacitor, while the competitiveness of hard disk drives depends on the magnetic recording material. For example, Murata Manufacturing, a company which started out in traditional pottery, enjoys a significant share in ceramic capacitors. Having established a continuous production system ranging from materials to final products, the company's philosophy is to focus on materials to achieve the necessary functions.[3] Another company, TDK, developed various unique materials starting from ferrite. Straightforward, ongoing research and experiments involving mixing powder, pulverizing it, burning it and then testing its composition repeatedly, led to substantial expertise on materials. This materials technology has led to numerous creative products unmatched by rivals.[4] The performance of aluminum electrolytic capacitors, in which Nippon Chemi-Con specializes, largely depends on the electrode foil, as its surface area determines the amount of electricity that can be stored. The company is also one of the world's leading manufacturers of aluminum electrode foil. In-house production of manufacturing equipment has helped the company boost its profits by keeping proprietary the processing technology to maximize the surface area of the electrode foil.[5]

In the semiconductor industry, Rohm, a leading manufacturer of custom LSI (large-scale integration) circuits containing both analog and digital circuits, has built a large profit margin through a distinct strategy that has not been adopted by other large manufacturers. The company produces in-house elements such as 300 mm silicon wafers and also develops most of the manufacturing equipment used in the later processes.[6] This strategy gives the firm an overwhelming advantage in quality and reliability through continuous quality control throughout production, from raw materials to final process.

Thus, leading electronic components manufacturers have created products that are hard for competitors to replicate, through in-house R&D covering upstream segments including materials and manufacturing equipment, followed by continuous production starting with raw materials. By building modular components around those key devices and providing a whole set of specific functions for customers, they have succeeded in streamlining circuit designs and reducing the burden of component mounting, thus adding further value to their products.

3. Electronic Materials as Key Factor for Differentiation of Flat-Panel Displays

The shift of profits upstream from assembly and production of set products to materials and manufacturing equipment is even more significant in the display industry. An LCD panel consists of a liquid crystal sandwiched between two glass substrates, which in turn are covered by layers of filters, so the cost of materials accounts for a large part of the total production cost. The right combination of materials and equipment is also crucial in producing LCD panels, so it is essential to develop and provide materials that suit the production environment of the manufacturer. Although Korean and Taiwanese manufacturers are making their presence felt in the production of LCD panels through massive investment, Japanese manufacturers dominate the market for core materials such as polarizing plates and color filters. Indeed, LCD panels cannot easily be made without using Japanese materials.

Building on technologies accumulated through core businesses, such as synthesizing, coating, film-forming and fine processing, Japa-

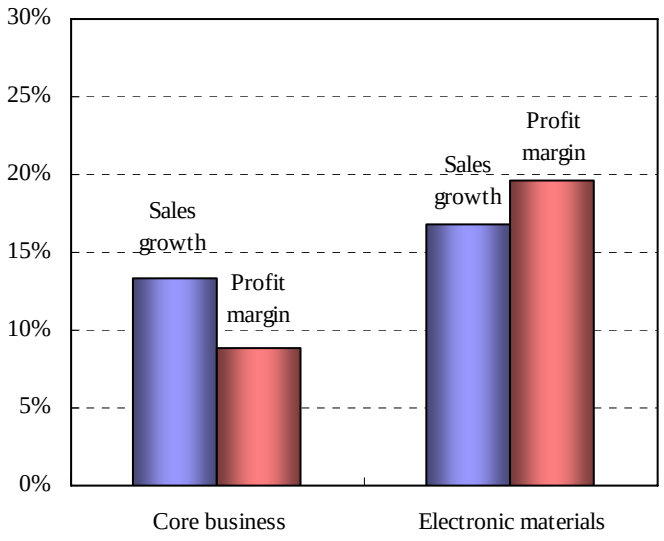
[3] See Murata Manufacturing's website at http://www.murata.co.jp/company/enkaku/index.html.
[4] See TDK's website at http://www.tdk.co.jp/tjaaa01/aaa30000.htm.
[5] Based on IR briefing documents prepared by Nippon Chemi-Con.
[6] See Rohm, "Annual Report," March 2007.

nese material manufacturers have developed original materials in a bid to diversify into electronics. Thus, Nitto Denko, a dominant polarizing plate manufacturer established in 1918, leveraged its varnish synthesizing technology for electrical insulating materials to generate semiconductor sealing materials and optical films, among other products, as it diversified into various high-polymer materials. Zeon (established in 1950) and JSR (established in 1957) applied nano-technologies and polymer technologies developed in their core synthetic rubber business to the coloring resist business and retardation film business, both of which now generate as much profit as their core businesses. Toppan Printing (established in 1900) has also succeeded in turning its color filter and photomask businesses into new profit bases by applying its fine processing technology accumulated over more than a century of its printing/plate-making business.

A survey of six Japanese manufacturers of materials for LCD panels found that their electronic component business has grown much faster than their core businesses. Indeed, the operating profit margin for the electronic component business (19.6%) is more than double that for the core business (8.9%). Many of those manufacturers depend on electronic components for most of their profits (Figure 14).[7]

Thus, added value is now concentrated on key devices including electronic components and materials, while overseas contractors, mainly in China, have emerged as major competitors in set product assembly. The following section considers which direction the general electric machinery manufacturers should take in rebuilding their business strategies under these circumstances.

Figure 14. Year-on-Year Growth and Operating Profit Margin for Manufacturers of Key Materials for LCD Panels in Core Business and Electronic Materials Business (FY 2005)



Sources: Compiled by DBJ from corporate financial reports.

[7] The survey is based on actual FY 2005 data for Nitto Denko, Asahi Glass, JSR, Zeon, Stanley Electric and Toppan Printing.

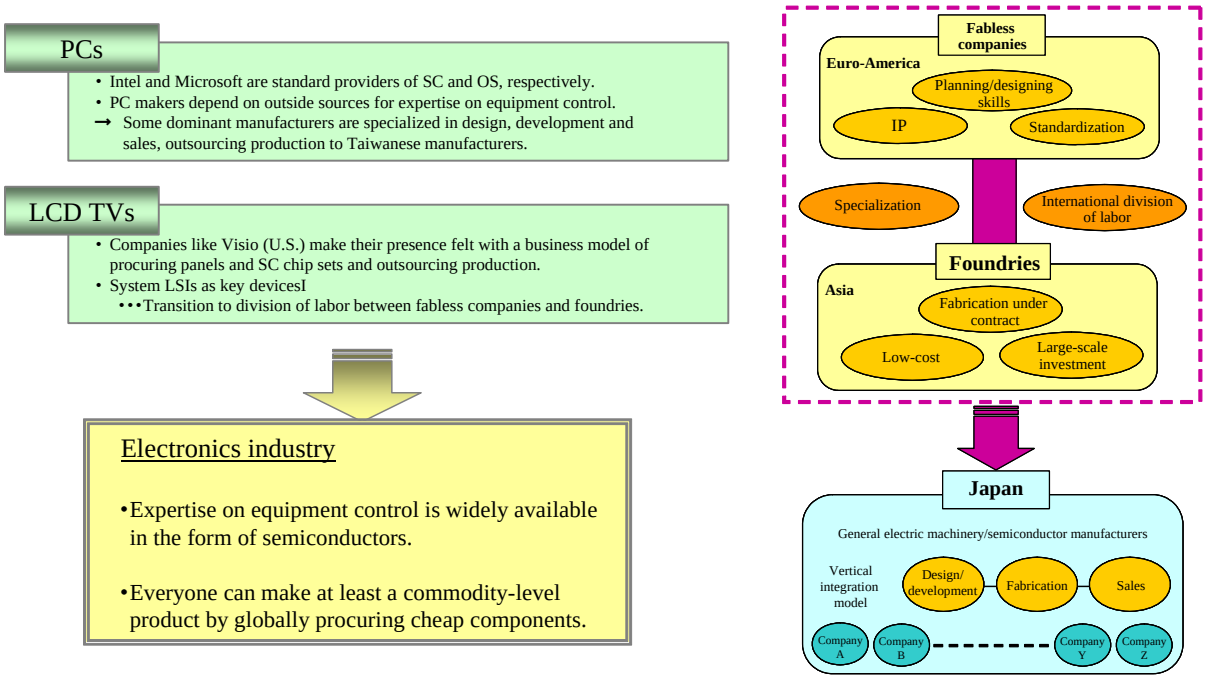
4. Policies to Rebuild Business Strategies of General Electric Machinery Manufacturers

