Oral History of James E. “Jim” Solomon

Interviewed by:
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James E. “Jim” Solomon, May 7, 2013

Doug Fairbairn: All right. We’re here at the Computer History Museum. It’s May 7th 2013. And we’re here to record the oral history of Jim Solomon who has an extensive career in a variety of technical areas. We’re going to cover semiconductor chip design and design automation and virtual reality and things in between, I guess <*laughs*> as the story unfolds. So, Jim, welcome, glad to have you here.

James E. “Jim” Solomon: Thanks, Doug.

Fairbairn: So, in these oral histories, we like to just start from the very beginning. And the goal is to capture early influencers, when you first became interested in technology, how you followed that path, why you followed that path, and that sort of thing. So, for starters, tell me a little bit about your family, where you grew up, where— how did things start?

Solomon: Well, I was born in Boise, Idaho in 1936 in the middle of the depression. One of my earliest memories is catching a 14” Rainbow trout when I was 6 years old (have picture). My dad was an avid fly fisherman. Another vivid memory, which affected my whole technology thinking, was the explosion of the atomic bomb in Hiroshima when I was nine years old. I recall listening to that on the big Grundig radio in our tiny living room. I recall listening to the announcer talk about this huge atomic blast. I was mesmerized. And ever after that, I had this curiosity about physics. For years after, I read about physics, did physics experiments. So that got one thread of my life interests going.

Fairbairn: What was your father— what was his—?

Solomon: Yeah, so the other big influence was my dad. He worked for the phone company installing PBX’s when I was little. As a result, we had wires all over our house. I had tools for working with wires, things like wire cutters, long-nosed pliers, and soldering irons. I knew how to solder when I was seven or eight. I played around with all sorts of things electric, but I was most dazzled by things electronic. So I was always fiddling with electronic stuff, building Heath kit test equipment, amplifiers and such stuff. My home town, Boise, was a great town for a kid to grow up in; I stayed there right through junior college. I learned how to ski in the mountains that were 40 minutes north of town. My dad loved golf, so I played golf from very early on. In the early days, I caddied at the country club, and learned to play well enough to consider becoming a professional golfer at one point.

Fairbairn: Golf wasn’t such a big thing back then.

Solomon: No, it wasn’t. But golf was an interesting and challenging sport—that’s all that mattered. I played on the high school golf team and won a few trophies in local tournaments. But there was one guy who always beat me, a guy named Jimmy Hiskey. Jimmy did become a pro as far as I know. But I figured if I couldn’t beat Jimmy, I couldn’t become a pro. So, I gave that one up. Other things that went on in my early life: when school let out and summer hit, I’d be bored for just a short while. And then I’d almost always come up with a project for the summer. I learned later to think that many of my most creative moments come out of this quiet boredom. I came to realize that you’re not really being creative if you don’t slow down and just think occasionally. I remember a couple of summer projects that I did as a kid that interested me a lot. I experimented with a giant Tesla coil with the big sparks, Frankenstein sparks rolling up and cracking. And this was amazing to me. A huge resonating transformer sitting there zapping out tons of energy. What I didn’t know was that it was blanking out all of the television sets in the neighborhood.

<laughter>

Fairbairn: Permanently, or only while you were firing up this device?

Solomon: Only when I fired it up. That was one of my first fun electric things. Another really interesting summer project was a Wilson cloud chamber that I built out of junk parts. I took an empty apple juice jug, tied a couple of strings around it, poured some alcohol on the strings, and lit them off with a match. Then I quickly tapped the jug. The bottom and top fell off and I ended up with a glass cylinder that was about 8 inches in diameter. I then set that in a shallow tub of alcohol containing some black ink, and set that on a slab of dry ice. With a cover on top and a strong light shining into the cylinder, I could see trails of cosmic rays forming and disappearing. It was mystifying to watch. I had this running when I was thirteen or fourteen. And like the Tesla coil, I was awed by it. I sent off for radioactive isotopes and played with those in the chamber. I had a little seven inch TV built into the wall in the side of my bedroom, and I tapped off the high voltage supply to electrify deflection plates inside my chamber. By photographing deflections of particle trails, I could very roughly calculate mass and polarity of the particles I was observing.

Fairbairn: Was that a Heathkit TV?

Solomon: No, I bought it used from the local radio repair shop for next to nothing. My basement bedroom, complete with an adjacent photo dark room and a bunch of other cool kid stuff, was the result of other summer projects. My parents built a new house in 1946, shortly after World War II ended. But even though it was a small 2 bedroom house, they couldn’t afford to finish the basement. I had the choice of sharing an upstairs bedroom with my big brother (3 years older), or building my own bedroom in the basement. Of course I opted for the latter. So I got to build out my own room including electrical wiring and lighting. My dad was worried that I might burn the house down, and had the power company come in and check me (I was ten at that point). I did pass inspection, and of course I had no doubt.

I also built a forty-five RPM turntable, a Heathkit amplifier, and a 12” bass-reflex speaker - my first hi-fi. To this day I remember one of the very first ‘50s rock songs, “Bill Haley and the Comets” blasting out “Rock Around the Clock” on that system. I still love rock music and dance to it for aerobic exercise despite my creaky 77 years.

I was into a lot of sports, but not team sports so much. I snow skied a lot with my friend Stan. And we loved to water ski when the snow melted, but we didn’t have access to a boat. So, as soon as we were old enough to drive—16 years old I think, we would tow each other behind my old car on the local canals using a single ski. We’d jump off the ski right before the 1 mile bridges, walk past the bridges, jump on again, and wiz away behind the car. Later on I sailed 16’ Hobie Cats for over 20 years, and just recently bought a 19’ Hobie Trimaran. Snow skiing and sailing became my major adult sports, with a little roller blading, golf and scuba diving thrown in.

Fairbairn: Any other interesting things that you did in your youth?

Solomon: I was big into photography. One summer, my best friend, Willy, and our two girlfriends Gretchen and Judy, spent the whole summer photographing every school in Boise Valley. It turned out there were a large number of schools supporting a town of 50,000. We did this at the urging of our 8th grade photo club advisor on our bicycles with a 4” by 5” view camera and tripod on board. We pedaled all over the Valley that summer. And, of course, it was a good excuse to be with our girlfriends—both on the bikes and in the darkroom. When we got back from the weekend rides, we made 16 by 20 inch prints of each of the schools.

Fairbairn: It might be historically important. Do you still have these?

Solomon: Unfortunately no, but they were presented to the school board by our photo club advisor. I think we realized that he was going to get a lot of brownie points for our work. He was very nice to us in class after that.

Fairbairn: Wow, these are large cameras. You’d have to put them on the back of your bike.

Solomon: They were big. The important thing about that type of camera is that you could raise and tilt the lens with respect to the film plane to eliminate distortion that one gets in architectural photography.

Along with the fun stuff, I almost always had part-time jobs. I caddied at the local Country Club early on.. I worked as a shipping boy, camera salesman and film editor, and at the Idaho Camera store. That got me a job on the Idaho Daily Statesman, the major newspaper in town, where I worked as an evening shift photographer (3pm to midnight) for two years while I was going to junior college. I worked with two really talented well-trained photographers. They taught me everything they knew about press photography, and tried to talk me into staying on and becoming a professional. That was a lot of fun but scary sometimes. A couple of the assignments almost got me killed. One time I was at the Idaho State Fair shooting the rodeo from inside the ring at night. A vicious Brahma bull suddenly charged me. I was carrying a bulky 4” by 5” Speed Graphic camera and a very heavy strobe unit slung over my back. And I’ve got a 2,000 pound bull charging me.

Fairbairn: And you’re in the ring itself?

