Steve Marum's Career Story

I started at TI in 1973, designing ICs (Integrated Circuits) using ECL (Emitter Coupled Logic). One specific design was a 1GHz dual-modulus prescaler for the GPS system that TI was developing. ECL was very power hungry but it was the fastest circuit family available in the 1970s. Even so it was a struggle to get it to work at 1GHz.

In the late 1970s (I think) our group changed from designing ECL to designing IIL (Integrated Injection Logic). IIL was a way to do very low power designs using bipolar technology. While PMOS (P-channel Metal Oxide Semiconductor) was available, MOS processing was still in its infancy and the very low power CMOS (Complementary Metal Oxide Semiconductor) which is ubiquitous today was not available. IIL was very different from normal logic circuits in which a logic gate has several inputs and one output. IIL gates had a single input and multiple outputs. This required a "rewiring" of one's brain to do logic designs.

I worked on several IIL watch chips. These went into TI branded wrist watches which showed the time on tiny LEDs after you pushed the button on the side.

My most memorable IIL design was the SN76489 sound chip used in the TI 99/4 Home Computer. This was the very early days of PCs. This chip, which was fairly complex at the time, looks quite simple now. It contains 3 programmable frequency generators for producing notes (all square waves), a random noise generator, and programmable attenuators to adjust the volumes of each sound source. It was a fun design to do.

In the mid 80s IIL technology became obsolete so we worked on one of TI's standard logic families, 74LS (Low power Schottky). Those years were uneventful.

In the early 90s our group shifted gears again and began doing CMOS designs, necessitating another cranial rewiring. The CMOS process had improved greatly, offering very high speed with very low power. With that combination nobody wanted to use the old power-hungry bipolar technologies. We designed the 74HC logic family, followed by 74AHC.

CMOS ICs can be very easily destroyed by ESD (Electro-Static Discharge). I'm sure at some time you have walked across a room on a cold winter's day and gotten a spark when you reached for a doorknob. Well, a spark such as that but so weak you don't even feel it will damage something on a CMOS chip, rendering it useless. Some designs had trouble passing the standard HBM (Human Body Model) ESD tests and I started working with the failure analysis folks to determine what had happened and how to avoid it in the future.

One ESD project I especially remember was one of our standard logic chip designs. One of TI's very large customers sent us a few damaged devices, saying "We can't buy these, they fail our CDM test." We looked at each other and asked "What is the CDM test? That's a new one." Well, CDM stands for Charged Device Model. CDM is now a standard test but we were starting from scratch. I got all the failure analysis reports (with their all-important photos of the damage!) and studied the CDM test to understand what it was doing. I got a chip layout and a red pencil. I pored over the layout, tracing current flow and marking up many of the power and ground traces on the

chip. Then I stuck my neck out. "These traces are carrying very high currents during the CDM tests and the voltage drop in the metal is too large, causing catastrophic breakdown in some gate oxides. We don't need to change the circuit, we just need to widen these traces so they have lower resistance and thus lower voltage drops." We widened the traces as much as we could without changing the chip size and ran fresh material. The new layout easily passed the CDM test with plenty of margin. I sure felt good when I saw that result!

I spent most of my last decade at TI working in the ESD protection field. It kept me busy. Newly developed processes were smaller, faster, and lower power. Unfortunately this meant they were more easily damaged by ESD so protection circuits that worked on the previous process were no longer good enough. I was constantly working on new ESD protection methods. I found having knowledge of CMOS as well as bipolar devices was very useful.

To sum up my career in IC circuit design I would like to quote the Red Queen from Lewis Carroll's Through the Looking-Glass: "It takes all the running you can do, to keep in the same place."