

Notes from Interview with Robert Palmer Regarding Development of Mostek 1K and 4K DRAMs

Jeff Katz 07 June 2007

SUMMARY

We spoke by telephone for about 40 min, and discussed his recollections of the development of Mostek's 4006 1K DRAM and 4097 and 4027 4K DRAMs, for which he was the process and manufacturing manager. Bob was at Mostek from its founding in 1969 through its acquisition by United Technologies Corp in 1980, until its acquisition by Thomson CSF (later ST Micro) in 1985.

ROBERT PALMER CAREER SUMMARY

After graduating from Texas Tech in the early 60s with a degree in Physics, Bob joined Texas Instruments working in the then-non-mainstream MOS research area when the company was mainly a Bipolar company. In 1969 he was part of the founding team who formed Mostek, and ran their MOS process activities. He became EVP of UTC, running the semiconductor business unit (former-Mostek) after the 1980 acquisition. When he finally left the company in 1985 he joined Digital Equipment Corp to head up its semiconductor operations, later rising to VP of Manufacturing and in 1992 becoming CEO. He remained at DEC until the company was acquired by Compaq in 1998, when he retired. In retirement he has served as Director for several companies.

HOW MOSTEK WAS FORMED

In 1969 TI asked many engineers to move from Dallas to its new facility in Houston. A group of them who preferred not to leave Dallas instead started Mostek, to continue their work in MOS. The founders, all but one of whom came from TI, were:

L.J. Sevin (who had worked in MOS R/D at TI)	These two were the lead founders
Louay Sharif (who worked in MOS manufacturing at TI)	
John Macdougall, Designer	
Ken Manchester, Designer	
Berry Cash, Marketing	
Bob Palmer, MOS Process	
Vin Prothro, Finance	

The company's focus was on ion-implantation as a means of reducing MOS threshold voltage in order to simplify the system interface and make it compatible with TTL. (This was at the time when Intel was working on Silicon Gate MOS to solve the same problem.) . The company's first revenue came from developing and shipping a 16-bit shift register for Burroughs. As they developed DRAMs, Mostek sold them to nearly all computer manufacturers.

An early investor in Mostek was Sprague Electric, a discrete passive component maker who wanted to get into MOS. It was in Sprague's Worcester, Mass. fab that Mostek made its first wafers, while preparing to build its own fab. As the company's first process developer, Bob spent most of his time in the Sprague facility. The first company-owned fab was put together in the same neighborhood, using used equipment from Sprague.

WHO DID WHAT, IN EARLY MOSTEK PRODUCT DEVELOPMENT?

Bob recalled several other early contributors to DRAM and MOS Logic technology at Mostek:

Bob Proebsting, Circuit designer who amassed 180 DRAM patents for the company
Gaynel Lockhart, Logic designer for low power MOS calculator chips
Bob Pallack (sp?), Circuit designer for low power MOS calculator chips
Dave Leonard, Circuit designer for low power MOS calculator chips
Richard Petty (sp?), Layout for low power MOS calculator chips

DISCOVERING ION IMPLANTATION AS A MEANS TO CONTROL MOS THRESHOLD VOLTAGE

In the early phase of the company Bob was seeking high-K dielectric material to use in the MOS process. He visited the Worcester Sprague plant, where he had heard that such material was being made. In a separate conversation there he happened to be talking with some of the Sprague hybrid circuit designers, who were making precision resistors. He asked them how they managed to get repeatable high precision resistances. Their reply was that they had developed a threshold-controlled MOS circuit that they used to calibrate the resistors. To control the threshold they used an ion implantation technique on the MOS material. Bob immediately called LJ Sevin in Dallas and told him Sprague had exactly what Mostek needed to build their low- threshold voltage MOS.

This ion implantation technique was the basis of much of Mostek's subsequent success. Later Bob and his colleague Chan Mai (sp?) were awarded a patent for combining ion implantation and Silicon Gate. The Mostek patent portfolio would ultimately prove more valuable to the eventual owner, ST Microelectronics, than the Mostek product portfolio.

MOSTEK'S FIRST DRAMS

In the summer of 1970, just over a year after the company was founded, Mostek introduced the MK4006 1K-bit DRAM, made with the ion-implanted MOS process. There was a cover story in Electronics Magazine, featuring a photo of Bob Palmer, John Macdougall and Ken Manchester. The chip was an immediate success, because it was easier to interface with TTL than competing memories.

THE PIN-OUT WARS IN 4K DRAMS

There was a major "Aha! Moment" during the development of the 4K-bit DRAM at Mostek. Top management had hired a few computer system designers in order to get their perspective into the design process. In moving from 1K to 4K capacity, each chip required two more address lines, which forced the package size into a larger version. At the time the most popular package was the 16-pin DIP, used for most logic ICs and for small capacity memories. But the extra pins required to accommodate the 12-bit address of a 4K chip meant that a 22-pin chip would be required, doubling the number of PC boards required and increasing the size and power requirements of the end computer system.

In a product definition meeting, Marketing VP Berry Cash asked the question, is there any way to get a 4K chip into a 16-pin DIP? Designer Bob Proebsting thought a while, then announced it could be done only if the address signals were time-multiplexed on the fewer pins of the small package. The system designers immediately confirmed that multiplexing signals was a

common and easy technique for the system to do. Proebsting had just invented the multiplexed address DRAM, an architecture that has spread widely and is still used in today's DRAMs.

With the ability to double the memory capacity per PC board, compared with competitors' 22-pin chips, the Mostek MK4096 inexorably became the product of choice among computer system designers. The competitors, notably Intel, mounted a concerted defense of their more straightforward but larger package offerings. But in the end the customers were happy to live with the slight extra complexity to achieve higher system density. Ultimately all the competitors needed to switch to the 16-pin multiplexed technique, which gave Mostek a further advantage in already being there and able to spend time developing the next generation.

While the competitors were playing catch-up, Mostek introduced an improved, better-performing and easier-to-make successor, the MK4027, which used the newly patented combination ion-implantation–Silicon Gate process. That chip was also developed by Proebsting, along with designer Bob Green.

OTHER EARLY MOSTEK PRODUCT DEVELOPMENTS

Japanese customer Busicom went to both Mostek and Intel to find a MOS supplier for their electronic desktop calculators. Intel won the first design, producing the programmable 4004 4-bit microprocessor chip-set in 1971. Later Mostek supplied Busicom with a non-programmable, one-chip 4-function calculator device which was used in their hand-held products. This chip was developed by Dave Leonard and Richard Petty (sp?).

Because of the lower power requirement achievable with Mostek's ion-implanted MOS, they were chosen by Hewlett Packard to supply calculator chips for the HP-35, breakthrough hand-held scientific calculator. This chip was developed by Gaynel Lockhart and Bob Pallack (sp?).

OTHER POTENTIAL SOURCES FOR STORIES ON EARLY SEMICONDUCTOR MEMORY

Bob suggested the CHM Semiconductor SIG could get further stories, and possible artifact donations from L.J. Sevin and/or Berry Cash, both reachable at Sevin-Rosen Funds 972-702-1100.

OTHER ITEMS

Bob told me of several original documents on the early Mostek DRAMs in his personal collection.

Should the CHM Semiconductor SIG decide to sponsor an Oral History panel discussion on early DRAMs, Bob would be a candidate participant. He can be reached at 214-528-6611 or rbptx@sbcglobal.net.