Oral History of Joseph Costello

Interviewed by:
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Penny Herscher: Today [May 16, 2008] we're interviewing Joe Costello, with questions about the EDA industry. So, Joe I thought I'd start with college. Talk to me about your college experience, what did you study and why?

Joseph Costello: I started at Harvey Mudd College, which is a little technical school down in Southern California. And I went there…actually hadn't planned originally on going to Harvey Mudd College. And the story of how I ended up going there is my father had asked me, maybe at the end of my junior year, what was I interested in, and I said I think I'm really interested in archeology. And he kind of gave me one of those "hmm," and nothing much in conversation. So towards the beginning of my senior year he asked the same question, and I said yes, I'm really liking this archeology stuff, and he said "Archeology? Bone dusters. Why would you be interested in something so idiotic as that?" And I said, "I don't know," and gave him my reason why, and then there was silence, and he said "How will you be paying for college?" And I said, "Oh, what are we going to be majoring in dad?" And so he suggested that engineering would be a good thing and so I applied to a bunch of schools, Harvey Mudd was one. I liked it because it was broad. They had several colleges there; you had to take 40 percent of all your classes in Humanities and Social Sciences. And so it seemed like an interesting place, and that's where I ended up going. I went majoring as an engineer, just like my father had wanted. And the first day I got there, I switched my major to mathematics, because it was as far from what you could do at Harvey Mudd as from what my father would have wanted me to do. So that's where I went to undergraduate school. And from there, I stuck with the math side of things for a period of time until my junior year, and I think it was the second half of my junior year, they made you, in the math track, take a course in applied mathematics. And so it was, I don't know how to describe it -- it was like they called it a lab and you had to work on projects. And the projects, there were half physicists and half mathematicians in this class, and the projects and things the physicists were doing intrigued me. And I realized physics is just math applied to the real world, and I got completely entranced and decided I must become a physicist even though it was kinda late in my career there. And so I ended up getting a double major, and deciding I was going on to undergraduate school in physics. And I ended up going the first year to Yale, because they gave me the best fellowship. So it was a money-driven kind of thing. And went there for a year…I was totally ecstatic about going to Yale, it sounded like such a cool thing. I loved my Harvey Mudd experience, I thought "Now we'll go and it will be all these kids who are interested in physics and we'll have a fabulous time like I had in undergraduate." And it wasn't like that at all, and I attributed that to Yale. And so I wanted to leave that experience, so I got a Master's there that first year, and went out to Berkeley. I also had a girlfriend who was in the West Coast in San Francisco going to law school, so that was another incentive. And, after two days at Berkeley, realized it wasn't Yale, it was graduate school that was the thing that was a bit of a drag, but that's how I got to Berkeley.

Herscher: What was going on in computing at the time?

Costello: You know, it was interesting. When I started at Harvey Mudd…there was no such thing as the computer science curriculum at Harvey Mudd. I don't even know, maybe at a couple of schools at that time they might have had one. As I remember, one of my friends made up his own course curriculum and he ended up at Carnegie Mellon, which might have had a computer science curriculum. We used computers…[the one] we were working on at the time, I think it was a 1620 IBM, an old machine, punch cards. And I was fascinated, I thought it was really a lot of fun so I enjoyed it. I actually did it as a summer job, I did computing kinds of things, because not many people could do that type of thing. But in those days, it was kind of a tool, something on the side. I thought it was a lark, it was really good fun. It

was super easy, from my point of view, to do programming, and you make money doing it. So that was kind of my attitude about it at the time.

Herscher: When you were at Berkeley, who was influencing you as you thought about going to work?

