**Scott Benjamin (1984-2011)**

My career started with an interview by Dan Holste at Iowa State in 1984. When Dan completed the interview, he accidentally displayed his notes where he had written "Good Prospect" in giant letters diagonally across the page. That pumped me up. However, he had also just shown me pictures of the airborne computers he had worked on, in an Alex Trumble Rack (ATR). Since I had already been exposed to the Apple II, Apple MacIntosh, and Vax computers, I had a real hard time getting excited about a box full of boards covered in ICs with no user interface. When I came to Eagan for my on-site interview by Jeff Parker, I saw an exciting atmosphere of really energized and positive people, like Pete Gorski and Bob Caauwe, and I was hooked. On my first day, June 4, 1984, my new boss Paul Burley asked me about my career objectives. I told him I thought I would be in management some day. He told me I could have his job right now. He did not want to be in management and just wanted to design stuff. I worked under Paul on the AN/UYK-44 and AN/UYK-44 Enhanced Processor (EP) for several of my 8 years on that program.

During my time on the UYK-44 program, I wrote software for the Remote Control and Maintenance Interface (RCMI) and Maintenance Processor (MP), and developed several integrated circuit chips and corresponding boards. After coaching me for my first customer presentation, Jeff Parker and Paul Burley gave me a 6 month raise just minutes before I gave my presentation and demonstration. In 1985, the UYK-44 project moved to Plant 1 to help ramp up production and complete qualification testing. When we returned to Plant 8 (Eagan), Lee Holck asked me to put together an old qualification test cabinet with a Maintenance Panel and put a Maintenance Processor with a bench power supply inside. I programmed the processor to display "44 DEAD" and Lee and his friends broke into the plant manager's office and left it on the desk as a parting gift.

On my first chip design I teamed up with Don Degerstrom to redesign the Shift Matrix and Support Hardware (SMASH) chip because our semiconductor plant was closing. We did this design with Texas Instruments (TI) with an aggressive schedule that included time for a second pass if needed. When the first part came, we put it on a board and it passed all the tests so we went to Plant 1 to test it over temperature with Jerry Hellickson on a thermal column. We were heartbroken to find it failed at -40C. Jerry hooked up his pile of logic analyzers and amazingly within minutes traced the failing sequence. We quickly realized TI had made a grounding error in a custom Read Only Memory (ROM) which they managed to fix so we still delivered on time. We then combined that part with all of the rest of the logic on the same circuit board under our "Shrink Program" and I got to design a universal Integrated Circuit (IC) package, a custom 4 layer Kevlar circuit board with no vias and two more big ICs (SMASH and General Register board and Arithmetic Logic Unit board). I found out about Paul Burley's 44$^{th}$ birthday and told Lee Holck who talked Cissie Lothian into baking a cake that looked like a UYK-44 cabinet with gray frosting. The cake collapsed but we all had a great laugh and really surprised Paul.

Brian Leininger was leading the UYK-44 Enhanced Processor development and asked me to join the team and design the interrupt logic (~1988) for the Instruction Processor (IP). I joined the A team with Don Fier as lead, Duane Breid, Paul Torgerson, and Kevin LeClair,

who had all come from the Semiconductor Group after designing 1100 mainframe processor chips. We had teamed with Winnipeg who sent Martin Andrusiak, Carl Swanson, and Ron Isliefson. (That was also the year I started bike riding with Martin and Don and we led the bike club until the end.) I ended up designing the breakpoint logic, the real-time clocks, the interrupt logic, some of the jump logic, the Serial Maintenance Interface (SMI) and I even wrote some microcode. Duane Breid had written the Dunet hardware description language (HDL) logic design tool as well as the Dusim four state logic simulator (timeless), and we cranked out an amazing design where we could simulate the entire processor, memory, and I/O controller running programs on workstations with the awesome Aegis Operating System. I built an automated script based system to centrally distribute all of our tests overnight every night on every workstation I could access. For the tests that took days to run, I realized we needed a save and restore state feature in the simulator so we could debug errors more quickly so I put together a crude solution and Duane finally put in a really good solution. We actually developed our own layout and routing tools to build the actual silicon. Don Fier designed all the cells and memories and we did all the layout and routing by hand. I also built the system to create test patterns for Motorola's Trillium tester and traveled to Phoenix with Duane several times to test chips. Duane and I even did a 24-hour round trip with no sleep so we could be back for a special lunch with Al Zettlemoyer.

