Episode 8
New Age of Memories and Microprocessors

In the early 1970's, the era of calculators which drove the LSI business was gone along with the oil shock, and after that the era of the memories and microprocessors was newly opened. This field has been the main battlefield for semiconductors for a long time since then. It was Intel that played the most important role in the development of memory and microprocessor products and market development.
First of all, I would like to talk about the foundation of Intel Corporation.

The time machine flies to 1955.
William Shockley, one of the transistor inventors, succeeded in receiving support from Arnold Beckman who ran an instrumentation company, aiming to establish his own semiconductor company, and started to scout nationwide top-notch semiconductor engineers. The Shockley Semiconductor Laboratory, founded in February 1956, started with members of 25, including Robert Noyce and Gordon Moore who would later become the founders of Intel.
Although Shockley was a person with an extremely excellent brain, his personality regarding personal relationships, on the other hand, was somewhat abnormal, and company members gradually lost trust in him. Under these circumstances, Noyce and other 7 members left the company in August 1957. Although they were labeled "8 Traitors", they would then become the central characters of the Silicon Valley and would contribute to the prosperity of the semiconductor industry as a whole.
Noyce was 28 years old then. By fully utilizing their various connections, they succeeded in getting support from a millionaire Sherman Fairchild, who was the owner of an aircraft camera company, and established "Fairchild Semiconductor" company in October 1957.

At the time, there was a strong demand for semiconductors from the military industry such as missiles and space satellites, and the performance of Fairchild Semiconductor grew rapidly. They introduced IC to the market as the first manufacturer in the world in 1961, and established the top position.
However, in 1968, due to the market slump, they fell to a deficit for the first time since their start. And the parent company in New York took the initiative to change the top personnel. Responding to this personnel affair, Noyce decided to leave the company and confided it to Gordon Moore. Moore left the company in sync with the determination of Noyce, and his subordinate Andy Grove also took action with them.

At that time, Noyce was 40, Moore 39, and Grove was 32 years old.
A new company was established in July 1968, with these three persons as the core members. Total members were about 10 people, and this was the start of Intel which reigns the semiconductor market today.

The first product the company worked on was semiconductor memory. Although magnetic core memories were used in the computers at the time, they were slow and had difficulty in miniaturization of computers. Intel aimed to replace core memory with semiconductor.

Their first product was 64-bit bipolar memory, but the product, which gave an enormous impact on the semiconductor industry, was 1 Kbit DRAM (Dynamic Random Access Memory), named 1103, which they commercialized in October 1970. The selling price was 10 dollars, which was also competitive with core memory. And this is the very epoch-making product which shines in the semiconductor history even today.

The semiconductor memory was very highly valued from the viewpoint of operation speed and miniaturization of computer. Many semiconductor makers subsequently entered the DRAM field, and fierce competition was repeated. It also triggered the trade friction between the US and Japan, and I will revisit this matter in the later section.

Now let's talk about the birth of microprocessor.

Intel introduced the 4-bit microprocessor 4004 to the market in November 1971, and the story behind its development was also very dramatic.

An order of custom LSI from a Japanese calculator maker, Nippon Calculating Machine Corp. (commonly known as Busicom), triggered this historic event. It was in 1969, soon after the foundation of Intel. Busicom requested the development of 13 different types of custom LSIs for the different calculator types, but it was difficult for Intel, a newly starting company, because of the shortage of engineering resources.

Ted Hoff, who was in charge of this project, addressed the problem from a different angle. And he came up with the idea that, instead of separately developing all the chips, a small number of chips would be able to cover different calculator types by combining the memory and the processor properly and coping with different specifications by changing the program contents of the memory. That is, the idea was similar to the computer processing of different tasks by changing software.

Together with Toshimasa Shima who was dispatched from Busicom, the 4-bit microprocessor 4004 was developed and commercialized based on this idea.

Since Busicom had borne the development cost of this chip, they owned the right to sell the products. But ironically, the calculator market went into a rough battle from that time. The business of Busicom became extremely difficult, and they sold all the sales rights to Intel. Intel, which gained the right to sell 4004, sold this product not only to calculator market, but also to various application fields.

It was a fundamental overturn of the way of system development which had been custom designed before. That is, they established a revolutionary method of building a system by combining a microprocessor (MPU) and a memory. And they responded by changing the software to change the specification of the system. This led to the opening of the age of memories and microprocessors in the 1970's. 10 years later in 1981, it led to the birth of a personal computer which can be called the origin of "digital revolution".

