In Memoriam
Professor Eiichi Goto

(1931-2005)

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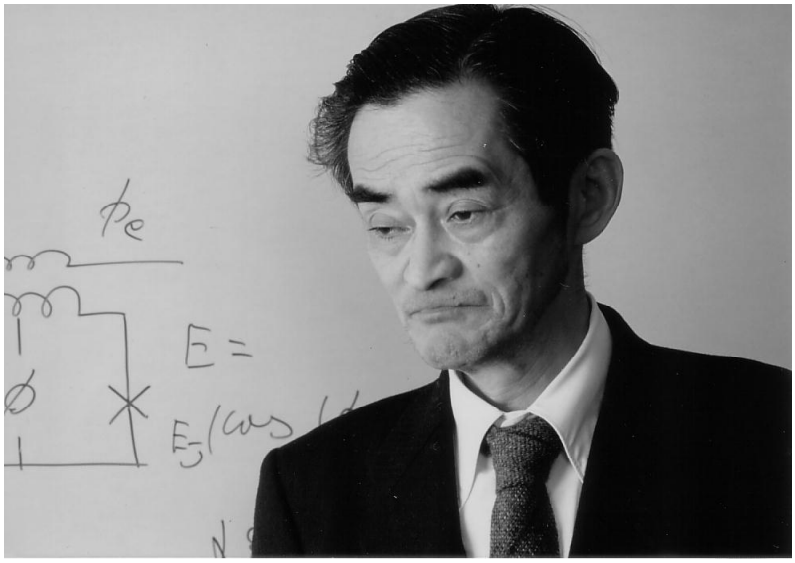

Prof. Eiichi Goto passed away on June 12, 2005 at the age of 74 after a long struggle with illness that was initially caused by diabetes. Despite his suffering, he continued to actively pursue his goals as a scientist, an engineer and an educator until his death. He was a Japanese pioneer in computing. His contributions in computing are so varied that one would need many pages to describe his achievements.

He was the inventor of PC-1 (Parametron Computer 1) [1, 2], one of the early modern general purpose computers in Japan. PC-1 was based on parametron logic, which he invented while he was a graduate student at University of Tokyo, Department of Physics, when vacuum tubes were predominant as logic elements of computers.

He was one of the few computer scientists who understood the principles of modern computers from physics of computing elements to logic of computer systems. Together with his supervisor Prof. Hidetosi Takahasi, he constructed PC-1 from scratch in 1958. Parametron logic elements had been used extensively for about a decade to build computers, until they gave way to transistors as building blocks of computers.

In 1971 (when I joined the Goto Laboratory), Prof. Goto seemed to be less concerned with building computers. However, I soon learned that it was the time he was gearing up to construct yet another kind of computer, a computer for symbolic and numeric computing, rather than just for number crunching. In the late 1960s he was busy with designing a high-precision tube for the analysis of films of traces of high-energy particles taken in bubble chambers, with his colleagues at Institute of Physical and Chemical Research (RIKEN). Being a Physics professor at University of Tokyo, he served as a chief scientist at RIKEN and ran the Laboratory of Information Science there from 1968 to 1991.

Around 1973, he started to work vigorously on symbolic computation. He needed a computer algebra system in order to manipulate the formulas which modeled electron beams for electron beam lithography equipment that he was designing. However, this time he did not say immediately that he would construct a machine for symbolic computation. What he first did

was the design and implementation of a new Lisp system on Japanese computers. Then his Lisp system was configured to host a computer algebra system Reduce which Anthony Hearn, then professor at the University of Utah, was developing.

In the area of symbolic computation, Goto's work turned out to be in concert with the efforts of the Japanese computer industry, which was making great efforts to produce computers that were comparable in performance to American counterparts. His work made symbolic computation available to Japanese scientific communities.

He saw the potential of Lisp. I remember he talked enthusiastically about Lisp, in particular Lisp interpreters and the lambda notation in his seminars and lectures. During the implementation of the Lisp system, he found that hashing greatly speeds up symbolic computation of Lisp. Hash cons (hcons) is his invention [3, 4]. He further studied deeply hashing from theory, algorithms, application and efficient implementation including parallel implementation [6].

After he understood thoroughly what was missing in the computers of those days and designing new algorithms and circuitry, e.g. for arbitrary precision arithmetic and for hashing, he proposed a machine for symbolic, numeric and associative computing. His work in symbolic computation culminated in the construction of FLATS machine [5]. The machine incorporated many great ideas of Goto.

While devoting almost all his time to research, he served for international and national professional societies for long time. Among others, he served as the vice-president of IFIP from 1971 - 1974.

His wife described his life in his last few years as follows. Due to his ailing body, he was forced to rely on a wheel chair in his daily activities. On the wheel chair, he was always thinking, about something in physics and mathematics somewhat formidable to his wife, with a pencil and the handbook of Mathematics in his hands. He was a master of mathematical modeling. Looking at his papers, we often find elegant and concise pieces of mathematical formulas that best describe models of the objects of his study. Symbolic computation was just one step away from his modeling. His mind was moving back and forth between mathematical modeling, symbolic computation and numeric computation.

He was a man of imagination. His talks jumped from one topic to the other like butterflies fly from flower to flower. We had to fill in the gaps in order to fully understand his talks. In that way his students learned how to do research; the rare and precious experiences for them, which are no longer possible now. (October 2005)

References

[1] Parametron computer principle, http://www.thocp.net/hardware/parametron.htm, October 2005.

[2] PC-1, http://www.iijlab.net/ ew/pc1/mtac.html, October 2005.

[3] Goto, E. "Monocopy and Associative Algorithms in an Extended Lisp". Tech. Rep. 74-03, Information Science Laboratory, University of Tokyo, 1974.

[4] Goto, E., and Kanada, Y. "Hashing Lemmas on Time Complexities with Applications to Formula Manipulation". Proc. ACM SYMSAC'76, Yorktown Hgts., NY, 1976.

[5] Goto, E., et al. Design of a Lisp Machine FLATS, Conference Record of the 1982 ACM Symposium on Lisp and Functional Programming, pp. 208 - 215, 1982.

[6] Goto, E., et al. Parallel Hashing Algorithms. Information Processing Letters 6, 1 (Feb. 1977), 8-13.