

Episode 20

Rise and Fall of Japanese Semiconductors

We do not see other industries in which technology innovation is so intense, and market fluctuation is so drastic like semiconductors, do we? Caused by its violent nature, a winner yesterday becomes a loser today, and it reminds us of the first phrase of the *“The Tale of the Heike”*:

“The sound of the Gion Shoja bells echoes the impermanence of all things; the color of the sala flowers reveals the truth that the prosperous must decline. The proud do not endure, they are like a dream on a spring night; the mighty fall at last, they are as dust before the wind”. (Cited from *“The Tale of the Heike”* translated by Helen Craig McCullough, Stanford University Press).

Regardless of country or region, whether it is by company or by individual level, the transition situations have been greatly impacted by the dynamism of semiconductors. However, there is one clear difference in semiconductors compared to a resignation view of *The Tale of the Heike*. It is that there is always a next chance of recovery, even if you once have become a loser from a winner. For those who are involved in semiconductor, you should never forget the mind of “never give up!”

The United States invented transistors and ICs, and they had become the world leader by establishing an overwhelming position until the 1970's. However, since the late 1970's, they lost their fierce competition against Japan, and they were in all pessimistic mood.

Meanwhile, Japan expanded its market share supported by a large domestic market in the consumer field at that time. Furthermore, Japan surpassed the US in the competition in memory field for the computer market, and it expanded its market share through the 1980's. Japan grasped more than half of the world market share in the late 1980's.

The decade of 1980's was the time of sunset in the US, and sun rise in Japan, and it was the era of *“Japan as No. 1”*.

However, this situation was overturned again in the 90's. The United States, which tackled the strengthening of semiconductors as a national move, revived their momentum, and passed Japan again with the share in 1993.

And they have maintained the overwhelming position until today. On the other hand, Japan's share of over 50% at its peak degraded to 20% level. In the 1990's the sun rose again in the US, and the sun set in Japan. Fig. 20.1 shows the trend of the semiconductor market share of Japan and the US.

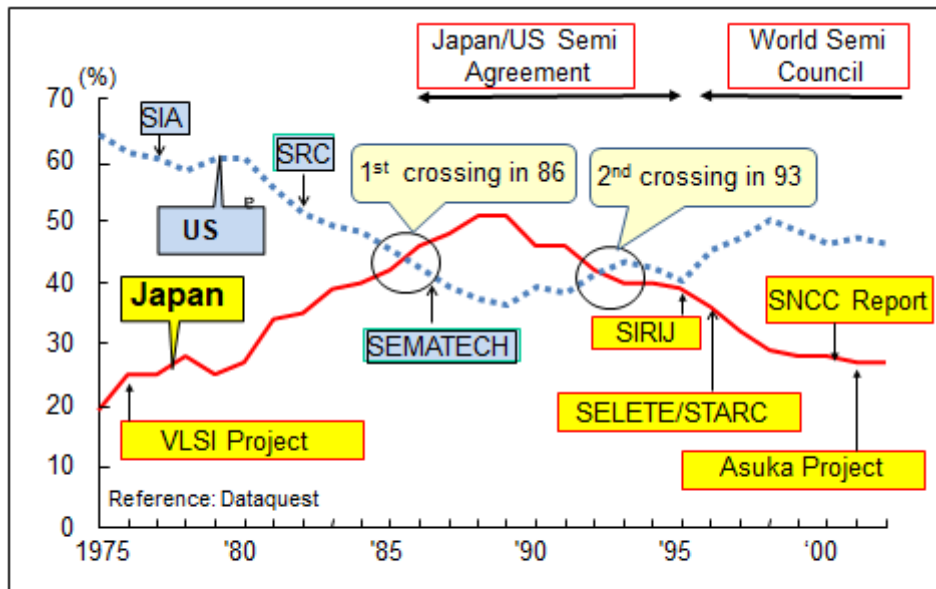


Fig. 20.1 Semiconductor market share of Japan and US

Such severe changes were naturally seen repeatedly on individual company basis as well. For example, let's see the transition of the top ten companies in the world. Since 1970 Texas Instruments (USA) reigned as the world leader for about 15 years. Among the top ten companies in 1981, five companies were American companies, four Japanese and one European. It was an era of sweeping victory of the United States.

Later, however, the big leap of Japanese manufacturers began, and finally NEC took the top position away from Texas Instruments in 1985. It was also a symbol of the era of "Japan as No. 1", as in the title of Ezra Vogel's book.