4.1 Emergence of Division of Labor Business Model for Set Products

In the global PC industry, companies specializing in design and development are starting to differentiate their products in terms of design and logistics, while outsourcing the assembly process to other manufacturers, mainly in Taiwan; Dell is a typical example. This is largely because PC manufacturers have to depend on outside sources for expertise on equipment control. Indeed, Intel and Microsoft virtually dictate industry standards for the centerpieces of control (i.e. semiconductors and operating systems, respectively). Even with regard to LCD TVs, a typical digital household appliance, fabless companies, including Visio (U.S.), are making their presence felt by procuring panels and semiconductor chip sets and outsourcing the fabrication process.

Thus, expertise on equipment control is available from specialized sources in the electronics industry, which means that any company can create at least a commodity-level product if it can procure key devices from around the world (Figure 15). As will be described later, a business model based on the division of labor is becoming predominant in the electronics industry, not only for set products but also for semiconductors, which integrate proprietary control technology. As a result, the typical business model for general electric machinery manufacturers, which is to produce within the group the whole range of products, from semiconductors to set products, has fewer areas of comparative advantage.

Figure 15. Emerging Division of Labor Business Model in Electronics



Source: Development Bank of Japan.

4.2 Distinction between Business Areas and Closer Coordination with Upstream Materials and Manufacturing Equipment Segments

General electric machinery manufacturers need to distinguish between the business areas in which differentiation is possible by incorporating upstream segments such as materials and manufacturing equipment on the one hand, and the business areas in which technology alone can no longer ensure differentiation due to substantial levels of commoditization on the other, to enable them to redevelop business strategies suited for individual areas to increase competitiveness, while using their limited managerial resources more effectively. With regard to the latter business areas, where branding and designing as well as business models and industrial standardization are crucial for differentiation, a general electric machinery manufacturer must concentrate managerial resources on development and marketing, while cutting back on fabrication activities, including through outsourcing (Figure 16).

After focusing on its strengths through this selection and concentration process, the manufacturer should heavily invest managerial resources in any areas where it can ensure differentiation by incorporating technologies related to materials and manufacturing equipment. Possible options for a general electric machinery manufacturer include (1) enhancing in-house research on technologies related to materials and manufacturing equipment and (2) building partnerships with promising materials / manufacturing equipment makers including through joint development, tie-ups and the provision of funds for business options.

As an example of option 1, Sony created a new Chemical Device Division in May 2006 to strengthen its chemical device business for LCD panel modules for TVs. Also, Hitachi has established a joint venture for lithium-ion secondary batteries with Hitachi Maxell, a battery manufacturer of the group, and Shin-Kobe Electric Machinery, a subsidiary of Hitachi Chemical. By maximizing the synergy among the three affiliates in the field of batteries, the group intends to develop, design and fabricate all key components of a hybrid vehicle — motor, inverter and battery — and supply them as a system.[8]

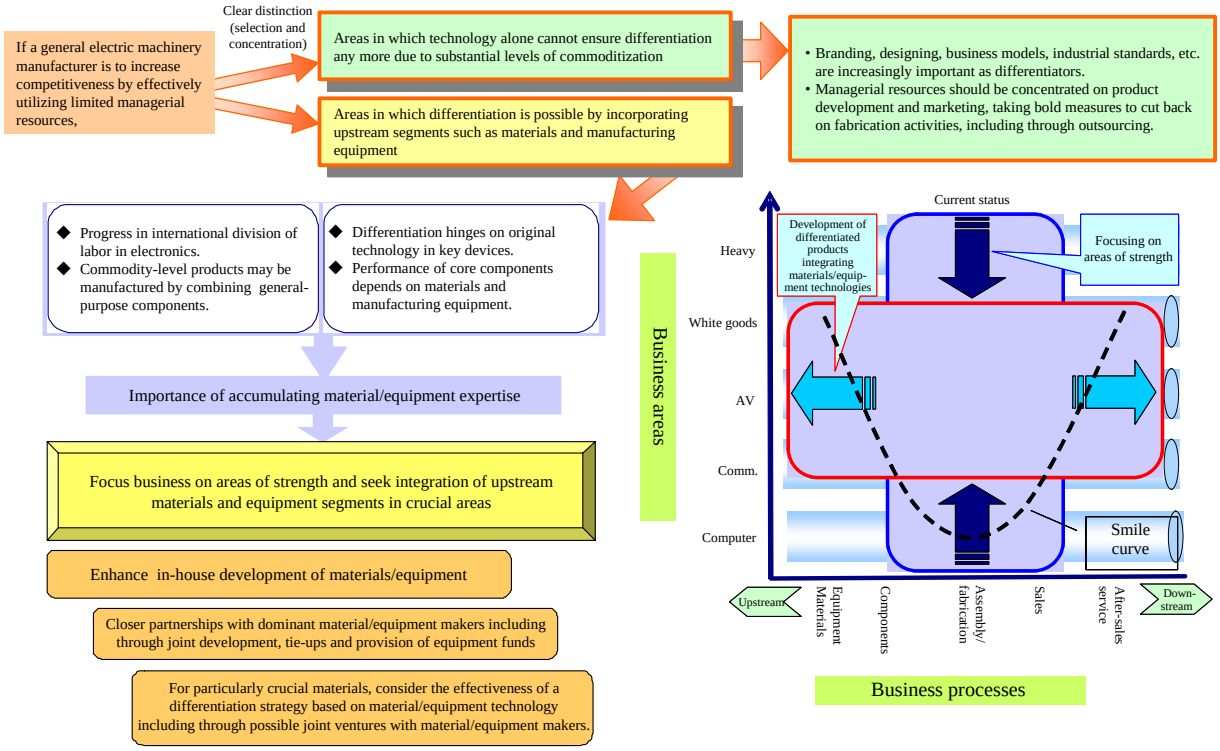
However, a general electric machinery manufacturer cannot produce all materials and equipment, nor quickly catch up with materials manufacturers which have accumulated expertise over the years. This is where option 2, building partnerships, is a realistic alternative. For example, Sharp has been involved in joint development from the designing stage with materials manufacturers to reduce the cost of backlights, color filters and polarizing plates for LCD TVs. The company's new Sakai plant, now under construction, will form an LCD manufacturing complex, as materials / manufacturing equipment makers are invited to build a fab in the plant. The aim is to achieve vertical integration that transcends the barriers between companies by pushing the vertically integrated business model further upstream in the supply chain, from LCD panels to LCD TVs, thus reducing distribution costs and unifying operations, including production planning. In addition, the close collaboration of Sharp engineers working with materials and equipment manufacturers that have superior technical capabilities should lead to technical innovations through the fusion of knowledge and know-how.[9]

For particularly crucial materials and manufacturing equipment, it is important to consider the effectiveness of a differentiation strategy incorporating materials and equipment technologies, including the possibility of a joint venture involving a capital alliance or corporate acquisition. In 2000, Matsushita Electric Industrial agreed with Toray on a partnership in the plasma display panel (PDP) business, in an effort to integrate Toray's rear panel manufacturing techniques with Matsushita's production technology ranging from panels to finished set products. Also, Tokyo Electron, a leading semiconductor manufacturing equipment maker, established in February 2008 a new joint venture company with Sharp, announcing the joint development of manufacturing equipment for thin-film solar bat-

[8] See Hitachi's press release at http://www.hitachi.co.jp/New/cnews/month/2008/01/0121.html.