Solomon: I’m inside the ring with that bull surrounded by an 8’ high wire fence. I ran for my life. To put things in perspective, I knew that a local photographer had been gored in this arena in recent times. So I threw the strobe unit over the fence and clawed my way up as high as I could get. I survived, but barely. Another time, I was shooting air force reserve Sunday afternoon war games at the nearby air force base. And I got behind a soldier shooting a weapon I was not familiar with. It turned out to be a bazooka that fires a missile out the front and fire out the back. As with the bull, I barely escaped with my life on that. But I got an amazing bunch of photographs, and won an Editor’s award for top photo coverage.

Fairbairn: So, did you have any siblings? Are you a—?

Solomon: I had one older brother, Wayne. He was always my sports competitor - golf, skiing mostly and little tennis. He got a PhD in chemistry, became an aerospace researcher - rocket scientist. He spent many years in industry working on high-powered anti-missile chemical lasers (so called “Starwars”). Until recently, he was head of the Aerospace Department at University of Illinois focused on space travel, space drives, and super lasers.

Fairbairn: So, you both ended up in technology. How did this happen?

Solomon: After Wayne got his PhD, he joined the Air Force because the Vietnam war was going on in those days, and he was up for the draft. He ended up working in an Air Force research lab near Palmdale, CA for most of his enlistment. That got him started in big chemical lasers.

Fairbairn: You both had this problem.

Solomon: Yeah, you mean the draft problem. My path was to try and get a critical defense job, something in electronics or physics. Not so easy in chemistry. I started out going to a local junior college to save money, and then hoped to go to Caltech, MIT, or Stanford. I had a chemistry teacher in junior college who I really respected. And she said, “No.” “Go to Cal-Berkeley,” partly because she knew I couldn’t afford Stanford, MIT and Caltech, and partly because she said Cal is just as good as those schools. I had good grades and SAT’s but it was not obvious how I was going to pay the tuition. So she was right. And it turned out to be amazing advice. It totally set the path of my life. So I went off to Cal-Berkeley. As I got to my senior year I noticed that most of the professors are very smart, but not necessarily great teachers. To my great fortune, there was one standout professor: Prof. Donald O. Pederson. He was a new professor, had only been teaching for two or three years. He took his PhD at Stanford and spent some time at Bell Labs before joining the Berkeley faculty. He was very raw and very tough - he would wash out half the students in his classes in short order.

Fairbairn: You entered Berkeley in ’58?

Solomon: I started in ’57 and took three and a half years to get bachelor’s and master’s degrees, getting out in January of ‘60. The life changing event was a senior course from Pederson in active circuit theory—I really liked it. So, I went on for my Master’s under him. I took all of his graduate courses—which focused on transistor-level physics and circuit design. I was dazzled by the stuff he was teaching.

Fairbairn: Did you graduate in physics?

Solomon: No, it was Electrical Engineering. When I started at Berkeley, I wasn’t sure whether I wanted physics or EE. So, I took several physics courses along with EE, but I couldn’t get excited about physics. I had a roommate Rocky who was studying physics, and loved it. But it wasn’t for me. What Pederson was teaching felt exciting and was also very grounded. Physics did not feel that way.

Don wanted me to stay on for a PhD. But I was certain that I wanted to design circuits. And I didn’t think a PhD would be helpful for that. I left Berkeley and took a job at Motorola Systems Research Lab in Riverside, California. It had to be a defense job, otherwise I’d get drafted. So, for three years, I worked on radar systems and missile control systems. Interesting stuff, and a lot of freedom doing military R&D. I designed three gigahertz tunnel diode down-converters, electronically variable bandwidth radar IF amplifiers, and electronics for a missile guidance system. Finally I told myself, “I don’t really want to do

warfare stuff” and I left. I moved from Motorola military in California to Motorola Semiconductor in Phoenix. I had three years of solid system and board design, then I jumped into semiconductor circuit design. Now, this, in retrospect, was such a great time. It was so early you could hardly do anything, and yet—

Fairbairn: So, what year was that?

Solomon: 1963. Bob Noyce had invented the first planar integrated circuit just a few years earlier. It seemed like a perfect time for a young circuit designer to enter. Silicon wafer sizes were around one inch, the largest integrated circuits were just ten to twenty transistors. Most of the engineers at Motorola were working on simple logic gates: DTL, RTL, and eventually ECL. I was working on analog. I’d done my master’s thesis on a digital flip-flop, but analog seemed a far the more challenging and interesting place to be. Microcomputers were a long way off still.

We were initially faced with what appeared to be pretty hopeless capabilities. We were missing vital analog components, essentially we just had just npn transistors and interconnect. It wasn’t immediately obvious that you could make anything analog work. I was in a new group of three guys, and it seemed at first that our job was to make something out of nothing. But we gradually figured out how to make lots of useful stuff. We just had to invent new ways to do old things. Instead of coupling capacitors, everything was direct coupled and temperature stabilized. We could use the accurate transistor and resistor matching to offset unpredictable absolute tolerances of the components. We basically got to reinvent all of analog design using new rules. And we not only designed our circuits, we designed the details of each and every device in our circuits. We got to touch the physics of semiconductor. We even hand drew our own layouts—no layout designers yet.

Fairbairn: Did you maintain any connections with Don Pederson during this time?

Solomon: Yeah, that’s a great question. I would go back and visit Don, initially just once in a while. Eventually, I would go back and see him every few months. I was in Arizona, so it was a pretty good trip back up to Berkeley. I made those regular visits for the rest of my professional career. Don was always a great inspiration to me. We did stuff together. We co-authored papers and co-edited technical journals. He’d often go to San Diego for the summer. I’d fly over and spend a week or two with him, his wife and his two daughters. He took me into the family. He was that kind of Professor; he let students get very close. But I wasn’t the only one who was close. There were many of us, the Pederson alumni we called ourselves. We all knew each other well, even though we lived all over the world. I knew superb R&D guys in Europe, Asia, Australia, and all over the US. Interestingly, I was one a few who did not have a PhD in this group. But I published a lot, and I guess that boosted me to “member in good standing”.

Solomon: So, back to Motorola Semiconductor: my group and I designed a variety of analog circuits for seven years from ’63 to ’70, and put into production many of the very first analog ICs. We designed and built op amps, voltage regulators, multipliers, audio circuits, TV circuits, stereo decoders … early consumer circuits. We built Motorola Linear into a very successful business. But we weren’t “number one”. And this was maddening. I felt we had the best analog IC design group in the world. There were about 30 in my group. But this guy Bob Widlar at National Semiconductor was doing better than we were. His circuits were very innovative and he was making a lot of money. National, initially, generated most all their revenue from his analog circuits and they grew really fast.

Fairbairn: Yeah.

Solomon: Meanwhile, almost everybody else was focused on digital circuits. I felt the one big edge Widlar had on us, other than being a very clever designer, was that he had his own fab. I was always fighting the fab. We had to use the same fab the digital guys used—and it was optimized incorrectly for our stuff.

So, then a string of big events happened. Fairchild began to fall apart. One of Noyce’s right hand men, Charlie Sporck, left to become CEO at National Semiconductor. Many others left Fairchild. Noyce and Moore left to form Intel. Sherman Fairchild hired away the Motorola Semiconductor Chief Les Hogan to replace Bob Noyce. Hogan, in turn, hired away all of his direct reports to come with him to Fairchild. So, the whole senior management of Motorola Semiconductor got wiped out in the blink of an eye. And what ensued was total chaos at Motorola. The management was awful. It became very political. This went on for a long time. And I was this intense technical guy trying to survive in this mess. So, I quit.

Fairbairn: Time to go.

Fairbairn: When was that, when did you finally cut the ties?

Solomon: 1970. I poked around Silicon Valley trying to figure out where to go. I first met with Bob Noyce. Intel was very young right then.

