

## Chapter 2

### The Opening of the LSI era

February 1966. In Philadelphia in the coldest season, and there was snow on the roadside. At that time, I was studying abroad at Stanford University, and Professor Linvill advised me to attend the ISSCC (International Solid State Circuit Conference) and I flew from the mild California to the freezing east coast.

I learned about LSI (Large Scale Integrated Circuit) for the first time in this occasion, and it would have a big influence on my future career.

By the way, I first became acquainted with Professor Linvill on his visit to Hitachi's Central Research Laboratories in 1964. Before and after as well as during my study abroad, he gave me a lot of advices and he was literally a "mentor" for me. Even after I graduated from Stanford, I had opportunities to visit him and enjoyed dinners, and received his guidance for a long time. Photo 2.1 is when I had a dinner with Professor Linvill with his wife in July 1998.



Photo 2.1 Dinner with Professor Linvill and his wife. (In July 1998 in Palo Alto, California)

ISSCC is the largest international conference in the semiconductor field and today it is held on the west coast (San Francisco) every year. However, in those days, the center of gravity of semiconductor research and development activities was on the east coast, with major companies such as Bell Laboratories, IBM, RCA, GE, etc. taking the lead. Because of such circumstances ISSCC was also held at the prestigious University of Pennsylvania on the east coast.

The keynote speech on the first day of the conference was given by the inventor of IC, Jack Kilby who was already famous at the time, and the theme was "LSI (Large Scale Integrated Circuit)".

I do not know when and by whom the word LSI started to be used. We cannot find the word in the famous paper by Moore (the paper that became the base of Moore's law) published in 1965, either. Perhaps it might have been around that time.

At least for me, this Kilby's lecture was the first occasion when I came across the word of LSI. It

was a speech on the technology that would be able to integrate hundreds of gates at the time of actual IC integration level of several gates at the most, and it gave me an astounding impression. Jack Kilby made a remarkable statement that, “As far as R&D is concerned, the era of IC is over, and the future is the era of LSI.”

In the first place, my goal of studying at Stanford was “learning the basics of IC”. However, I was strongly impressed that studying IC alone was not enough. I decided in my mind that I had to study more about LSI, and I tried to acquire knowledge through literatures and seminars. My superiors at that time were Masami Tomono (Factory Manager), Kogo Sato (Design Dept. Manager), and Shotaro Shibata (IC Design Sec. Manager). In my report to the superiors after returning home from the study abroad in July 1966, what I emphasized most was a proposal that “We should prepare for the era of LSI in Hitachi as soon as possible, and I myself want to be engaged in such works.”

The executives at the time did not just hear my suggestion, but seriously took it up. In 1967, one year after my return to Japan, I was transferred to the Central Research Laboratories (hereafter referred to as CRL) for the research and development of LSI. Minoru Nagata of the Third Dept. became the leader, and I also worked on LSI research as a member of the group. Without the decision of the superiors at that time, my semiconductor life would have been a very different one, and I still appreciate for having good superiors.

My research themes were mainly comparative research on LSI’s various approaches (fixed pattern method, selective wiring method etc.), and development of LSI CAD.

This CAD system became a major force in LSI design at a later time, contributing to the development of the business. In 1973 we, with Nagata as a leader and the fellow researcher Seiji Kubo, received the Ichimura Prize for “Development of CAD system for calculator LSI”, and this award was based on research activities at this time. See photo below