[9] See Sharp's press release at http://sharp-world.com/corporate/news/070731.html.

Figure 16. Focusing Business Areas and Incorporating Upstream Materials / Manufacturing Equipment



Source: Development Bank of Japan.

teries.[10] Tokyo Electron's mass production equipment technology using vacuum plasma, which the company has developed in its semi-conductor and flat-panel display manufacturing equipment, will be combined with Sharp's solar battery manufacturing technology to develop more productive manufacturing equipment.

4.3 Building Strategies for Active Incorporation of Upstream and Downstream Segments

Manufacturers in materials-based industries, such as chemicals and iron & steel, have become involved in R&D activities downstream, including for automobiles and electric machinery. Classifying the major manufacturing industries into materials and processing/assembly industries, we find that the materials industries — chemicals, textiles, iron & steel and cement, ceramics & glass — invest 10–20% of their R&D budget in downstream processing/assembly industries (Figure 17).

The development of a new material often requires decades of painstaking research, which requires long-term management support. A comparison of electronic components production in Korea and Japan reveals that Korea exceeds Japan in the production of semiconductors, but trails far behind in general electronic components such as capacitors, resistors and connectors (Figure 18). In Korea, the export-led growth of some major blue-chip firms such as Samsung and LG Electronics contrasts sharply with the weak supporting structure including manufacturing equipment and components/materials industries as well as SMEs. For this reason, any increase in exports to the U.S. or China entails an increase in imports from Japan, thus aggravating the trade deficit with the country (Figure 19). The Ministry of Commerce, Industry and Energy (currently the Ministry of Knowledge Economy) has stated

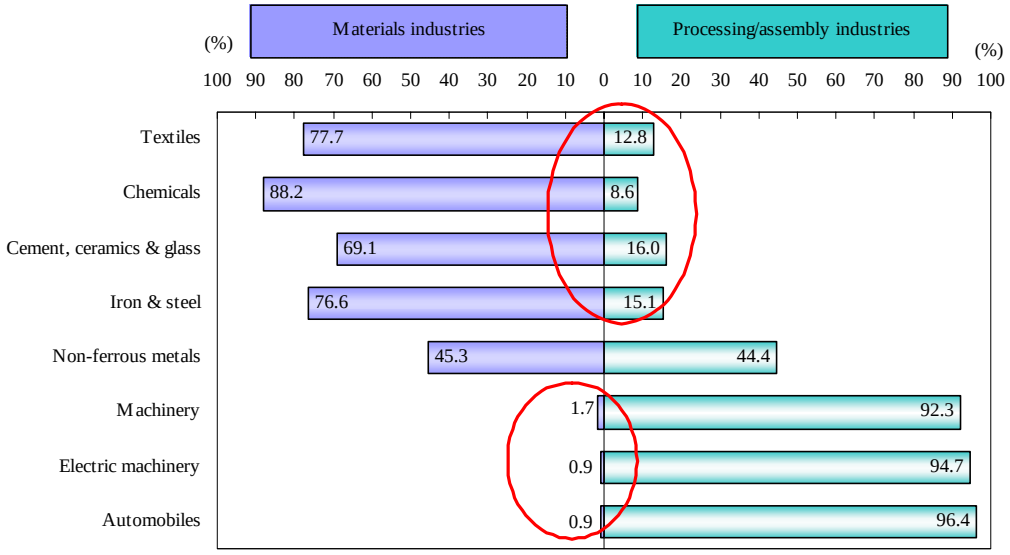
[10] See Tokyo Electron's press release at http://www.tel.com/jpn/news/2008/0218_001.htm.

that the trade balance in components and materials urgently needs to be improved, as the sector apparently accounts for more than 60% of Korea's trade deficit with Japan.[11]

Although many of the dominant electronic materials manufacturers are still Japanese companies, overseas manufacturers have been closing the gap rapidly. If general electric machinery manufacturers invest part of their huge R&D expenditures upstream in the joint development of materials, Japan may remain a center for the development and production of innovative new products incorporating materials technologies. This will not only benefit the general manufacturers themselves but also bring medium- to long-term profits to materials makers.

Even for semiconductors, which are the key part for controlling electronics products, the global trend is toward a division of labor between fabless companies specialized in design and software development, and foundries specialized in fabrication under contract. Part II outlines the progress of the division of labor model in the semiconductor industry, focusing on Taiwan, and examines how Japanese semiconductor manufacturers can restore their international competitiveness.

Figure 17. R&D Expenditures in Selected Manufacturing Industries by Destination (FY 2006)

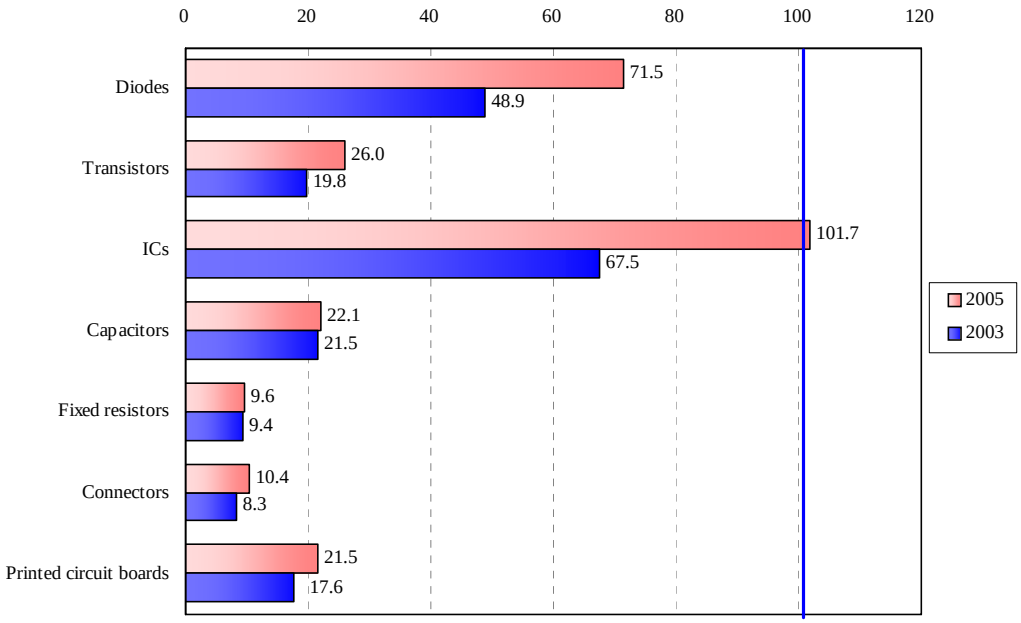


Notes: Materials: textiles, paper & pulp, chemicals, cement, ceramics & glass, iron & steel and non-ferrous metals.
Processing/assembly: general machinery, electric machinery, transport equipment and precision machinery.
Data do not include food & beverages, publishing & printing, petroleum & coal, rubber & metal products or other industrial products.

Source: Ministry of Internal Affairs and Communications, "Survey of Research and Development."