I was responsible for checking out the Standard Electronic Module (SEM) card version of the EP in the lab. I had to rewrite Dick Thomas's MicroProcessor code before we could do anything. Frank Dropps had been lead for the Bus Interface chip, and he checked out the VME version of the EP. When we got the EP to customer sites to test it, I was usually the field guy and Martin ran the simulator. I would find a way to reproduce a problem with as little code as possible and Martin would duplicate it in the simulator and fix it. On a trip to JHU-APL in Baltimore, we went to eat at a seafood restaurant even though I told the team I had a shellfish allergy. Dave Senechal spent the night in the ER with me and with only two hours of sleep, we still managed to catch the problem before catching the plane. We had a team at General Dynamics in Pomona, CA working on the Close In Weapon System (CIWS aka Phalanx Gun) for several weeks trying to get the immature Embedded Processor working with a brand new ADA compiler with a new ADA run-time library and incomplete ADA application code still being developed. Pete Gorski was the hardware guy for the first few weeks and I got the last six. We both experienced the wrath of the Phalanx when we shorted something out and caused the gun to turn, hit the stops, point at us, and fire a burst of blanks in our face – loud and intimidating.

The VP of Engineering Bruce Roberts came to visit in Pomona and after I dominated the dinner conversation, I was soon recruited to the only job rotation in engineering - cost engineering. In 1993, I worked as a hardware cost engineer with Roy Brandenburg supporting hardware director Rick Martin while working under Dan Holste, then Eric Spring, and lastly Mary Leopold. I worked the P-3 Airborne Improvement proposal and Roy worked the Advanced Display System (ADS) proposal. We won them both which created a renaissance which lasted until Lockheed Martin decided to close the plant in 2013. During my first years, I had survived many layoffs and the closing of the semiconductor plant, Plant

1, Pueblo, and several other office spaces, but I helped complete the last indigenous computer design in a great history of which I am very proud to have been a part.

In 1994, Rick Martin took over as VP of engineering and booted me from cost engineering during the re-org. Mike Farmer gave me the job as lead engineer for the ADS (later AN/UYQ-70 or Q-70) Radar Digital Scan Converter (RDSC) working with Steve Sohn, Vince Splett, and Doug Peterson. I added Martin Andrusiak, Chuck Forslund, and John Gohman to the core team. Mike had somehow stolen the design from DRS. Martin had been the last one to finish perfecting the Enhanced Processor. Dr. Sohn and Dr. Farmer had previously patented some software scan conversion algorithms, but we quickly found the Quad TI C40 processor board still was not fast enough, so Steve came up with a faster algorithm. Martin did the Radar Interface (RIF) board, Chuck did the Quad C40, and Vince did the Display Interface (DIF) and RADDS board. We got the RDSC/2 built and tested, and John, Martin and I took control. I got pretty embarrassed during the Preliminary Design review when I failed to understand the Navy's complete lack of understanding of radar scan conversion so I could not understand their confusion over hole-filling. Mike Farmer had to bail me out on that one. Over the years, we found significant latent bugs, lacking customer requirements, and discovered that insufficient performance can require extreme complexity to hide. We also met a lot of Navy people. I even got to spend 3-1/2 days on an acceptance trial for LHD 7 with field engineer Bob Hinderks. That was my first experience sleeping in a file cabinet only to be awakened by the crash of tons of anchor chain being dropped in the middle of the night only feet from my rack. The miss-wired thermostats meant for some uncomfortable competition between berthing spaces. Oh, and we ran out of food since the test was only supposed to be 1-1/2 days.

Around 1996, Martin, Jim Kassel and I were handed an opportunity by Harvey Taipale to design the A-Scope Radar Converter (ARC) for the Aircraft Carrier Landing System (ACLS) with the SPN-46 radar. Dave Bohne amazed me when the customer claimed they only had $400K for our $500K bid and Dave said wait until the morning, they have the money – and sure enough, they did. I never did get my ride on a carrier.