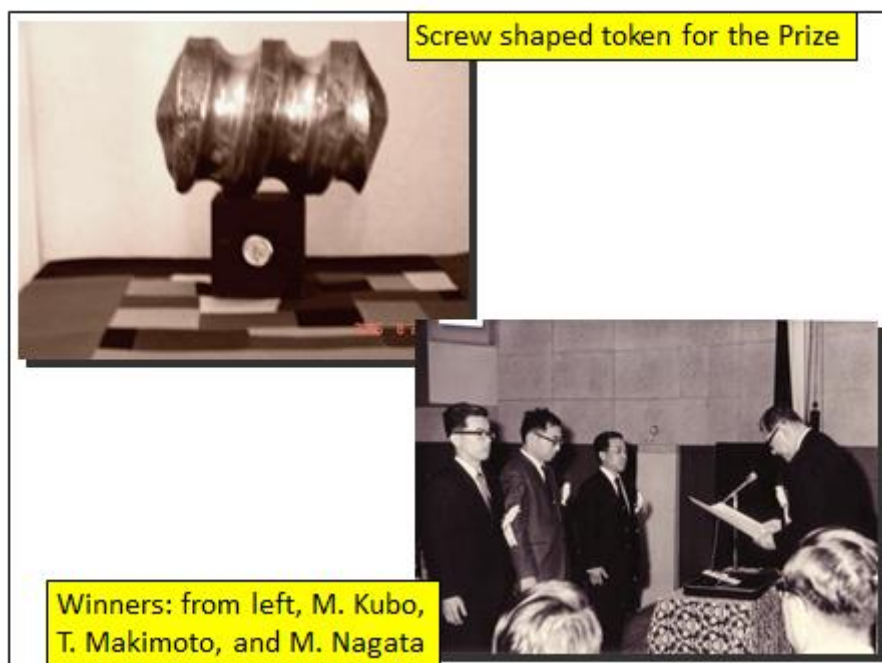


Photo 2.2 Award of the Ichimura Prize for “Development of LSI CAD System for Calculator” (1973)

I was engaged in research activities at CRL for only one year, and in the following year of 1968, I was again assigned to work at the Musashi Works (Factory) as Section Manager of IC Design. The era of LSI was approaching, and we were to tackle its commercialization.

At the time in Hitachi, the Kameido Works was in charge of the calculator business, and there was a growing momentum to realize LSI calculators through collective efforts of the company.

In October 1968, two months after my relocation to the Musashi Works, the goal was presented from the Kameido Works “to commercialize all-LSI calculator by the end of 1970.” And the number of LSIs was set to be less than 10. It was quite a challenging target at that time. Following this proposal, the development activities started. And an executive meeting of the “Special Research Project on the LSI development” was held on January 4, 1969. The special project was called “Tokken” internally, and it was to be promoted by the collaborative activity of Merchandize Division in charge of calculator business, Semiconductor Business Division, and CRL.

Deputy General Manager of the calculator factory by the name of Ishigaki became the project leader, and Kirino, Dept. Mngr., Karasawa, Sect. Chief, and Kurokawa, Subsection Chief, attended from the system side. Incidentally, these three members were called KKK trio from capital letters of their names. On the semiconductor side, Shibata, Dept. Mngr., was the leader, and Kobayashi, Sec. Chief of Application Circuit and I, Sec. Chief of Design, attended. Kawasaki, Dept. Mngr. of System Design, Nagata, Dept. Mngr. of LSI Development and others from the CRL attended.

Soon after the start of this Special Project, a shocking announcement was made by Sharp in March. The LSI calculator QT-8D (Photo 2.3 below) which was developed in collaboration with North American Rockwell was announced. The calculator was composed of 4 LSIs and 2 ICs, and it was much smaller and lighter than conventional products. The price was 98,000 yen that cut 100,000 yen for the first time.



Photo 2.3 World’s first LSI calculator QT-8D developed by Sharp (1969)  
4 LSIs were manufactured by North American Rockwell.

The announcement of this calculator gave an astounding impact both on the calculator industry and on the semiconductor industry, and immediately the momentum for LSI heightened. In other words, it was to declare the beginning of the real LSI era.

In November of that year, in the semiconductor division of Hitachi in preparation for the era of the new LSI, a major revision of personnel affairs and organizations was executed which had never been precedent. It should also be referred to as “organization structure for LSI shift”, and it was the shift from the traditional “factory-centered” system to “business division-centered” system.

In Hitachi’s traditional organization, design and development groups belonged to factories, and the basic pattern was “factory profit center.”

In the new regime, the design and development department became the “profit center” which belonged to the business division, and the factory was positioned as the “cost center” centering on manufacturing. A significant young appointment was made in terms of personnel along with the organization change. I was appointed “Department Manager of Product Development Dept.” at the age of 32, which became the record of the youngest department manager in Hitachi.

Various newspapers and magazines took up this news in a big way (Photo 2.4).