In 1989, the top ten positions were occupied by six Japanese manufacturers with NEC as the top, and three from US and one from Europe. In the analogy of the Olympic Games, Japan monopolized all Gold, Silver, and Bronze medals, and it became the age of overwhelming victory of Japan.

However, in the 1990's, the relative share of Japanese manufacturers gradually decreased. Especially the decline of Japan after the big depression in 1996 was prominent. The number of top ten companies by country in 2006 was 4 in the United States, 2 in Japan, 2 in Korea and 2 in Europe. Compared with 1989, the number of Japanese companies drastically decreased from six to two, and the number of other areas increased by that amount, resulting in the form of "Japan being the only loser".

What is the factor that brought about such marked changes? The answer, of course, is not simple, but by examining the historical trends so far, it is possible to mention several factors as below.

The first factor is the change in the geographical market structure.

Until the early 1980's the US market was the largest in the world, and US manufacturers took advantage of such situations to take a majority share of the world. At that time the Japanese market

was much smaller than the US market, and accordingly Japanese manufacturers' market share was around 30% in the early 80's. The US was far leading. However, in the late 1980's the situation drastically changed.

Thanks to the rapid increase of consumer sector, the Japanese market exceeded the US market, and became the world largest. Japanese manufacturers made a leap forward making full use of this advantage, winning the world market share of 52%. It was a reversal of the game between Japan and the United States.

However, in the 1990's, the market was driven by PC, and Japanese manufacturers missed this tide. The ratio of domestic market in the world shrank relatively, and along with this the share of Japanese manufacturers continued to decline year by year, and now it has fallen to less than half of its peak.

The second factor is the conversion of technology and products.

From the late 1970's to 1980's, memory product (DRAM) was in the center of rapid increase of exports from Japan to the US. In a sense, DRAM was a kind of specialty of Japan.

Since the 1990s, however, a major change occurred in product composition. The proportion of microprocessors and logic LSI's exceeded that of memories, and the US had much stronger competitiveness in these fields.

The third factor is the role of the governments responsible for industrial policy. In the 1970's, Japanese government clearly positioned semiconductors as an important strategic field of the country. "VLSI Project" that was started in 1976 symbolizes this situation. However, this project would face to the strong criticism from the United States as the "system of the government and the private adhesion" or the "system of Japan Inc."

As the result, from 1980 when this project was over until 1995, no such collaborative project of industry and government was conducted in Japan, and it is called "15 years in blank".

Meanwhile, in the United States, Europe, and Asia, semiconductor was positioned as "the country's most important strategic field", and large-scale public and private collaborative projects were started in various countries since the 1980's, following the model of Japanese project as the success example. Among them, the SEMATECH of the United States which was established in 1987 achieved a major accomplishment.

The fourth factor is the change in management style (business model).

Until the 1980's when Japan was leading the industry, most of the semiconductor management was vertically integrated within the companies. In other words, it was a system that included almost all of the business operations such as design and development, wafer manufacturing, assembly / test, all the way down to sales.

However, a big change took place in the 1990's. That was the rise of the horizontal business model. It was TSMC in Taiwan that led such a new movement. The company established a new business model (silicon foundry) that undertook only the wafer manufacturing.

At the same time, a fabless business model in which only design and development were done within the company started, and manufacturing was outsourced in this model. Xilinx, Altera, and

Qualcomm etc. are in this category, and these companies have been working in collaboration with foundry makers. Japan lagged behind in responding to this horizontal division move, and it is one of the causes of its share decrease.

The fifth factor is the difference in the organizational form of the corporations.

In Japan, in many cases, semiconductor businesses have been managed as division operations of major electronics manufacturers, whereas in the United States, most of them are specialized semiconductor manufacturers, like Intel, Texas Instruments, and Micron etc. Also in Europe they were major electric manufacturers such as Siemens (Germany), Phillips (Holland), and Thomson (France), etc. who initially led the semiconductor, but now they have been all transformed into independent semiconductor specialized companies.

Similar moves in Japan are now starting, and industry reorganization is proceeding. NEC and Hitachi's DRAM business were spun out to establish independent DRAM company, Elpida, in 1999, and it became the first semiconductor specialized major company in Japan. In addition, after a big recession in 2001, NEC Electronics was spun off from NEC, and Hitachi and Mitsubishi's system LSI divisions were merged to form Renesas Technology.

Although conditions are being set for prompt decision making, the goal is still long way off.

The sixth factor is the expansion of globalization.