In late 1996, I was working on the LPD17 proposal on an alternative solution for digital network based radar video distribution when the Navy decided to abandon the Navy lab developed FDDI based Digital Radar Video Data Distribution System (DRVDDS) and stay with traditional analog switchboards. Shortly afterwards, Martin and I had an "aha" moment and realized that we could repartition our scan converter architecture and create a low bandwidth system with an array of channels to extract unique data for each operator display. We got the go ahead for a patent application and labored to learn the patent language from Glenn Bowen. We had wanted to build a software based emulation of the system to demonstrate and prove the concept. Steve Sohn had mentioned that he had an idea for a "Ruler Algorithm" so I started working on the idea over the Thanksgiving holiday. Martin began a competition but got distracted by looking at the cause of the hole problem. He came up with a simple fill-pixel solution and when we combined it with the ruler algorithm we had another patent and a much more efficient software algorithm. As we were puzzling over how to do scan conversion in software on a PC, Bob Monson tossed out an

idea for a different approach to synthetic decay and we combined that with a polar buffer idea and had a third patent. I asked Rick Martin if I could approach our graphics and display partner Barco to discuss our algorithms and maybe put them on their cards. He approved and Barco got so excited they chose to build a custom board to capture our algorithms. When they demonstrated it to the Navy and unplugged the Ethernet cable to prove it worked, the excitement was so strong that Roy Brandenburg called me and told me to get the hardware built by the next October for the annual demo. Martin and I worked with Charles Grimner and Jim Cunningham to design the Video Digitizer and Azimuth Decoder (VDAD) VME module and the Range Scale and Window Detection (RSWD) PMC module. Martin and I spent many late nights working with Mike Krumm getting software and device drivers written for both the client and the server in time for the demo. It was amazing how fast the system stabilized, and we still look back with pride over something we consider our masterpiece of design.

Selling the Integrated Radar Imaging System (IRIS) wasn't as easy as building it. There was lots of market interest caused by Primagraphics, so Barco licensed our design and built a Compact PCI version. The market failed to materialize until Sonia Liedman designed it in to the LCS proposal while no one noticed. We worked with Ryan Scheller to get it running on LCS 1 and it worked like a charm. Ryan became our east coast marketing department and made sure we stayed on LCS. We finally got some IRAD money and developed the OpenGL based software scan converter that emulated the Barco graphics hardware. Ryan helped us prove it worked and he put it on LCS 3 and then he put it on the National Security Cutter too. When I explained the OpenGL approach to Chief Engineer Steve Karban and I pondered other potential problems we could solve, he asked if our approach could fix the LCD display flicker problem with Sonar waterfall displays. I figured it probably could, put together a spreadsheet model to test my theory, and my first idea worked extremely well.

In 2004 it became apparent that the RDSC/2 was no longer producible so we finally got funded to build a replacement. We upgrade the IRIS VDAD to the VDAD2 module creating a dual purpose single card radar scan converter (RDSC/3) and IRIS VDAD board. Alex Stephens joined the team to help with analog design and John Gohman added the software to provide a common application programming interface that would work with the old RDSC/2, the new single card RDSC/3 and IRIS. Years of learning from our RDSC/2 experiences resulted in a nearly perfect RDSC3 design that was low cost, high yield, high performance, and highly reliable. The key was going to back to our roots in hardware design which required some rather clever design and a large FPGA.

The LCS success finally convinced Navy System Engineer and former Sperry Univac AN/UYK-43 Field Engineer Larry Swinford to give IRIS a chance. We were significantly cheaper than alternatives and he put us on the LSD class and CVN 78 which got us going. However, Navy politics meant we still had to compete with the Frontier Electronics LRADDS system which was much more expensive and controlled Aegis.

During the boring late 90's while we were begging for funding, Mike Green explained to me that he needed a method for complementing a Technical Manual with configuration specific

documentation. I found out that Mike was the leader of the band "Teaser" and that in the early 1980's, they played regularly at Burnsville Bowl which my parents owned – small world. I had been helping configure orders in my spare time. I imagined a database was the right approach for this problem and knowing little about how to develop one, I got funded for the idea anyway by Dave Partridge. I was partnered with database expert John Raisanen and quickly learned the art. We got the Configuration Identification Index database running and it became a critical part of our production process and the Navy's support system. I wrote a patent application for the database as a project in an Intellectual Property class as part of my MBA so we submitted it. It ended up split twice resulting in three patents and all were sold to a commercial enterprise along with several other patents.

In 2005, Ben Manning retired and I became a functional manager over 56 system engineers on the Q-70 program. We eventually split the group and John Winkler took half of it. In 2010, I got to conduct my first layoff (ick) but nothing could beat starting out 2011 by giving notice to my entire team, and getting mine too. This isn't necessarily where the story will end, but it is pretty close to the end for the partnership of LM and Scott and Martin (24 years). I never expected to spend my whole career with one company, but the relationships I developed with so many incredibly talented and kind-hearted people kept me here until we were all escorted out. I have been extraordinarily fortunate to have had a string of successes because of dedicated and talented friends whom I will never forget.