Photo 2.4 Hitachi’s youngest Dept. Manager at the age of 32, top right (Weekly Post, 1969)

In the newspaper, President Komai’s remark was cited, saying “You should open up a new way in the electronics field by the best use of young brains”. It was a reform that symbolized the dynamism and flexibility of Hitachi at that time.

By Sharp’s LSI calculator announcement, all the members participating in the “Special Project” took seriously that “LSI era became the reality!” and the development of both LSI and the calculator product gained stronger momentum.

The Special Project achieved more than expected results, and in May, 1970 Hitachi made a press release titled “First domestic made LSI calculator is completed.” Although it was late for over a year

since the announcement of Sharp, it gained honor for “first domestic”. The LSI developed at that time was the HD 3200 series (Photo 2.5), and it became the forerunner of moneymakers for Hitachi semiconductor.

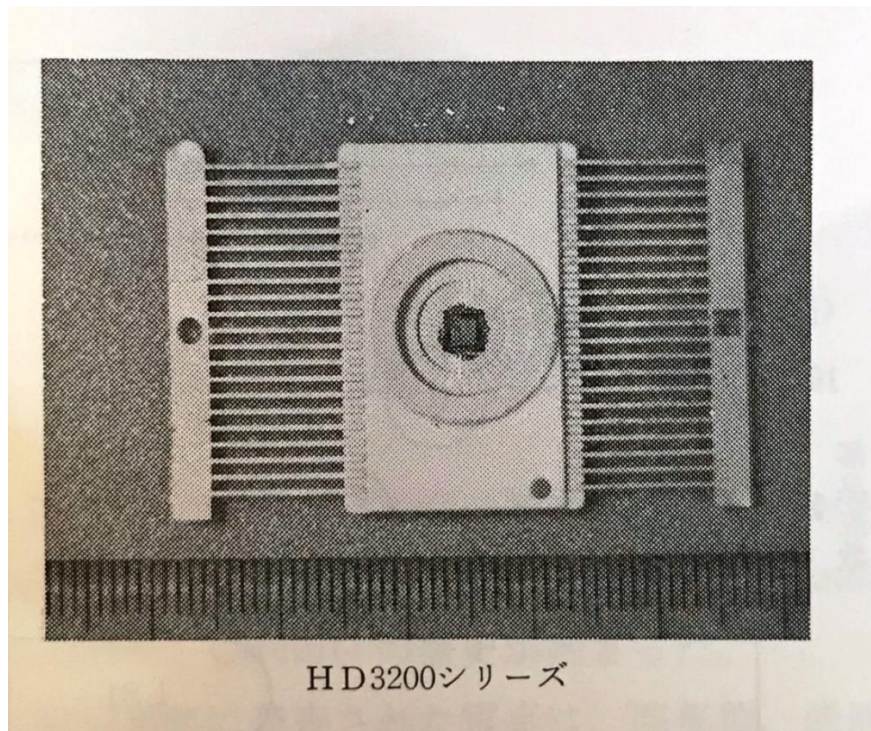


Photo 2.5 First LSI for Calculator “HD 3200 Series” (1970)  
(Source: Thirty Year History of Hitachi Semiconductor)

In addition to its excellent process and device technologies, the HD 3200 series was able to effectively digest requests from many customers for their custom LSI development, thanks to the early adoption and establishment of CAD system.

In addition, also thanks to the top sales by Takei, Director of Electronic Devices Group, and Tomono, General Manager of Semiconductor Division, the market share reached 65% in the second half of 1972, and the semiconductor division’s sales and earnings recorded the highest ever.

In the world’s sales ranking in 1973, Hitachi semiconductor surpassed the sales of Fairchild and occupied the third place in the world ranking after TI and Motorola, and it established its golden age.

The system design for calculator LSI was accomplished mainly by CRL, adopting a method called “ROM based method” in order to achieve the high flexibility for model change. Only the rewriting of ROM was necessary to cope with different models of calculators, and it was close to the idea of microprocessor, although it was not exactly the same.

Looking back from today, it may be said that this time was surely the era of the first stirring of the microprocessor. As a matter of fact, in the following year of 1971, Intel developed the world’s first microprocessor through their projects of LSI development for calculator

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The original version of this article was first published, in Japanese, on the Home Page of Seminowa-kai, a circle of Hitachi Semiconductor OBs, from July 4, 2011 to October 30, 2011.