Fairbairn: Yeah, started in ’68, ’69. So, it was very …

Solomon: .. small. I liked Noyce. And I liked Intel. And I figured they’d have the best fab in the world. So, I told him, “Look — I can build a whole linear analog IC business for Intel. This could be great.” He looked at me and thought carefully about it. He said, “You know, my venture capitalists tell me I’ve got to focus.” He said something like, “they think I have too broad an appetite. I know it’s an opportunity, but I shouldn’t do this.” He added, “Why don’t you talk to Charlie Sporck at National Semiconductor, they’re doing analog

stuff.” I basically said, “Okay, I appreciate the advice,” and left. It was a nice one-hour meeting in a very small office. It surprised me how small Noyce’s office was at the time. And so, one thing led to another. I ended up — I didn’t interview with CEO Sporck, but ended up interviewing with the GM of analog integrated circuits at National, Jim Diller.

And another very fortuitous event occurred right around then. The top National analog designer and my old nemesis, Bob Widlar, had just resigned. Interesting. Right around the moment when I’m deciding that I need to make a change.

Fairbairn: Right when you walked in the door?

Solomon: He had left a few months before. Bob had done very well for the company and himself. He had talked Sporck into giving him enough stock that he had made a million dollars within just a few years. A million dollars in 1970 was real money. Widlar had once told me that he always told himself “once I get to a million, I’m done. I’m out of here.” Now, Widlar was very different from other designers. He was loud, brash, irritating, and alcoholic, yet at the same time a creative and solid analog designer. I was on an evening expert panel at the International Solid-State Circuits Conference with him one time where he drank a whole bottle of Chivas Regal whisky and still seemed completely lucid. It pissed me off because I couldn’t drink at all — one drink and I am done.

I used to think Widlar designed his circuits in a drunken haze. But not true. I was invited to write his IEEE obituary when he died at age fifty-three—he had a heart attack while running. I spent a lot of time talking to the people who had worked closely with him. They were very clear: he was dead sober and serious when he designed. He had his demons. He was kind of crazy. He couldn’t stand to be around people, and most people couldn’t stand to be around him. Still this was my strongest and most successful competitor. He was more intuitive and empirical than theoretical. The academics dismissed him. But I respected him. So I moved into the hole he left at National.

Fairbairn: What kind of position? Did they hire you to run the group?

Solomon: No, I didn’t take Widlar’s group. There was a Widlar understudy, Bob Dobkin, who had taken his group. I came to realize that Dobkin was actually very smart in his own right. I took over a competing group, which was pretty much in its formative stages—not nearly as strong as I had at Motorola. I took it over, thinking ‘I’ll build it into something great’. The important thing is I got my own fab line. Dobkin’s group had its own fab line. And I had my own fab.

Fairbairn: Different fabs?

Solomon: Different fabs. Linear was a big business at National. We built a third consumer linear fab a few years later.

Fairbairn: Wow.

Solomon: It did take a lot of work to re-build the group to be as strong as I had at Motorola. But I eventually did that. I brought in a few of my old “Motorolans” and hired a few young guys out of school. And after a while, we again had a world-class group and had successful designs rolling out.

Fairbairn: You were designing the same kinds of things you were doing at Motorola?

Solomon: We were moving on, we were still doing op amps and power conditioning circuits, which Dobkin was also doing, but I moved heavily into mixed analog and digital: A-to-D converters, D-to-A converters, switched capacitor filters - which Paul Gray pioneered at Berkeley. Paul was another superb Berkeley professor that I stayed very close to. Then we moved into telephony. We built the first, I’d like to say, one-chip digital telephone handset. But it actually was two chips. We weren’t able to integrate big digital with analog at that point. And it was not designed for cellular yet. But it was the start of digital telephony where all the voice traffic was converted to digital, went through a digital switch, and then got converted back to analog in the handset. We designed that partnering with Bell Northern in Canada and LM Erickson in Sweden.

Fairbairn: Was there competition between your group and Dobkin’s group?

Solomon: Yes, it was quite intense. And what made it more intense is that Widlar came back and got re-involved at National. He had retired to Puerto Vallarta, Mexico, but got bored after a while and decided to set up a consulting agreement with Dobkin—meaning he was back in the design game at National, this a couple years after I got there. There is another interesting aside here: Immediately after Widlar resigned from National, he had visited Michael Gay (one of my designers) and me in Phoenix—as he was driving down to Mexico. He was exploring Mexico as a possible place to land and “retire”. He came by, and we all went out and got drunk together. It’s the only time we really socialized. Actually, we had one other sort of social interaction right after I joined National. I got a call from him early one morning, and he just screamed a steady stream of profanities at me. His voice was so boozy that I didn’t recognize him at first. The gist of it was that he was mad that I had moved into “his territory” at National.

Later on when he started consulting with Dobkin, he would show up in the lab occasionally and we would talk “across the fence” between our groups.

There were a few very competitive moments between the groups, because we did have overlapping charters. At one point, we came up with one of our better semiconductor patents, a bipolar-compatible junction FET—co-invented by associate Jim Dunkley and me. “Dunk” was my old device/process guy from Motorola. It began as an ion-implanted resistor “process accident”, but I immediately recognized that we had discovered a really important device. We desperately needed a fast npn-pnp complimentary process, and this gave us a fast p-channel FET along with our normal npn bipolar device. In short order we had a powerful high-speed complementary technology which clearly had great potential. Shortly after this, Dobkin belittled the technology causing us problems when a layoff hit about then. A little while later, of course, he copied our technology and started using it. But we got a lot more mileage out of it than he did with a new line of fast BiFET operational amplifiers that sold really well.

Fairbairn: What do you think your most important technical contributions were?

The most important ones were not in computer-aided-design for sure, but were in chip design. I wrote a paper in 1974 on the fundamental theory underlying monolithic amplifiers. It was an outgrowth of a lot of experience, along with some theoretical work I had done related to our designs. Much of this was written down while preparing for a graduate class that I taught at Stanford under the wing of Prof. Bob Dutton. I then wrote a paper which I called a “The monolithic op-amp: a tutorial study”. I believe it really did bring a new kind of understanding into how analog circuits work. That paper made me reasonably famous in the small world of analog chip designers. Even Widlar’s guys said it helped them understand stuff they had been empirically hacking at for years. The paper is forty years old today, but is still in the top most cited references for analog design. Based on this and a few other papers, I got elected Fellow of the IEEE, which was pretty a pretty big deal for a circuit designer back then.

About this time, I got invited to be on the technical program committee of the prestigious ISSCC, the International Solid State Circuits Conference. I kept getting invited back to that committee for the rest of my design life, which turned out to be about another ten years. Not only did this keep me amazingly relevant with analog R&D, but I gained a certain degree of fame that would help me start my CAD company later on. Further keeping me relevant, of course, was the synergistic relationship I had with the whole Cal-Berkeley EECS staff, all starting with that lucky accident in a senior course back in 1958.

Fairbairn: And the chemistry professor who told you to go to UC Berkeley

Solomon: Yes. What if she hadn’t told me to do that?

At this point, another big change happened: In the late ‘70s, we used to regularly give analog seminars educating our customers on our newest analog chips. Audience acceptance was great and sales boomed. Then one day the microprocessor came on the scene. The microprocessor guys started giving seminars too. People began to leave our seminars and go to theirs. It was maddening. I asked myself,

“What is this microprocessor?” So, I did a lot of reading and ended up buying a Radio Shack TRS-80 microcomputer. The Apple was prettier but didn’t seem to provide the technical access I wanted. And I started to teach myself how to code.