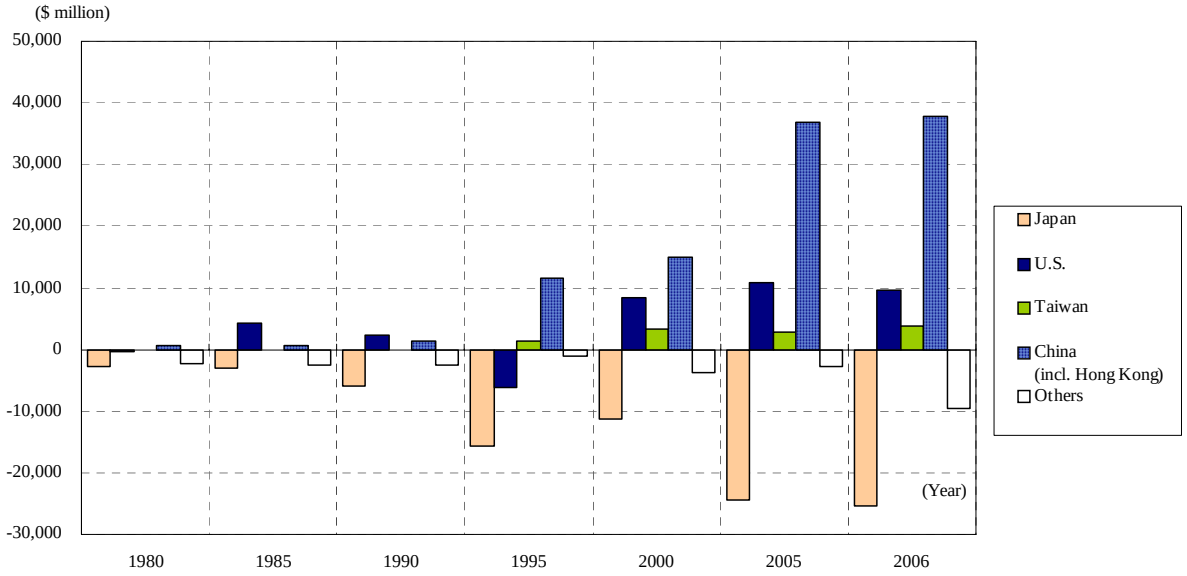
[11] See http://www.korea.or.jp/data_view_k.asp?seq=864.

Figure 18. Value of Electronic Component Production in Korea (Japan = 100)



Source: The Yearbook of World Electronics Data, Volume 2, 2006, Reed Electronics Research.

Figure 19. Trade Balance of Korea by Partner



Source: Korea International Trade Association (KITA).

II Policies to Rebuild Business Strategies of Semiconductor Manufacturers

1. Emergence of Global Division of Labor Business Model in Semiconductor Industry

1.1. Taiwanese Semiconductor Industry: Development of Division of Labor Business Model

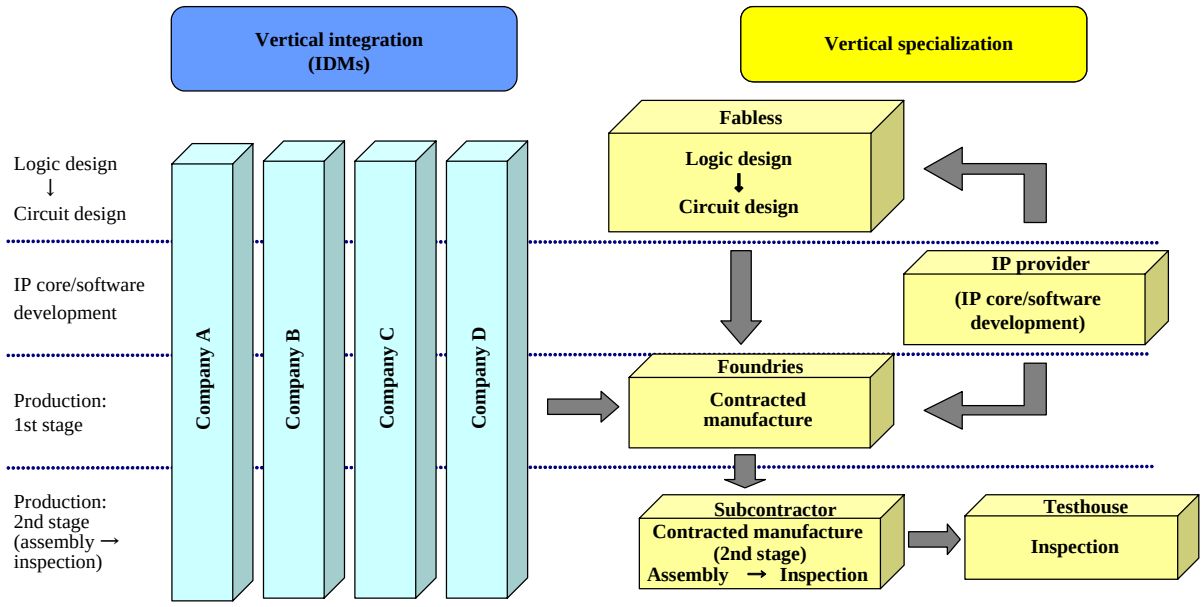
Most Taiwanese semiconductor manufacturers, which are newcomers to the market compared with U.S. and Japanese companies, have specialized in specific areas, rather than developing into integrated device manufacturers (IDMs), which cover the entire business process from design to in-house fabrication through vertical integration (Figure 20). A division of labor business model based on global partnerships between fabless ventures in Silicon Valley, specialized in designing without having their own plants, and foundries in Taiwan, specialized in fabrication under contract, has fundamentally changed the world semiconductor industry since the 1990s. A fabless company designs and develops a semiconductor at the request of a client. Once the design is completed, the fabless company sends the design data to a foundry for production under contract. The foundry often outsources the later processes (i.e. assembly and inspection) to a specialized subcontractor or testhouse.

Figure 21 shows the structure of the semiconductor industry in Taiwan, which clearly has an advantage in production where foundries play a key role. Thus, Taiwan Semiconductor Manufacturing Company (TSMC) and United Microelectronics Corporation (UMC) account for 60% of the world foundry market among themselves. Taiwan also has many leading contractors in the later processes, including assembly and testing, such as Advanced Semiconductor Engineering (ASE) and Siliconware Precision Industries (SPIL). Furthermore, fabless companies have grown spectacularly in Taiwan, including Media Tek and Sunplus Technology. The number of Taiwanese fabless companies has increased substantially, from 140 in 2000 to 260 in 2004.[12]

Figure 22 plots annual sales growth and operating profit ratio for major Japanese and overseas semiconductor manufacturers. Highly profitable manufacturers may be grouped into the following four categories: (1) leading IDMs (Intel, Texas Instruments [TI], Samsung Electronics), (2) foundries, (3) fabless companies and (4) intellectual property (IP) providers. Among IDMs, only the top three companies are making sufficient profits, with Japanese and European IDMs trailing far behind in general. In Europe, business restructuring by IDMs has been accelerating since 2005. For example, Philips separated its semiconductor department from the company's main structure, while Infineon spun off its highly volatile memory business.