The picture below is Intel's microprocessor 4004 that revolutionized the semiconductor industry.
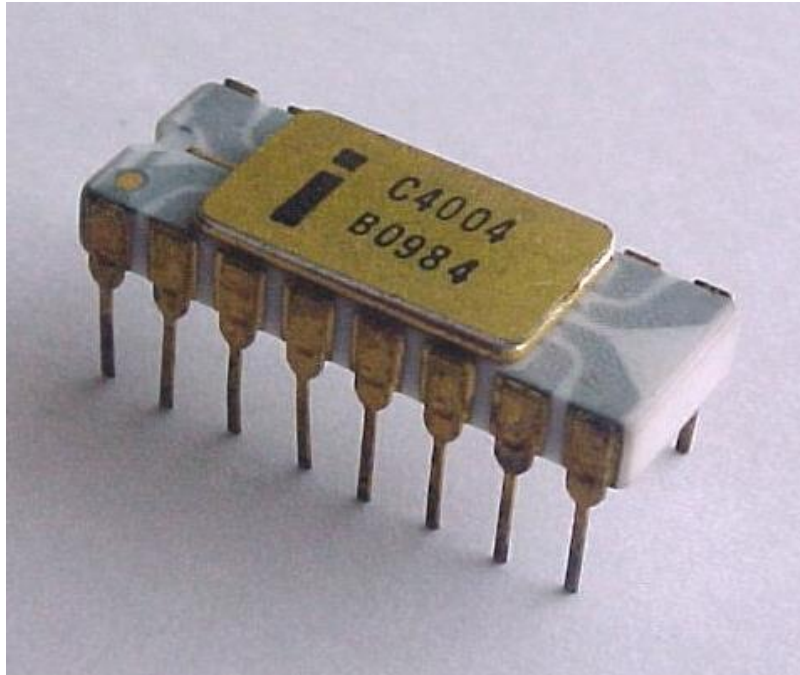
Photo 8.1 Intel's microprocessor 4004 introduced in 1971

Here, the time machine flies to 1997.

The Kyoto Prize of this year was awarded to the contributors to this great product: microprocessor. The Kyoto Prize is an international award (with prize money of 50 million yen) founded in 1984 by Kazuo Inamori, the founder of Kyocera, and is given to those who made outstanding contributions in science, technology, and culture.

This time, four people were selected as the winners for the development of microprocessors: namely Federico Faggin, Edward (Ted) Hof, Stanley Mazor, and Masatoshi Shima, who were all main contributors in the development of 4004.

The time machine flies further to 2012. And the team leader Federico Faggin was awarded the Global IT Award of this year from the President of the Republic of Armenia.

As I wrote in the previous Episode, Hitachi's semiconductor business was badly hit by the oil shock, and two factories (Komoro and Kofu) were downgraded to branch factories in February 1975, and many executives were dismissed or relegated.

In June of the same year, a new General Manager of the Division came in from the Division of Heavy Electric Machinery and he made a substantial reorganization of the division. In this process, I was also dismissed from the Dept. Manager position in December 1976, and assigned to a Deputy Chief Engineer.

I proposed to establish a design company in the US, and I myself also moved to the United States. The picture below is a photograph when I started working in the United States.

Photo 8.2 Initial members to prepare for the design company (1977)
From left, the author, secretaries (Terry and Suzan), and Fumimaro Kawakatsu

Meanwhile, a new personnel initiative came out within Hitachi during this time.

Hitachi was facing a situation to further strengthen the field of memories and microprocessors. Until then, the development of these devices was conducted by a group within MOS LSI Design Dept., but it was decided to organize a new department independent from the current one to intensify development activities of memories and microprocessors. And a new Dept. Manager was needed to organize and lead the group.

Then, suddenly, I was called back from the United States to become the Dept. Manager of this new "Memory and Microprocessor Design Dept." in August 1977.

Hitachi's common sense at the time was that it was almost impossible to return to the Dept. Manager from the Deputy Chief Engineer position. But I got to know later the background to this exceptional move.

A senior person who knew the difficulty of semiconductor business made a strong recommendation to the Division General Manager, who came from the Heavy Electric Machinery Division that "Makimoto is the single best person for this post." This is an unforgettable human bond between the senior person and me. Without this human bond, my semiconductor life would have been totally different.

I felt tense and elevated that I would now be able to challenge the main battle field of semiconductor from now on: memories and microprocessors.

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