Since Japan was the world's largest market in the latter half of the 1980's, Japanese semiconductor manufacturers focused strong attention on the domestic market. However, the market composition of today has changed greatly, and the shift to Asia is clear.

The challenge of Japanese manufacturers is how to cope with such changes in geographical market structure. Fig. 20.2 shows the difference in geographical market structure between 1990 and 2005.

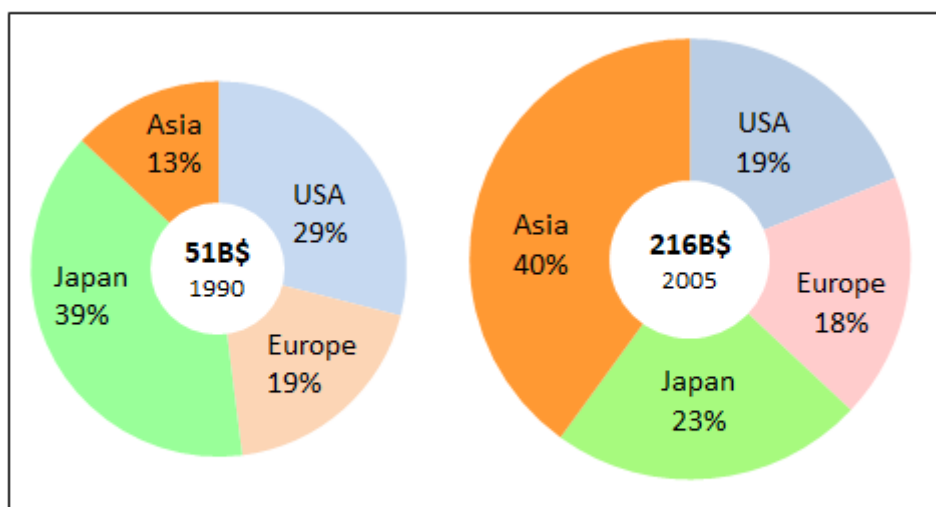


Fig. 20.2 Geographical market share of semiconductors

The seventh factor is collaboration between academia such as universities and national laboratories and industry. Since semiconductors are based on leading edge technologies, the roles played by universities and research institutes are quite large. If we look into the development history of Silicon Valley for example, it is clearly understood that the adjacent Stanford University and the University of California/ Berkeley played very important roles.

What is expected of the university is to fulfill the leading role in research and to provide talented human resources. SRC (Semiconductor Research Corp.) was established in the United States in 1982 and has played a central role for industry-academia collaboration. Since the establishment of SRC, research on semiconductors has been actively conducted at universities in the US, and the number of presentations at major international conferences has overwhelmed the universities in other areas.

In Japan, STARC (Semiconductor Technology Academic Research Center), a model based on SRC, was founded in 2005, which, however, lagged behind SRC by more than 20 years.

The decline in the competitiveness of Japanese semiconductor is due to the failure to adapt successfully to the situation changes as described above, including management and technology. In Charles Darwin's evolution theory, the survival of the fittest means "*It isn't the strongest of the species that survive, nor the most intelligent but the ones most responsive to change*".

The semiconductor industry in Japan have lacked in the quick response to the changes for many years.

The response from the Japanese government up to today also contains a big problem. Until the 1970's, the government regarded the semiconductor as important strategic field. The change occurred after the "US-Japan Semiconductor Agreement" concluded in 1986. Since it was decided to double the market share of foreign-made semiconductors in Japan from 10% to 20% in this agreement, Japanese government made strong administrative guidance to the semiconductor users in Japan "to use foreign made semiconductors as much as possible, instead of Japanese made products."

It seems that the DNA embedded at this time still substantially remains unchanged until today.

Due to the various factors mentioned above, the sun which rose in Japan in the 1980's declined in the 1990's and finally set in the big depression in 2001.

Comparing today's situation of Japanese semiconductor with that at its height, it reminds us of a phrase of *The Tale of Heike* "*The proud do not endure, they are like a dream on a spring night*", but this is also a consequence of the intense dynamism of semiconductors.

However, its dynamism gives new opportunities to losers, too. The Japanese semiconductor industry must challenge the new era without losing the mind of "Never give up!".

For that purpose, we need efforts to gather all the power of the country, and I will revisit on this point later.

Note: The original version of this article was first published, in Japanese, on the Semiconductor Industry News (Sangyo Times Co., Ltd.) from July 12, 2006 to January 9, 2008.