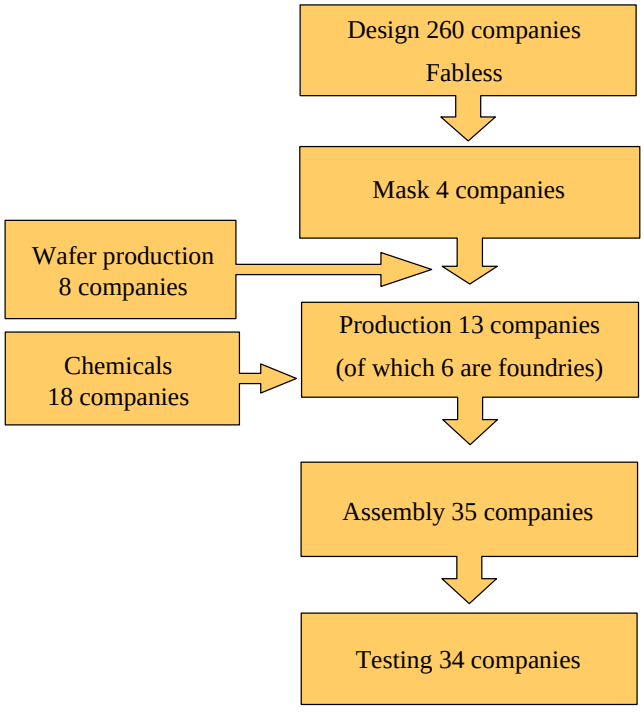
[12] Industrial Technology Research Institute, "Semiconductor Industry Yearbook 2005."

Figure 20. Vertical Integration and Division of Labor Business Models in Semiconductor Industry



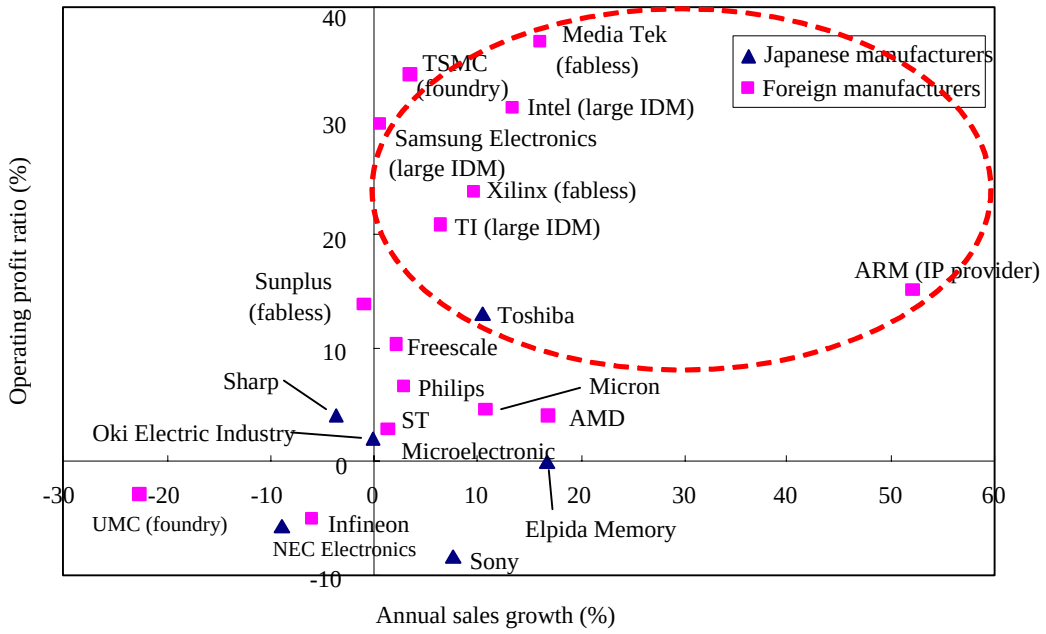
Sources: Japan Electronics and Information Technology Industries Association, "IC Guidebook"; interviews.

Figure 21. Structure of Taiwanese Semiconductor Industry



Source: Industrial Technology Research Institute, "Semiconductor Industry Yearbook 2005."

Figure 22. Relations between Sales Growth and Operating Profit Margin of Major Domestic and Foreign Semiconductor Manufacturers (2005)



Notes: As at the end of FY 2005. The fiscal year ends in March for Japanese manufacturers and in December for foreign manufacturers except for Micron (August), Infineon (September) and Xilinx (March).
Sources: Corporations' fiscal year end statements.

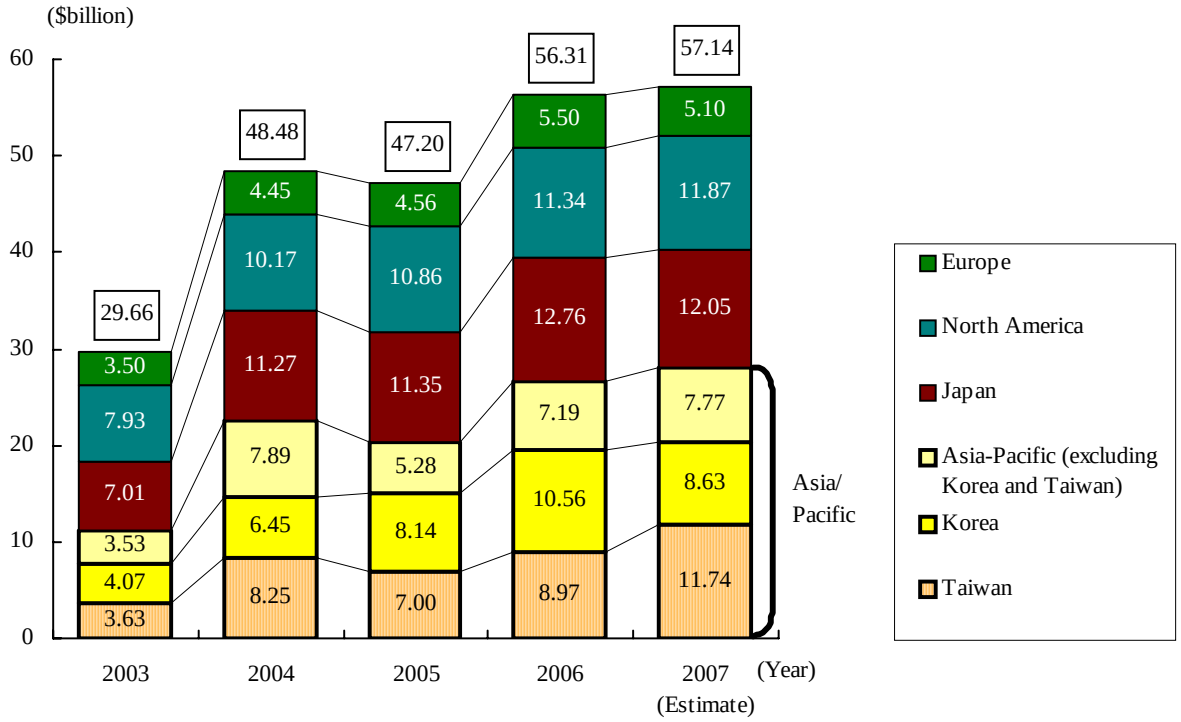
1.2 Evolution of Foundries from Fabrication Contractors to Solution Providers

The strengths of Taiwanese foundries include (1) cost competitiveness, (2) quality service, (3) leading-edge technology, (4) broad product lineups and (5) provision of IP libraries. Figure 23 shows the level of investment in the world semiconductor industry by region. Taiwan has shown substantial investment in recent years, almost catching up with Japan and North America in 2007, mainly due to the construction of 300 mm wafer fabs by foundries. Taiwanese foundries enjoy higher production capacity per fab, and have been improving their cost competitiveness through massive economies of scale. Indeed, the sales/cost ratio of TSMC is significantly lower than that of Japanese manufacturers. This, coupled with its low sales and general administrative expenses, has allowed the company to enjoy a wide profit margin (Figure 26).