It didn’t take long before I had captured the op amp theory from my 1974 paper into the computer. I extended the theory and used it to write high-level computer models for the analog circuits we were designing at work. I called these models, macromodels. In short order, I had a whole library of these things, including every important op amp that had been designed up until then. I also had to figure out a way to test my models. So I designed test circuits, ran circuit simulations, printed out and evaluated results—all on the microcomputer interacting over the phone line with a big timeshare machine. I was able to I make a deal with the local timeshare company to give me access to SPICE circuit simulation. They ended up licensing my model libraries to speed up SPICE simulations for board and system designers. The macromodels ran up to 100 times faster than transistor-level models. And I made enough money off that to make my house payment.

Fairbairn: These are in BASIC?

Solomon: The coding I did was Assembler, BASIC and SPICE input language. The models themselves were in SPICE format. Most importantly I used this project to learn how to code. I taught myself how to write editors, parsers, test languages and control programs. It sounds trivial today, but this is the late ‘70s. I even bought an expensive Daisy Wheel printer and this allowed me to automate my test printouts.

Fairbairn: The daisy wheel.

Solomon: I spent a lot— I don’t know a thousand or two thousand dollars on that printer. But it allowed me to completely automate my system at home. I didn’t think about it so such at the time, but I was writing crude CAD software.

Fairbairn: This is on the TRS-80?

Solomon: Well, as I got more serious, I migrated to a TRS-80 Model Two which did not rely on quirky tape drives for storage.

Fairbairn: Oh, okay.

Solomon: It had an eight-inch—

Fairbairn: Floppy.

Solomon: Floppy. I wrote a lot of code. And I shared it with Pederson. He said, “Wow, that’s interesting.” So, he bought a TRS-80 and did some coding. About this time, Don had taken over Berkeley SPICE from Ron Rohrer, so this got him very interested in software. Ron had left Berkeley and had gone off to NYU. Don, of course, became known as the “father of SPICE, advising several SPICE PhD students over the years. He also got very interested in my macromodels and had a couple PhD students working on them. We ended up co-authoring a paper on that. It was referenced a lot; and it pointed the way for people to later do high-level analog modeling in Verilog-A.

Meanwhile, at work in my real job, our chips were getting too big to deal with manually; design was getting hard. I instinctively knew from what I’d been experimenting with at home that computers could do something to help us. I’ll never forget the chip we called “Big Bertha”. It was a twelve-bit Analog-to-Digital converter. Two hundred mils on a side, and many of the drawn components had to be precise to .01% or so. We stayed up much of the night doing what we called a “beer check” where you hand color the interconnect lines to check for layout errors. We got through that, and I said to myself, “Why are we doing this manually? This is stuff the computer should be doing.” So, I took on, as my assignment as design manager, to go find some computer tools to make life easier. I had a group of about fourty to fifty designers, researchers, and technicians at the time.

Fairbairn: What year was this?

Solomon: Right around 1980. I then did what I always do. I went to Berkeley and talked to Don about it. I said, “Don this is getting too hard.” He said, “Hang on, I can help.” In short order, he introduced me to Alberto and Richard: Professors Alberto Sangiovanni-Vincentelli and Richard Newton who I didn’t know up to that point. And of course I’m a neophyte in real CAD and proper software development. But I had spent a lot of time with SPICE, my microcomputer, and bigger machines. I had also hired a Berkeley graduate, Frank Jenkins, to write two earlier versions of “SPICE” for me, with Don’s help of course. Don said Richard and Alberto understand and are working on this problem. Then he told me very carefully “you’re going to work with both these guys, not one without the other”. I am guessing he said that because Richard was pretty new still—he was only 2 years out of his PhD, while Alberto had graduated some 10 years earlier. So, Don, Richard, Alberto and I started meeting at regular intervals. We met every month or so for two and a half years starting in 1980. We talked about a new kind of CAD system. They already had PhD students developing various pieces of CAD code in one of the Berkeley labs. They had networked DEC VAX’s running UNIX and everything was written in C. They had an early version of Ethernet that was just becoming commercially viable about then—even though PARC had invented it years earlier. The whole idea of networked microcomputers was high in our minds. We all saw the thirty-two bit microprocessor coming. And we knew you make microcomputers out of microprocessors.

Some other interesting asides: While I was getting my microcomputer exposure at home, I was also getting involved with larger machines at work. I purchased a DEC VAX, an 11-780. This was initially to do research on speech recognition and synthesis which was done in close cooperation with Berkeley EECS professor Bob Broderson and physics professor Forrest Mozer. This was a sizable project that I had started two years earlier at the request of Charlie Sporck. We had a large automotive customer who wanted a speech synthesizer in the car, and my group was chosen to design that. If you know a little Joe Costello history, you may remember he started out working in speech synthesis. That happened when I hired him into my speech group. Over time I came to realize that he was one of the smartest guys I had ever run into. In relatively short order I had him running the group.

Joe Santos was also part of this speech effort. You may know that some years later Santos became architect and group head for development of Cadence’s OpenAccess, the third generation of the Cadence unified database. Santos was a digital chip designer working for me in those early days, and later retrained himself to become one of Cadence’s top software developers. He was also a Berkeley grad who came to me from Prof. Bob Meyer who worked closely with Pederson. One of Joe’s earliest chip design projects was to design a small microprocessor that became the core of our speech synthesis chip. I’ll never forget that he was a proponent of the Mead-Conway design style and used that to rapidly design the microprocessor, beating out a very seasoned microprocessor designer that I had hired to compete with him. The kid fresh out of school beat the very smart and experienced “old dog”. As I watched Santos do this, I came to realize that, even though he was a little complicated, he was off-the-charts smart. Santos and Costello were eventually going to be the only two National Semiconductor employees that I would take with me from the IC hardware design world into the computer-aided-design (CAD) software world.

Because our linear chip business was so successful, I had a lot of freedom to explore a variety of things. I had many balls in the air. I was doing R&D on telecommunications, speech synthesis and recognition, this along with data acquisition, sampled data filters, traditional op amps, voltage regulators, sensors and transducers. And now CAD software.

Fairbairn: Mmm Hmm.

Solomon: Getting back to the Berkeley meetings. As the meetings went on, I came to realize that the big contribution from Richard and Alberto was going to be the architectural definition of a CAD system. We actually spent very little time discussing CAD tools. We focused mostly on infrastructure, especially design of a database that would lie under the tools.

Berkeley did, of course, have important tool efforts we could leverage: there was a unified schematic and layout editor known as KIC and the circuit simulator SPICE. Interestingly, most all other important first tools would come from developers I would hire from the Bell Labs CAD group under Herman Gummel. The Bell-derived tools list included a place-and-route system, a design-rule-checker, a schematic-to-

layout verification system, and an extension language. These combined with Berkeley’s schematic capture and custom layout editors would make up the tools in our first system release. Missing was a logic simulator that I hoped to have Frank Jenkins write, but that never happened because Frank preferred to work alone. Also missing was a C-version of SPICE. I really wanted to get away from Fortran-based SPICE. But despite a sizable SDA effort under one of Richard’s PhD graduates, that project never completed. Several years later this finally got done under the wing of the Cadence Analog Division by young Berkeley PhD, Ken Kundert along with Jacob White, an MIT professor. Jacob and Ken were both extraordinary simulation guys who graduated under Alberto in 1985 and 1989 respectively.

You can see from this list that the proper credit for what SDA accomplished in its early years should be given to UC Berkeley *and* Bell Labs—to a large extent we were formed out of Newton-Alberto-Gummel roots. And Don Pederson was the enabler of it all.

A very important part of the Berkeley architectural vision was our hardware environment: Single-person UNIX-based 32-bit personal workstations with color monitors, networked together with Ethernet, each circuit designer on a project having access to all views of a design. We would use the Berkeley version of UNIX from Bill Joy who later left Berkeley for Sun Microcomputer. Our plan was to build portable CAD software—with the idea being that we would port our whole CAD system including the OS if necessary to whatever hardware was appropriate at the time. The workstation would be based on one of the new 32-bit microprocessors that we believed would soon be available; we fully expected (incorrectly) it to be a DEC MicroVAX. This was a very important decision; we were going to be a software-only entity—while other CAD startups at the time, Daisy, Mentor and Valid all were built on proprietary hardware with proprietary OS’s. This hardware independence and the early choice of UNIX became a large advantage for us later on.

