Bob Norman's Random Memories of Silicon Valley Daze

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At AMI in 1973, Don Trotter was showing me a wafer of memory chips when a hair from my new beard fell on it. It looked like the log across the chip under the microscope. The next day, bearded men were required to wear snoods

Our MOS work started in Fairchild R&D. C. T. (Tom) Sah was studying channeling in Jean Hoerni's PNP Power transistors. He developed the Gate Controlled Transistor, Tetrode, which we evaluated in Device Evaluation. We observed the drift problem. Tom's next attempt was a gate controlled channel, which of course became known as the MOS Transistor, which still had a drift problem.

Another important byproduct of Jean Hoerni's PNP power transistor work was the LED. When we were testing those transistors in the lab, we observed an anomalous breakdown in the collector. Under a microscope we could see light emission from the transistor. We actually built a silicon array for Fairchild camera using this phenomenon which they used to encode information on film they were shooting with their satellite camera. Gordon Moore set up the Electro-Optical Department under Irv Solt to continue this work.

We had been pressing at Fairchild for some time to switch to epitaxial isolation instead of diffused isolation. Since we'd planned to use that process at GM-e we wanted to make sure Fairchild had it first. When Phil Ferguson's Pilot Line began out-producing manufacturing on R-13 using epitaxial isolation in the fall of '62 we knew we could safely leave Fairchild.

Jim McMullen from Rheem Semiconductor (Ed Baldwin) and Don Farina were our first two GM-e employees. We built our own epitaxial reactors. I remember Jim bringing me in to the reactor room to show me his first wafer. He cautioned me not to run the microscope into the wafer. Unlike at Fairchild, there were so few defects it was like looking at a perfect mirror. The next step was to deposit epi on a wafer after Dick Craig did a sub-epi diffusion and we were off and running. Don Farina had designed the R-13 chipset, except he improved it! Our customer was upset because our parts were faster.

While our principal customers such as DOD (R-13) and Apollo related were happy with the integrity of the hermetic 8-Lead TO-5 can, we were feeling pressure at Fairchild to come up with a competitive "flat pack" solution. Early on at GM-e we started work on that. Our solution had to be welded hermetic to preserve reliability. Les Suddick and his people came up with the round flat pack, "It's easier to seal a circle", which we used on both military and commercial (calculator) projects.

Frank Wanlass was building MOS switches for us at GM-e, for NASA. MOS switches had the advantage over bipolar transistor switches in that they had no offset voltage.

Frank produced the first run of MOS 20 bit DDA registers in June of 1964. Jim Imai did the circuit design and H. E., Gene, Stephenson the chip layout. (Gene found and fixed a logic/circuit problem on my original shift register design which is why he is on the patent.)

Art Lowell (Col. A. C. Lowell) resigned as President of GM-e in December, 1964, and went to Autonetics. In January, Phil took over as President, I became V.P. Operations, Semiconductor and Systems, and Howard Bobb remained V.P. Marketing and Sales.

Ray Sonners did a great job of running semiconductor manufacturing at GM-e. As I recall, he came out of Autonetics and went back there from GM-e after we sold it to Philco Ford. We had engaged IBM to generate reports for each step in the semiconductor process. We wound up with detailed weekly reports about 2 inches thick. We were running at least four processes at the time, R-13 Milliwatt Logic, Signetics DTL, the TFX TTL process, and MOS. We prevailed upon IBM to take the next step that reduced the reports to something reasonable for running the line. Once Ray began comparing monthly sales forecasts to sales orders, he could come up with a reasonable manufacturing resource allocation. That was a big help to getting the Semiconductor Division profitable. The Systems Division and Jim McMullen's Materials Division had been profitable for some time

Frank Wanlass and Warren Wheeler wanted us to spin off an MOS/LSI Co. with them in charge. We perceived MOS/LSI as being the next generation of the semiconductor industry (which it became) and we were opposed to spinning it off. Frank and Warren left and set up shop in General Instrument.

Art of course got Autonetics into MOS. I remember when Don Farina described Autonetics four phase shift register to me. I was a little jealous that we hadn't thought of it. On the other hand, we were executing random logic in two phase dynamic logic and our perception of the added complexity of the four phase approach discouraged us from pursuing it.

I didn't realize until now that the Autonetics register was a DDA (digital differential analyzer) register like ours. We had proposed a distributed 20 bit DDA computer as part of our IHAS (Integrated Helicopter Avionics System) contract with Nortronics. The proposed computer was distributed about the chopper so that it could work around partial battle damage. The 20 bit word length was dictated by the dynamic requirements on the DDA. We had made extensive use of DDAs in a submarine signal processor we built for the Navy at Sperry Gyroscope. There were two tries to a one chip solution. The first emulated the National Bureau of Standards pumped logic which worked over a narrow clock frequency range. The second, MOS approach, adapted a technique used in linear sweep generators which used a vacuum tube as a current source. The rest, as they say, is history.

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