Although foundries have grown rapidly by producing low-priced semiconductors, there has been growing concern that a simple division of labor model may not be sufficient to meet the new challenge of custom products such as system LSI circuits, which require coordination between design/development and fabrication. A system LSI circuit refers to a single semiconductor chip that integrates processor cores for sound, graphics, and so forth, in addition to memory and logic, and plays a central role in controlling electronic equipment. Each core has its respective IP, and it is impractical for a company to develop all the IP from scratch; it would take too long and cost too much, affecting profitability and possibly leading to the loss of clients. Fabless companies must therefore focus on the core design. They need a technique for combining their own IP with other excellent IP from around the world to ensure the rapid delivery of products.

Against this backdrop, TSMC and UMC have introduced services to help shorten total design time by creating in advance the libraries

Figure 23. Investment of World Semiconductor Manufacturers by Region



Source: Gartner, "Forecast: Semiconductor Capital Spending, Worldwide," October 2007, GJ08006.

of IP commonly used in many products or IP for peripheral circuits, to be provided for fabless companies. Since IP developed on a foundry's production line is verified before being included in its library, chips designed in this way are likely to work properly. Thus, foundries are working closely with fabless companies and EDA (electronic design automation) tool vendors from an early stage of semiconductor design and development, to grow themselves from mere fabrication contractors into providers of total solutions for the client.

1.3 Growth of Taiwanese Fabless Companies in Partnership with Foundries

Fabless companies have also been responding to the various needs of clients with efficient design techniques. Sunplus Technology, a Taiwanese fabless company, continues to grow strongly through the design of consumer semiconductors, including for toys and consoles. In the consumer semiconductor industry, efficient design is a serious challenge for management as low-cost, fast development is required. In meeting this challenge, the company was one of the first to introduce the concept of "re-usable IP." Whenever possible in designing a new chip, instead of starting from scratch, the company reuses existing IP that has been proven to work properly. It also uses the same IP for hardware where possible and only modifies embedded memory to meet the demands of different clients. This method greatly reduces the design time by reducing the design workload. The company reportedly uses such design techniques for most semiconductors used in toys.

Nonetheless, client demand for early delivery is insatiable. In response, the company devised a "wafer bank" strategy in collaboration with a foundry to cut the lead time further. For system LSI circuits comprising 15 layers, for example, the company accumulates on the 1st to 10th layers common circuit blocks that are needed in every type of chip and then builds a stock ("bank") of wafers made up of these 10 layers. On receiving an order from a client, the company draws a 10-layered wafer from the wa-

fer bank and customizes the remaining five layers. If delivery takes six weeks when all 15 layers are designed from scratch, the new strategy may reduce the lead time to about two weeks. This approach is impossible without close collaboration with the foundry from the design stage.

The semiconductor industry requires good coordination between design and fabrication. To compete with IDMs, which have both of these functions in-house, establishment of a mutually reinforcing system is being pursued in Taiwan by combining fabless companies' own efficient design techniques and foundries' flexible production technologies to respond more promptly to the diversified needs of clients.

2. Policies to Restore International Competitiveness of Japanese Semiconductor Industry: With Special Focus on System LSI Circuits

Semiconductors are manufactured by the hundred in the form of wafers upon which circuits are constructed with a mask. Production costs will decline if more wafer chips can be manufactured from a single mask (the advantage of scale). Therefore, securing an overwhelming market share for a general-purpose product, such as memory or processors, is the best way to ensure profitability in the semiconductor industry. Likewise, success in application-specific products depends on standardization to allow sales to as many customers as possible, rather than focusing on a small number of specific clients.

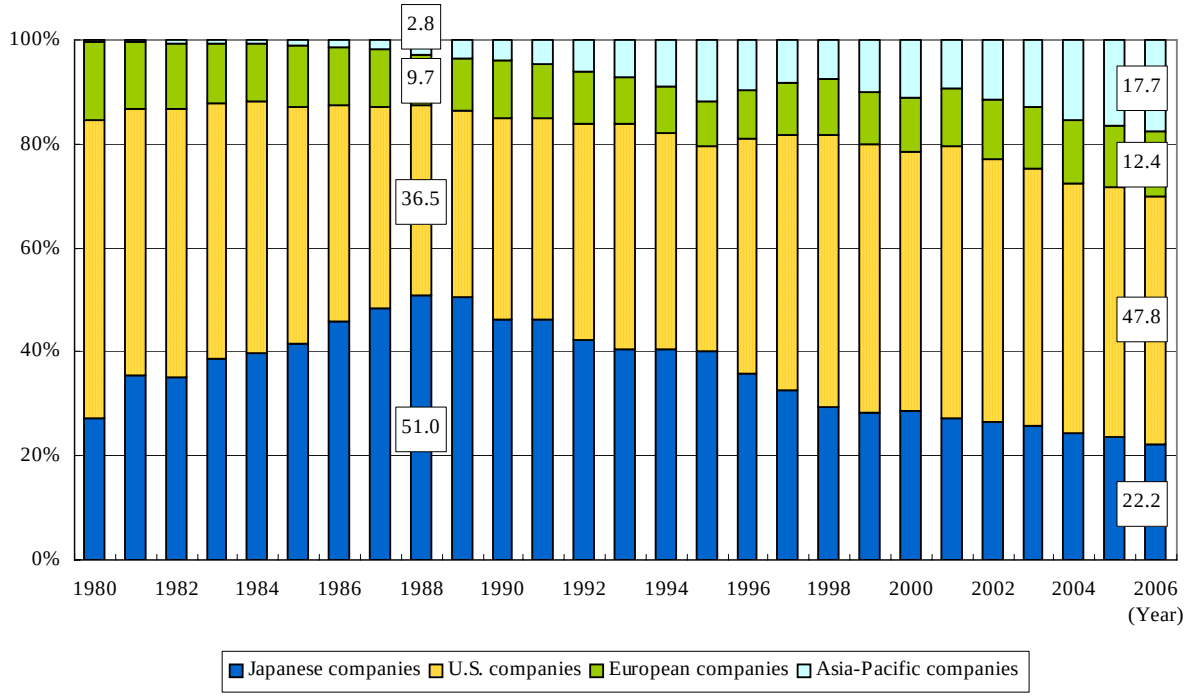
After exiting the general-purpose DRAM market, many Japanese manufacturers turned to application-specific custom products. However, the share of Japanese manufacturers in the world market fell by over 50% from the peak of 51% in 1988 to 22.2% in 2006, reflecting the continued decline in their international competitiveness (Figure 24).

Application-specific semiconductors can be broadly classified into application-specific integrated circuits (ASICs) for a single client and application-specific standard products (ASSPs) for two or more clients. Japanese manufacturers hold an advantage in the former type of product. However, demand for an ASIC heavily depends on the sales of the final product on which it is mounted. The ensuing high-mix, low-volume production virtually precludes the advantage of scale. Regarding the highly promising ASSPs, on the other hand, overseas manufacturers have the largest market shares, indicating that Japanese manufacturers are falling behind in the competition for standardization in the industry. As they followed the herd and shifted to high-end custom products, while having no product with an overwhelming market share or originality and struggling in overseas markets, competition has intensified among Japanese manufacturers in the domestic market, suppressing their profits (Figure 25).

Investment by most Japanese manufacturers has not yet reached ¥100 billion, with the exception of memory makers. The difference in production scale with Taiwanese foundries, with a capacity of 30,000 – 40,000 chips per fab, ultimately affects cost competitiveness. Even among IDMs, there is a striking difference in profit structure between Japanese and U.S. manufacturers. A comparison among NEC Electronics, TI and Intel reveals a wide gap in the operating profit ratio, despite the fact that the ratios of sales, administrative and R&D expenses to total sales are similar (Figure 26). Thus, the huge R&D and sales expenses incurred by Japanese manufacturers are not sufficiently reflected in the sales prices of products, which reduces their profits and does not bridge the financial gap with overseas competitors.