So the focus of our regular Berkeley meetings was largely on the details of an underlying hierarchical database that was needed for a next generation CAD system. This was not a relational database such as Oracle—that was deemed to be too slow. Richard was the primary driver for this, and likely drew a lot from interaction with his PhD student Ken Keller, who was well along designing KIC with a similar underlying database. This was Ken’s PhD thesis under Richard.

As we defined this database, we tried to envision all data types that future CAD tools might need. We struggled, for example, with how important it was to have a unified electrical-physical database. How important was it for layout to interact with schematics? In 1980, IC line widths were around 10 microns and physical parasitics had relatively minor effect on chip performance. We decided to keep electrical and physical unified anyway, and of course this turned out to be the right decision. With today’s feature sizes reduced by a factor of nearly 1000 from those of 1980, physical parasitic effects dominate electrical performance.

In our discussions, we also planned for a single common GUI for all the tools, this at a time when command line was the norm. Except at Xerox PARC. Job’s Apple Macintosh with PARC’s graphical GUI came out in 1984, and SDA’s first product release was about a year later. We used “X-Windows” just released from MIT as the basis for our GUI. Doug, you were at Xerox PARC, and you know that they had common GUIs well before either Apple or we did.

Fairbairn: Yeah, ’73, ’74.

Solomon: One thing that was not in the first vision was an extension language. As we began to develop our software for real, we put an extension language in straight away, one that would allow access to the database, but not change it. That turned out to be one SDA/Cadence’s greatest competitive edges.

This new architecture seemed to be very clean compared to what others were doing. But it was also very ambitious. We had a vision for a new company, where we would develop from scratch every CAD tool one could think of on top of a new unique database.

At this point, I’m sitting there thinking ‘what to do with this grand idea?’ We had been going at it for almost three years. Richard and Alberto clearly had an interesting vision, but there was much to do to make it a reality.

I thought about this for weeks, and finally decided the best approach would be to form a new company funded by a consortium of semiconductor companies—the customers for the CAD tools. It would take too much money for one company such as National Semiconductor to fund alone.

I knew this idea for the new entity was a little like Austin-based SEMATECH which formed about the same time. SEMATECH was a consortium of semiconductor companies that focused mainly on manufacturing equipment—pooling US resources to make us more competitive against Japan. But I didn’t like one of SEMATECH’s main ideas. They staffed the consortium with volunteer engineers from member companies, often less skilled engineers than you would want. I had a strong belief about what we were doing: we needed to bring in only the very best software developers in the world to attack the CAD problem. And I was certain the way to do it was to form a real company and give significant stock ownership to the employees.

This was of course the formula for a typical Silicon Valley startup—except I wanted all the funding to come from industrial partners who would take minimal ownership. Charlie Sporck, the National CEO, was tracking what I was doing; he liked the idea, but knew that I was treading in water that was very different from my world of chip design. I think it didn’t hurt that Sporck and Noyce were working on the formation of SEMATECH around that time. It was a similar idea to ours—support a common effort to strengthen US semiconductor companies.

The other reality is that Charlie played an amazingly generous role in this story. Most CEO’s would be worried that I might run off to a startup—and they would do whatever they could to talk me out of it. That was my immediate boss’s position. Charlie did the reverse. He helped me in every way he could and he became the first investor in the new venture.

Charlie convinced me that I needed the help of some VCs. He introduced me to Don Lucas who was a very different VC from the norm. Lucas became my “start-up business partner and mentor”, and put together a small group of excellent people to help - in the form of Augie Moretti of Heller Ehrman (legal), and Jim Benson, a senior partner at Arthur Anderson (accounting). This combination of Don, Augie and Jim provided exactly the brew that I needed to put together the business aspects of the new entity.

We came up with a formula for a new kind of startup that fit what I wanted. I was to set off on a mission to find three or four industrial partners to invest $1.5M each, and Don would form a syndicate of other investors including himself, BJ Cassin (Don’s close associate and definitely in the category of “good VCs”), Alan Patrikoff Associates and a third lesser known VC firm. For every dollar I raised from the partners, the investment group would put in a matching dollar. Employees would initially keep two-thirds of the company, the investors one-third—with the industrial partners getting about half the ownership per dollar that the venture capitalists got. The idea was that the partners were going to be able to influence our directions, so it seemed fair that they have smaller ownership.

With that plan in my pocket, I visited about 20 potential semiconductor partners throughout the US and Europe. I did not visit Japanese companies because I felt the US was under attack by Japan—copying us and manufacturing cheaply. The story for the new company was not such an easy sell to hard-nosed US semiconductor companies, however—they are very tight fisted with their cash.

Fairbairn: Yes, absolutely.

So most companies in the US did not bite. I ended up closing investments only from Harris Semiconductor, thanks to GM John Cornell, who knew me from my analog design reputation and who was also close to Berkeley, GE Semiconductor at RTP, and National Semiconductor. Not a terribly good score, but enough to get us off the ground. The Europeans showed a lot of interest—it gave them early access to advanced US technology. Still the Europeans make decisions very slowly. Telecom giant L.M. Ericsson in Sweden, who knew me from work we had done on the digital handset, committed but took over a year to close. This initially brought in $4.5M in partner money and a matching venture amount of $4.5M for a total of $9M, with significant partner investments following later.

Fairbairn: That was a lot of money in 1983.

Solomon: Yes, looking back on it now, it seems huge. With that we were off and running with what seemed to be plenty of cash to properly implement the Berkeley-SDA architecture.

Fairbairn: So, how long did it take to raise the money?

Solomon: I started climbing on planes in early 1983. I had verbal commitments for all the money by mid-1983, and we incorporated in July 1983 under the name Solomon Design Automation. I had intended to use the name Isis Design Automation, but at the last minute we found a conflict on that - so our lawyer just penciled in my name as a placeholder. We wanted to accept first money in from National so we filed quickly. We submerged my name by using SDA rather than the longer self-serving name.

Later on we raised additional money by adding other partner companies who had a very specific focus; for example Toshiba and Philips signed up for direct access to the SDA database, while Sony, SGS Thompson, and BNR became partners of our Analog Division, which I started from within Cadence in 1989.

Fairbairn: What about staffing? When did you start hiring people?

Solomon: The idea we used for building the initial staff was this: Richard and Alberto would identify the “best software developers in the world” for each of our target technologies (e.g., data base, place and route, simulation, layout, schematic editors, schematic-to-layout-verification, design-rule-checkers, etc.). Several would come out of the Berkeley CAD research lab. I started getting on airplanes and went out to recruit the rest starting in mid-1983. My thinking was that if we started with a small team of the very best, they would attract a second wave of excellent people; and we would continue to grow a superb staff in that manner. This approach worked as planned for a long time - until we started acquiring companies.

One chance event made the hiring process go much smoother than expected. AT&T was going through its government mandated break-up in the 1982-1984 time frame. Bell Labs at Murray Hill were in turmoil, and this made it easier for me to hire many of their very best people. As this progressed, Herman Gummel, head of the CAD group at the Labs (and famous for the Gummel-Poon transistor model) complained that SDA was little more than “Bell Labs West”.

Fairbairn: Talk a little more about how the early hiring went.

Solomon: The first focus technology for me was place and route; so I started with that in June 1983, meeting with a Ulrich Lauder from Siemens Research in Germany. He was judged by Berkeley to be the best routing guy in our chosen design style. I was able to meet with him in Miami Beach where DAC was being held that year, this allowing me to avoid a trip to Germany. He was intrigued and very tempted by

my plan and offer. He wife was American even. So, how hard could it be? But he ended up saying “No”, largely because his wife did not want to return to the US. So my first critical hire didn’t happen. I was not feeling too good at that point. (Ulrich told me years later that saying “no” to that offer was one of his great life regrets.)