The future of the Japanese semiconductor industry will depend on three categories of product: (1) memory, (2) power semiconductors/sensors and (3) system LSI circuits. As regards memory, a short-list of potential players has already emerged for both flash memory and DRAM. Japanese manufacturers may also capitalize on their strengths in power semiconductors and sensors, particularly for industrial use and vehicles. Against this backdrop, the most serious challenge facing the Japanese semiconductor industry is how to support the business of system LSI circuits, which are the heart of electronics products. Although demand for system LSI circuits is expected to grow in the years ahead as they are essential for making equipment smaller and more sophisticated, Japanese manufacturers

Figure 24. Composition of the World Semiconductor Market by Manufacturer Region



Source: Gartner Dataquest, March 2007, GJ07198.

Figure 25. Issues Facing the Japanese Semiconductor Industry

(1) Lack of products with an overwhelming market share or unique features

(2) Insufficient business investment

(3) Slow response to changing business models

(4) Decline in cost competitiveness

(5) Weak sales ability and marketing in overseas markets

(6) Financial base susceptible to volatility

(7) Slow progress in industry-academia-government collaboration

Source: Development Bank of Japan.

Figure 26. Cost Structures of Major Foundries, Fabless Companies and IDMs (FY2006)

(¥billion, ratio)	Foundries				Fabless companies				IDM					
	TSMC		UMC		Xilinx		Altera		NEC Electronics		TI		Intel	
Sales	1,027.1	100.0%	362.4	100.0%	215.5	100.0%	149.5	100.0%	646.0	100.0%	1,658.3	100.0%	4,116.0	100.0%
Sales cost	522.9	50.9%	293.3	80.9%	84.0	39.0%	49.8	33.3%	477.5	73.9%	813.9	49.1%	1,996.7	48.5%
Gross profit	504.2	49.1%	69.1	19.1%	131.5	61.0%	99.8	66.7%	168.5	26.1%	844.4	50.9%	2,119.3	51.5%
Operating cost	92.4	9.0%	52.4	14.5%	90.8	42.1%	64.7	43.3%	204.2	31.6%	452.8	27.3%	1,461.8	35.5%
Sales & marketing expenses	12.1	1.2%	10.9	3.0%	45.4	21.1%	35.8	23.9%	83.3	12.9%	197.4	11.9%	778.6	18.9%
General & administrative expenses	28.2	2.7%	11.1	3.1%										
Research & development expenses	52.0	5.1%	30.5	8.4%	45.4	21.1%	28.9	19.3%	120.9	18.7%	255.3	15.4%	683.2	16.6%
Operating profit	411.8	40.1%	16.7	4.6%	40.7	18.9%	35.0	23.4%	-35.7	-5.5%	391.7	23.6%	657.5	16.0%
Pre-tax profit	431.6	42.0%	118.4	32.7%	50.4	23.4%	41.8	28.0%	-42.4	-6.6%	421.7	25.4%	822.2	20.0%
Net profit	411.6	40.1%	104.0	28.7%	41.0	19.0%	37.6	25.1%	-98.2	-15.2%	505.0	30.5%	586.8	14.3%

Notes: 1. The financial year ends in December for TSMC, UMC, Altera, TI and Intel, and in March for Xilinx and NEC Electronics.
2. Exchange rates: T$1 = ¥3,577 (2006 average), $1 = ¥116.3 (2006 average), $1 = ¥117 (FY2006 average).
Sources: Corporate annual reports.

are finding it difficult to be profitable in this area. How can they increase their international competitiveness?

The decision on what to make in light of the functions required of the final product is a major factor in producing a system LSI circuit. Since success depends on design/development skills and marketing, management should focus again on these two factors. Larger shipments are essential for profitability. Therefore, a marketing technique is required for turning a product into an ASSP by building versatility into the product from the development stage and marketing it to other clients. Design engineers should be able to identify the most generalized needs that are common to multiple clients. Assigning engineers to the marketing department would help give feedback to the development process (Figure 27).

In the LSI business, it is crucial to link product development, fabrication and sales strategies horizontally when making business decisions. An overhaul of corporate management, organizational control and personnel evaluation is urgently needed if Japanese manufacturers are to fully adapt to the system LSI business. For example, thorough evaluations should be made on a cross-departmental basis, in addition to the traditional evaluation by individual departments such as production and design.

In order to increase the volume of shipments, it is important to sell products developed for in-house use to external clients. This will entail the rebuilding of relationships with internal set product departments. An enabling environment needs to be developed for the semiconductor department to make independent business decisions by clarifying in the corporate strategy whether to give preference to internal or external sales.

In partnership with fabless companies and EDA (electronic design automation) tool vendors worldwide, foundries have created a smooth division of labor mechanism, thus undermining the traditional advantage gained from vertical integration of all processes, ranging from design and development to fabrication. Being focused on application-specific custom products, Japanese semiconductor manufacturers often do not have a whole range of products at the global standard level that can ensure sufficient shipments to warrant huge investment. Thus, investing hundreds of billions of yen in a state-of-the-art semiconductor fab is not likely to produce sufficient profit to cover the cost. In view of their limited managerial resources, many Japanese semiconductor manufacturers should now put top priority on coordinated enhancement of their product development and marketing capacities within their LSI business. As for fabrication, they should seek revitalization by leveraging complementary partnerships on a global scale, for example.

Figure 27. Strategies to Strengthen Competitiveness in System LSI

1. Refocus operations on design and marketing
   - Shift from custom-made ASICs to widely marketable ASSPs.
   - Development of standard products through design efficiency and enhanced coordination between design and sales
2. Active involvement in global alliances
   - Departure from self-sufficiency, selection and concentration of business on areas of strength
   - Enhanced partnerships with fabless companies, foundries and IP providers
3. Rebuild relationships with final set product departments
4. Overhaul of corporate management, organizational control and personnel evaluation
   - Horizontal linkage of product development, fabrication and sales strategies
   - Attitude to appreciate cross-departmental efforts

Source: Development Bank of Japan.

3. Increased Importance of "Management" and Involvement of Funds in Semiconductor Industry

Euro-American investment funds are increasingly becoming involved in business restructuring in the world semiconductor industry (Figure 28). In September 2006, investment funds including Kohlberg Kravis Roberts (KKR) and Bain Capital provided 80.1% of the capital for NXP, a semiconductor spinoff from Philips. They are expected to increase the value of the company, including through corporate acquisitions leveraging their abundant financial resources. Freescale, a Motorola spinoff established in 2004, became a private company? following the completion of a leveraged buyout (LBO)[13] in 2006 by a private equity consortium that included Blackstone and Carlyle. Michael Mayer, president and CEO of the company, said that the LBO facilitated faster decision-making with greater flexibility and provided ample opportunity to gain additional insight and resources, noting: "I believe this model [becoming a private company through an LBO] is particularly advantageous as the semiconductor industry enters a consolidation phase."[14]

Now that some Euro-American investment funds have been facing difficulties in financing following the subprime mortgage crisis in the U.S., government-sponsored funds, particularly in the Middle East, are emerging as new shareholders of semiconductor manufacturers. In November 2007, Mubadala Development, an investment company wholly owned by the Abu Dhabi government in the United Arab Emirates, acquired 8.1% of the capital of Advanced Micro Devices (AMD), a leading U.S. semiconductor manufacturer. Previously, many government-sponsored funds focused on long-term stable investment, including in sovereign bonds. But in recent years, they have diversified their portfolio into other sectors including energy, heavy industries, infrastructure and airlines, taking into account such factors as the level of return and the development of the domestic industry. As a recent example, Istithmar, an investment firm affiliated with the Dubai government, outbid Japanese competitor Fast Retailing in the acquisition of Barneys New York, a U.S. high-fashion retailer. Government-sponsored funds are also increasingly interested in general electric machinery manufacturers. Thus, Dubai

[13] Acquisition of a company using borrowed money, often by pledging the assets of the company being acquired as collateral. Companies whose market capitalization is undervalued are considered to be easy targets for LBOs.