Fairbairn: *<laughs>*

Solomon*:* I came back and met with Richard and Alberto and said “okay, who’s number two in place and route?” Their answer: Jiri Soukup, formerly Bell Labs Murray Hill, but now working for BNR in Ottawa, Canada. There is some interesting background information here that I didn’t know about at the time: About 12 years before I first met him, Jiri and his wife Hana had made a harrowing escape from behind the Iron Curtain in Czechoslovakia. As a result he was still suspicious of virtually every stranger he met, worrying that the Chech KGB might still be looking for him.

I flew to Ottawa and met with Jiri. After explaining the plan to him, he threw me out with almost no discussion. *<laughs>* Threw me out. Now I have two failures in a row. I drove back to my hotel pretty discouraged *<laughs>* Then I got a phone call from Jiri.

Fairbairn: You weren’t carrying a cell phone at the time.

Solomon: Jiri called me at the hotel and said, “I’ve changed my mind. I want to talk.” What had happened was this: after I left, he had called a trusted friend of his, Bernie Murphy at Bell Labs, to check me out. As I mentioned earlier, 1983 found Bell Labs in turmoil because of the divesture. Bernie Murphy, who was quite respected, was thinking about spinning out himself. So, Jiri Soukup called Bernie and asked “who’s this guy Jim Solomon? Bernie answered, “The Jim Solomon?” This is the quote Jiri Soukup gave me later; and I am in debt to this day for this lucky response from Bernie.

Fairbairn: *<laughs>*

Solomon: Bernie knew me from my 10 or so years on the ISSCC (International Solid State Circuits Conference) program committee, as the tough guy who rejected most papers submitted over the years by Bell Labs chip designers. It was not easy to get a paper into ISSCC in those days—it was and still is the premier conference for chip design, and very few papers make it in.

<laughter>

Solomon: So it turns out I had a lot of respect at the Labs. I had no CAD credentials, but Bernie respected me as a designer. Bell was unusual in that they had CAD and design working closely together. They were designing the BellMac-32 about that time, an early 32-bit microprocessor. Jiri had worked on that. A bunch of superb guys whose credentials fit exactly what I was seeking were in that group. And little known to me, Bernie told Jiri, “Take the job. Go for it.” And I am on my way to my first and most important hire outside of the Berkeley group.

Fairbairn: *Hmm.*

Solomon: Unfortunately Jiri wouldn’t leave Canada. So I ended up starting a three-person operation in Ottawa; SDA North we called it. And the Jiri hire opened Bell Labs up to me.

Fairbairn: Hmm.

Solomon: I ended up attracting a third of my founding group from Bell Labs. I got Paul Swartz, who had done some excellent early design rule checking (DRC) software for the BellMac. Ked Mednick joined Paul shortly after, a truly amazing DRC expert. Steve Law who did a masterful job in writing our SKILL extension language came straight away. George Janac, Charlie’s brother, came a bit later when they tried to ship him to Bell Laboratories in Pennsylvania. George told Herman, “No thanks on Pennsylvania, I’m going to California.” <*laughs*> Mike Meyer followed, a superb guy who single-handedly filled in the holes in our tool flow.

Fairbairn: Who were the most important early employees?

Solomon: The early hero of SDA was Ken Keller who wrote the whole framework. He wrote the framework/database, working day and night. He also wrote the schematic entry system and the layout editor. One guy. He brought Richard Newton's vision from Berkeley to SDA. It didn’t hurt that his PhD thesis was a first version of the framework and editors in the form of his Berkeley program, KIC.

Fairbairn: My God.

Solomon: I should mention that, as we started SDA in 1983, I had a very specific vision for how software development should be done. I didn’t believe in large teams. I felt one to three really good developers would do better on each major task than a team of 10 or more average developers. My feeling about this came from working with Frank Jenkins, who had written SPICE-class circuit simulators for me at Motorola in 1969 and again at National in 1971.

Frank, along with SPICE author Larry Nagel was in one of the original Berkeley CANCER classes under Ron Rohrer in the late 60’s. This class is where CANCER and SPICE were born. Pederson sent Frank to me to write this before Nagel’s version of SPICE was made available by UC around 1974. Frank’s Motorola version was very primitive, using fixed-format FORTRAN input. Ugly and clumsy, but it simulated our chips. And this started what became a long and distinguished history of SPICE development efforts at Motorola Semiconductor.

I will never forget coming to work in the mornings and finding Frank looking kind of blue—he had been up all night programming. Keller was the same way—he pulled many all-nighters. Once on a roll, they couldn’t stop; they were both world-class software guys.

The full story of the SDA/Cadence evolution would be a book in itself. What I think might be interesting at this point would be to highlight some of the more interesting occurrences and events that happened during the early years of the company.

Fairbairn: OK.

Solomon: Let’s start with the Costello-Santos story: As a condition of National Semiconductor’s investment in SDA, I had a handshake agreement with CEO Sporck that I would not hire any employees away from National, even if they had left. About a year after SDA started I wanted to hire Joe Costello, who used to work for me but had left the company. Costello, a physicist by training, was clearly an extraordinary guy. I didn’t know yet what I was going to have him do, but I knew I wanted him. I also wanted Joe Santos, the amazing young chip designer I had hired out of Berkeley a few years earlier. I met with Charlie, made my plea, and he was gracious enough to give me permission. A few years later when we merged with ECAD, Joe Costello was my choice to become CEO; and he did an even more impressive job than I could have imagined. Joe Santos retrained himself to become a world-class software developer and architect (on top of being expert in chip design). He designed and led development of two of Cadence’s most important software technologies: the Virtuoso custom layout editor, and OpenAccess, the current version of the Cadence Framework. OpenAccess of course has been made openly available and has become the EDA industry standard framework.

Fairbairn: What were some of the problems you ran into?

Solomon: There were, of course, many bumps in the road as we grew what became Cadence. One of the more bizarre and personally painful ones, was a time when Don Pederson got upset with me and did not talk with me for over a year. The cause was the following: IBM and DEC gave lots of money and computers to support Berkeley research. When they discovered that I had hired most all of the best young PhD’s under Don, Richard and Alberto, they got so upset that they threatened to cut off Berkeley funding. They accused me of having “undue access” to the university. My private reaction was that they

thought that just giving money was enough, and did not understand the importance of spending quality time with students and professors. But that didn’t make Don any less mad; clearly his funding had been reduced. Years later, the head of CAD research at IBM, who at the time didn’t think I could possibly pull off my plan, told me that I had indeed done the impossible and apologized for the uproar. I had invited IBM to be an early corporate partner, and he apparently thought it was hilarious that I thought I could outrun IBM research. In recent years, I had the privilege of “roasting” him at one of his retirement events. Good fun, and we are friends today.

I hired a lot of people, and I hired them fast. Thinking back on it, I thought very little about the budget and how quickly I could ramp revenue to offset costs. I had $9 million in the bank and it was hard to imagine running out. I didn’t know what I didn’t know. I did, however, feel that I needed a business guy in addition to my CFO. <*laughs*> And by good chance, Jiri Soukup had a best friend at Bell Labs with a son who was a young Stanford MBA, and he suggested, “Go talk to this guy, Charlie Janac.” Jiri actually just wanted Charlie to confirm to him that our business ideas made sense.

Fairbairn: mmm …

Solomon: So I met with Charlie, who’s very smart and quite respected in the EDA industry today. Charlie had just taken a Stanford course focused on starting new companies. And he was in love with that idea. I ended up hiring him and we have been close friends ever since. And course, he told Jiri, “Go with it. This is exciting stuff.”

Fairbairn: <*laughs*> How did the product development go?

Solomon: The new team dug in and started developing all the stuff in our plan at an amazing pace. We had a first-cut built in a year and a half and were ready to ship the first alpha product. It was surprisingly quick. We were showing at DAC 18 months after we started. It didn’t have everything we wanted in it, but it impressed a lot of potential customers.

Fairbairn: You showed at DAC in ’84?

Solomon: Hiring consumed the second half of ’83. Development started in earnest in early ’84 and we showed in a private suite at DAC in June of 1985 in Las Vegas.

Fairbairn: Now Daisy and Mentor and Valid have their schematic entry and logic simulation and so forth?

Solomon: They had all that stuff. But they were mostly board—

Fairbairn: Yeah.

Solomon: —focused, not IC design focused. Our plan was to focus on chip design and do board-level later on. That eventually did happen, but never became as big a business as chip design. Daisy had a few tools that were IC capable. I did have a battle or two with them. I hired one of their guys, and got a call from the CEO one day saying he wanted to meet me in the parking lot for a fist fight.

Fairbairn: <*laughs*>

Solomon: He was a scrappy ex-Israeli paratrooper, Aryeh Finegold.

Fairbairn: Oh, yeah. Aryeh—

Solomon: I thought about it for minute and said, “Okay. I’ll meet you in my parking lot.” <*laughs*> I didn’t even know what Aryeh looked like; I am not a big guy and certainly not trained for street fighting.

<*laughter*>

Solomon: Well, it turns out that my guys, Ken Keller and Joe Santos, were both trained in the martial arts. So I brought them along as my wingmen. And he… <*laughs*> Aryeh had his CFO with him, who I think was there to keep him from getting sued. It turns out Aryeh is not very big either. And so we had this screaming argument about me hiring his people. No punches were thrown. And that was the end of that.

Fairbairn: How did your sales force do?

Solomon: I didn’t understand marketing and sales well enough. Just didn’t. My experience was only that of being an R&D manager. Very sheltered.

Fairbairn: Build it and they will come, right? You don’t need to… <*laughs*>

Solomon: Yeah. I wish it had been that simple. I hired a guy whom we shall hall call Roger to be our VP of sales. Roger was good and he was bad. Things ran well for a while, then I got married and went on a honeymoon for a week or so. When I returned, I found that Roger had quit and joined competitor Silicon Compiler Systems, and also had hired all my sales guys away. <*laughs*> While I was gone, such a chicken. Roger and Phil Kaughman, the CEO (now deceased), if you’re listening … you know I was not happy about that. The irony is that I later received the Phil Kaufman award for lifetime EDA achievement.

Solomon: Our revenue, which was ramping fine up to that moment, stopped cold, and we quickly ran short on cash. I had to scramble to hire a new sales team; I pulled Joe Costello and Charlie Janac into the breach. Over Charlie’s objections we put him in charge of Silicon Valley sales, and we made Costello acting VP of sales.

Both Joe and Charlie ended up being brilliant at marketing and sales. Costello is the best strategic marketing and business guy I’ve ever worked with. Charlie is one of the best high-level sales guys I’ve ever met, and also a great strategic thinker. These are just two of the young kids (both under 30) who were around me at that moment. Charlie, in short order, owned Silicon Valley EDA for us. Costello was, without me thinking much about it, being prepared for something bigger.

Fairbairn: Yeah.

Solomon: So we got revenue back on track and were off and growing again. Joe and Charlie basically saved the day. And the growth continued back on track. Our revenue run rate was up to $8 to million a year or two later.

Fairbairn: This like ’85?

Solomon: More like ’87. And then Lucas, being the venture capitalist, says, “Let’s go public.” And I said, “Why would we do that? We have plenty of cash and we are growing nicely.”

<laughter>

Solomon: Which is about all I knew about it. Next thing I know, we’re doing a road show in New York, pitching SDA to large investment firms. And it goes well. Our growth rate is off the charts, more than doubling every year. I remember talking to somebody on Wall Street and him kind of dismissing me. He said something like, “We only invest in large companies. What’s your market cap?” I said, “We plan to go out at around a billion dollars.”

Fairbairn: Yeah.

Solomon: The guy just sat back in his seat and listened. It was an outrageous number, some just unbelievable thing, based on I have no idea what. And I began to understand better why Lucas was so interested in an IPO.

<laughter>

Solomon: So we “sold out the book”, meaning we had numerous top investment firms lined up to buy our stock - with Goldman Sachs leading.

Fairbairn: Mm-hm. Yeah.

Solomon: We are all ready to price the stock and take it out the next Monday morning, but that day turned out to be one of the biggest disaster days of all time on Wall Street. Black Monday, October 19, 1987. The SDA IPO was one of a small number of IPOs that had to be pulled that day.

Solomon: The week before the market was dropping 100 points every day—which at that time scared everybody.

Fairbairn: Right. It dropped about 25 to 30 percent on that Monday.

Solomon: And it was the beginning of the end of Wall Street as we knew it. It has never recovered completely from that. Many brokerage firms disappeared shortly thereafter, some who planned to invest in us.

Fairbairn: Mm-hm.

Solomon: Up to that moment, SDA had been on an amazing path with near perfect timing in everything we did. Much of it just good luck of course. But our IPO timing could not have been worse.

Solomon: At that moment, I was CEO and had elevated Joe to President and COO. We had done the road show together. And we came back home devastated.

Fairbairn: And you had to raise other venture capital or other money in between?

Solomon: We actually did. And we never used it.

Fairbairn: Mm-hm.

Solomon: We were offered nine million dollars from a “mezzanine VC” just before our attempted IPO. Don thought we should do that to be safe—we should have some more money in the bank. So we raised nine million dollars at a reasonably high valuation. The money guys were initially very tough on price. We

had Oracle’s Larry Ellison’s on our board at the time and he objected to the price that we were offered. Oracle had gone public a couple years earlier, so Larry was already worth quite a bit.

Fairbairn: Larry Ellison was on your board?

Solomon: Yes, Larry was on our board. Don Lucas was the lead VC and chairman of both Oracle and SDA at the time, and brought Larry in. In a board meeting, Larry thought about the mezzanine offer for a minute, then said, “You know, I’ll give you a better deal than that.” <*laughs*> “I’ll take the full nine million at $3.50 a share.”

Solomon: So we went back to the money guys and they buckled, the price went up and they put the money in. Larry walked away without actually doing anything but he was very helpful …

Fairbairn: <*laughs*>

Solomon: In any event, less than a year later Don is still itchy about getting public. I’m thinking, “Gee, the stock market’s crashed, and he somehow is still in a hurry to get liquid”.

Fairbairn: Yeah.

Solomon: Don hired some bankers with a mission to go around looking at who we could merge with. They recommended merger with design-rule-checking (DRC) company, ECAD. We initially rejected the idea. Later we decided to do exactly that. This would make us a public company since ECAD had gone public a year before the crash. And Don and the investors would be liquid.

Solomon: There are some interesting asides on the merger with ECAD. I already knew ECAD’s CEO Glen Antle and key technologist Paul Huang. Paul worked in CAD at National Semiconductor and developed his first prototype DRC code (Dracula) while there. SDA and ECAD started about the same time, and we were comparing notes back then. Glen started out as CEO but didn’t really want to run the company. He eventually took the chairman job and hired a friend to be CEO. The CEO’s wife was a pretty strong character. We were just starting first merger discussions and the CEO’s wife said, “We’re going to take a vacation in Hawaii—we already have it planned.” Essentially, “the merger can wait”. So they flew off to Hawaii. Not a particularly good idea, it turns out.