[14] See Mayer's address at Freescale Technology Forum Americas 2007 at http://media.corporate-ir.net/media_files/irol/19/196520/FTF2007_Keynote_Michel_Mayer.pdf.

International Capital (DIC) announced in November 2007 that it has made a substantial investment in Sony.[15]

Until recently, fund managers did not consider semiconductors a potential target of investment. The recent inflow of investment money into the semiconductor industry indicates that the industry has entered a transition period. Indeed, the volatility of the silicon cycle has diminished, improving the prospects for relatively stable growth. Moreover, the performance of semiconductor manufacturers has come to depend on successful management, as well as on the superiority of advanced technology in terms of miniaturization and yield.

Faced with the changing environment, an increasing number of semiconductor manufacturers are now looking for a new management model. For example, TI has introduced a hybrid model using both its own fabs and foundries for the production of advanced logic semiconductors.[16] This model aims at reducing the huge investment burden, focusing on expanding production capacity for its signature analog semiconductors, and keeping the company's fabs running at a high level by adjusting to demand fluctuations through outsourcing. TI believes that the foundry industry has closed the gap in the development of cutting-edge processes and will meet the company's requirements. Indeed, the next-generation 32 nm process will be developed in collaboration with foundries.

Business strategies are also being reviewed by domestic semiconductor manufacturers. Fujitsu, for instance, will spin off its semiconductor business in March 2008 to speed up decision-making, while allowing for more discretion in management to increase business value.[17] Renesas and Sharp will jointly establish a new company to integrate their medium- and small-sized LCD driver IC businesses. As a fabless manufacturer, the new company will specialize in design/development and sales, and outsource most of the fabrication process to Powerchip Semiconductor Corp. (PSC) in Taiwan. Driver ICs for medium- and small-sized LCDs are in high demand, led by rising cellular phone sales in China and India, but price competition has intensified due to the emergence of fabless companies. The two companies are responding to the stiffer market competition by making maximum use of PSC's fine processing capacity and production cost competitiveness.[18]

As the construction of a modern semiconductor fab requires huge investment, only a handful of manufacturers can make profits from semiconductor production. As noted earlier in this report, fabless companies are also growing rapidly in Taiwan, the home of world-leading foundries, indicating that the source of differentiation in the semiconductor industry is shifting to the design and marketing of standard semiconductors and software. Since success in this business depends essentially on ideas, the market is relatively easy to penetrate even for a small venture, provided that it has unique expertise. Although some semiconductor ventures have started up in Japan, they lag far behind their overseas counterparts in number and scale. If IDM-structured Japanese semiconductor manufacturers can break away from their traditional preference for self-sufficiency and make more effective use of external resources, business opportunities for venture companies will expand, possibly making the domestic semiconductor industry more competitive.

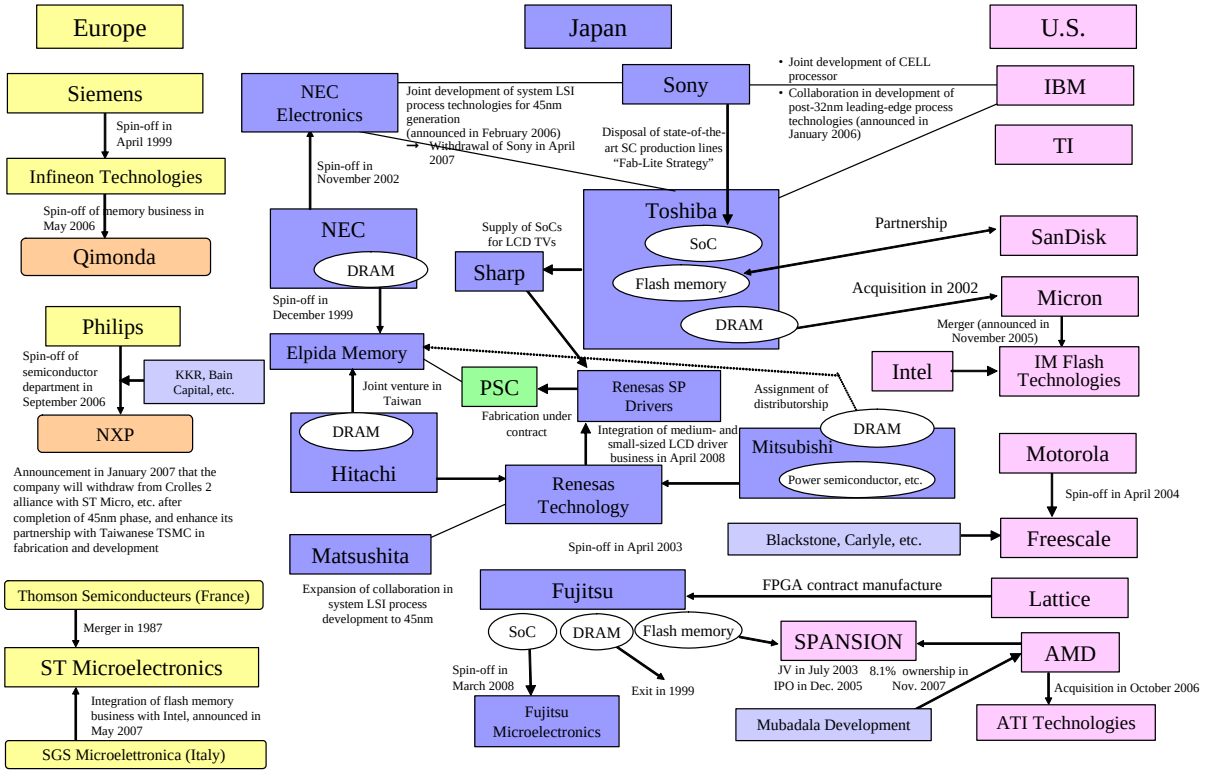
[15] See DIC's website at http://www.dubaiic.com/en/latest-news/gsef-sony-corporation.html.

[16] Document prepared for a TI analyst meeting, available at http://www.ti.com/corp/docs/investor/analyst2007/pdfs/Ritchie.pdf.

[17] See Fujitsu's press release at http://www.fujitsu.com/global/news/pr/archives/month/2008/20080212-01.html.

[18] See Renesas Technology's press release at http://japan.renesas.com/homepage.jsp.

Figure 28. Partnerships and Restructuring in Domestic and Overseas Semiconductor Industry



Source: Development Bank of Japan.

Conclusion

This report verified the causes of the decline in the international competitiveness of Japanese general electric machinery manufacturers and semiconductor manufacturers, which mainly specialize in application-specific custom products such as system LSI circuits, by comparing them with electronic components and materials manufacturers. It also identified a major challenge common to general electric machinery and semiconductor manufacturers — how to respond to three key trends: progress in the global division of labor, changing differentiators, and expansion of emerging markets led by low-end products.

It is reasonable for a general electric machinery manufacturer to retain a semiconductor department within the group and continue investment in cutting-edge processes, if the group has a significant application that serves as a differentiator. However, there are very few such manufacturers, if any. It is increasingly difficult for semiconductor manufacturers to operate the whole system LSI business in a vertically integrated manner, from designing through fabrication. For products that entail huge investment and substantial risk, semiconductor manufacturers should concentrate resources on design/development and marketing, and consider forming partnerships with foundries and other companies.

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