So I met with Glen first and then Paul and said, “We’ve got the usual merger problem. We’ve got two CEO’s, and I don’t particularly want to be CEO. I don’t like running big things, and when we put these together it’s going to be a $40 million company ramping to $100M in no time.” But I have a super guy that

I think will do a great job named Joe Costello. That’s the guy I want as CEO. I’ll step aside. We’ll put Joe in as CEO, but we have to lose the other CEO. Glen thought about that for a while and he said, “Well…” He’s real slow talking and thoughtful... “Well,” he says, “you know, I like most of your idea, but one little problem. This Costello guy. He’s a kid.” He was. He was less than 30 years old.

Fairbairn: Yeah.

Solomon: He says, “I’ll tell you what. I’ll lose my CEO, and you become chairman. I’ll become CEO,” Glen says. “And we’ll let Costello run it as COO and I’ll give him three months to see if I’m impressed. If he’s as good as you say he is, I’ll step aside.” I said, “Great. Let’s do it.”

Fairbairn: Costello was okay with this?

Solomon: He and Don were tracking things and were OK with this.

Fairbairn: Interesting.

Solomon: After we closed the deal, COO Costello did an amazing job of executing it as a merger of equals. Within 30 days, Glen Antle looked me in the eye and said, “This Costello guy,” <*laughs*> he says, “He’s better than you said.” Glenn is a man of few words. And he immediately stepped aside and retired, Costello became the new CEO and we renamed the company Cadence Design Systems. And at that point I was looking for something else to do.

Fairbairn: Mm-hm.

Solomon: I was still interested in developing a real analog CAD system. So with a little nudge from John Cornell at Harris, who was also interested in analog CAD, we decided upon—

Fairbairn: Was he on the board of Cadence?

Solomon: No, but that is a good question. From the beginning, we did not believe we should allow customer-partners on our board. We believed it would not be good if we had them seeing data on other customer activity. But at the same time, Cornell was a key investor and we always did listen carefully when he or others made suggestions. In retrospect today, I think we should have allowed Cornell and other partners to be board observers; it would not have been difficult to keep them isolated from sensitive stuff.

Fairbairn: Mm-hm.

Solomon: Cornell was a big believer in what we were doing. He could be a bit wild at times, but he is also a visionary who acted with great conviction on things he believed in. After National Semiconductor, Harris was the first industrial partner to back SDA—if he had not believed in us, there would have been no SDA.

Solomon: So Cornell gave us two guys to help us and influence us in analog CAD. One of them, Paul Hernandez had already prototyped an analog flow on top of the Cadence system using our SKILL extension language. That was a perfect seed to get us started. So we hired Paul and we brought Paul’s boss, James Spoto, along to help manage the group.

Fairbairn: Mm-mm.

Solomon: The three of us sat down and basically worked out the plan for a new analog CAD system. I decided to start it just the way we started SDA. I didn’t even think to ask the Cadence board for money to fund us. I went out and found new industrial partners. We raised a million dollars each from Bell-Northern Research, SGS-Thomson, and Sony Semiconductor. National Semiconductor and Harris were included as default partners. We were now friendly with the Japanese, dropping our idealistic views in favor just doing good business. And we formed Analog as an independent subsidiary of Cadence. It was a startup within a startup.

Fairbairn: Mm-hm.

Solomon: I was excited about it. I wanted something small where I could still touch technology. I next brought Charlie Janac into the unit, grabbing him out of Cadence sales and put him in charge of the analog sales channel. I now understood sales pretty well after the early difficulties with Roger. After that, I personally focused on getting a new circuit simulator while Spoto focused on refining the Harris prototype.

Fairbairn: Mm-hm.

Solomon: I started my search for a simulator guy by talking with Alberto. He was key for this—he had graduated several world-class simulation PhD’s in recent years. He said, “the best guy in the world is a fellow named Jacob White, a professor at MIT, easily the best”. And he said, “there’s a second best guy named Ken Kundert at HP Santa Rosa.” I talked to Jacob. He had just joined the MIT staff and it was clear he wasn’t going to leave, so I went after Kundert. It was not an easy decision for Kundert—HP had paid for him to get his PhD. I pushed on him very hard, and he finally agreed to come. Next, we actually got Jacob to come on as a consultant to work with Ken. He ended up flying out and coding a week or two at a time, until he and Kundert were exhausted. It was not long before we had a new simulator which Ken

called “Spectre.” Sales did not ramp quickly for this; we had to do battle with existing SPICEs, but after several years, Spectre ended up dominating the analog design world.

The analog unit went on to be very successful. As Synopsys attacked the digital side of Cadence in recent years, the analog revenue remained strong and accounted for nearly half of Cadence’s revenue. So I am pretty proud of how well it did.

Fairbairn: Justifiably so.

Fairbairn: When did you leave Cadence?

Solomon: I left in 1996. Costello left a year after. And I have to say, I was partly staying to be sure that Costello stayed. I somehow didn’t think he would stay if I left. And he didn’t. I don’t quite know what that was about, but I just sensed it.

Fairbairn: So that was ’96.

Solomon: Yeah.

Fairbairn: What made you leave? What was the trigger and what did you go off to do?

Solomon: My son, Todd, graduated in mechanical engineering and had been working on semiconductor wafer-handling robots. He had an idea for building a better robot, but couldn’t get his company interested in it. We thought it would be fun to start a company in robotics with him, so in 1994 we did that, naming the company Smart Machines - a name suggestion from Jiri Soukup, interestingly. I provided initial funding for the company and brought Charlie Janac in as CEO. Five years later Smart Machines had a successful exit, selling to Brooks Automation. Todd moved on and is now on the design team for the da Vinci surgical robot at Intuitive Surgical.

In parallel with the formation of Smart Machines, my significant other, Nanci Magoun (Nanci and I are now married and have been happily together for over 20 years), and I had been thinking about other things. A couple years earlier, we had gone to a conference in LA that got us interested in virtual reality. While I stayed on at Cadence, Nanci started seriously studying this. We thought Smart Machines might eventually expand into this realm, because there is a lot of synergy between designing real robots and virtual ones.

Meanwhile, Joe Santos was getting a little tired of EDA and was impressed by the “visual programming” in an early first-person “shooter”, Doom. It didn’t take long before he decided he wanted to start a game company. So in 1995¸ I provided initial funding for a new company, Xulu Entertainment, with Nanci as Creative Director and Joe as CTO. The pull to join Xulu was strong, so I left Cadence and I joined as CEO in 1996. We ended up focusing on a story-based virtual world with a physics-simulation-based platform and a number of multi-player adventures. Xulu did a lot of pioneering work in virtual reality, including very robust physics-motion, user-interfaces with haptic feedback, surround visuals, and even motion-based pods. We had plans for opening a showcase venue and bringing the world online until the Internet crash of 2001.

We later restarted Xulu in 2007 with an Internet-only focus, with Nanci as CEO, Joe as CTO, and me as Chairman. Xulu is still ongoing today. Since 2001, I have served on a half dozen boards in EDA. I am presently on the board of an impressive analog simulation startup, Cigma Design, whose founders both came from Cadence Analog. Cigma is of course going to be world-changing.

I think that pretty much wraps it up. I just want to add a last thought. Thinking back on my professional career, I clearly was very lucky. I arrived on the integrated circuit design scene in 1963, just as it was beginning huge growth that would forever change the world. My curiosity jumped me into software in 1980, just as software was beginning to explode. I arrived on the IC CAD scene in 1983 which would shortly ramp into the multi-billion dollar EDA industry. By sheer good luck, I found a superb mentor in Don Pederson who along with others at UC Berkeley helped me with all this. Along the way, I was able to work with and draw on the talents of an amazing number of truly superb people. My life so far has been a very exciting journey.

Fairbairn: Thank you very much, Jim, I appreciate it.

Solomon: My pleasure.

END OF INTERVIEW