Costello: When I went to graduate school, I was a mathematician. I wanted to be a theoretical physicist, and I had actually even something that I wanted to work on. So I was headstrong, and that was my vision about what physics graduate school should be all about. You know, you have ideas and you go off and do them. And again, I discounted the Yale experience but get to Berkeley, and I realized very quickly at Berkeley, there were -- it was the largest physics graduate school in the United States at the time. There were around 50 kids every year that entered. And one of them would get a theoretical physics appointment. So it was like "wow," it was low odds that you make that. And so I thought oh, what the hell, I'm going to give it a shot, and I went…to see what kinds of things did you get to do. And I remember going into the groups that were "hiring" or taking on physics theoretical graduate students, and they were doing some God awful, like fourth-order calculation for quantum electrodynamics in solid states. It actually looked like prison to me, more than anything else, to have that as your fate, as what you got to do. So I realized quickly, (a), I was unlikely to get the job; and number two, if I got it I'm not sure I wanted to do it. And I thought I'm going to have to do experimental physics.

So I started wandering around to different labs, to see what could I do? And I looked in the catalogue of all the professors, what they were doing, and the ones that sounded cool, I went and visited them. And the first one I remember walking into was a super conducting set of experiments, they were doing superconducting magnetics. Josephson junction kinds of circuitry you could call it. And it was really interesting what they were doing. But I walked in and it's a big-- like it's walls of electronics. And as I'm talking to the other graduate students and then to the professor, I realized, these guys know a lot about electronics, and I knew like nothing, Maxwell's equations, you know, I didn't know anything about… So I thought well, if it's just that, I'll just go to the next one. I can't remember the next lab I went to, same story, nothing but electronics everywhere. And so I realized I'm going to have to know this stuff. And so I made the decision, this was 1975 I think, and I said I'm going to have to learn this. So I got a summer job down in Silicon Valley. My father was actually the head of purchasing for the electronics side of General Motors. And so he would come out here, and he was always down there and it seemed like a lot was going on in electronics. And so I said that's cool I'll go get a summer job. And I got a summer job at National Semiconductor at the time, to learn electronics, that was the idea. And it turned out my summer job lasted two-and-a half years or something thereabouts, because it was so much fun and it was so exciting. It was the time when the microprocessor was being birthed, and I was at National Semiconductor, which was an also ran or way behind the pack in microprocessors, but trying to get in, and they didn't know diddely about software or programming or anything like that. And so I was this kid who, I could train on that, I knew how to program things. And so I learned how to do programming of microprocessors and other things. That's what kept me there and got me all excited.

Herscher: Did you finish at Berkeley?

Costello: I went back to Berkeley, so I did my two-and-half year summer job, went back to Berkeley, and got an appointment in a research laboratory doing laser spectroscopy. And a funny adjunct to that story is I walked into the lab and I realized in about a week I knew maybe 100 times more electronics than I

had to know. Because I had this impression that people understood everything they were doing in all this electronics, and the truth was, they knew how to operate it, but they didn't know it. And I became the lab technician, because I had actually learned how to make all these things work. So I went back, was doing laser spectroscopy, and I did that for a few years. And I had this moment where I thought, you know, is this really the right thing for me and should I continue this? And I actually went around and talked to a bunch of people, people I worked with at National, my parents, friends, and professors -- and should I really spend the time? Because I had come to the point where I didn't think laboratory science was the right thing for me and my personality. It just didn't feel right. And everybody said yeah, yeah, yeah, but you know, you spent all this time in getting to this point, take the extra couple of years and finish it, and then you'll have the degree and the credentials. And I listened carefully and it wasn't like I didn't, you know, throw all their opinions, but all the reasons they gave didn't seem to resonate, so I left at that point and decided not to finish. I got my second Master's degree and then split actually to start my own company.

Herscher: And that company was?

Costello: The first thing and what had gotten me excited, the lab, this was at Lawrence Berkeley labs where my laser spectroscopy work was being done -- and across the street there was at LBL, there was a lab that was doing energy conservation research. And they had symposia and I had gone to a couple of these things, and it was pretty fascinating what they were doing and this was the Carter years and you know, the first energy crisis we had. And I thought, that is fascinating stuff. And I remember going after one of these lectures that this guy gave, Art Rosenfeld, and said, "Why don't you just do it?" I mean, "It's really interesting, why don't you actually go create a company? It's a great idea, these are good techniques, just do it." Well, [he said][“we don't do things…we study it, and we make proposals and we get the Government to do it and then other people will do it.” And so I volunteered, I said, "Well, look. I will work for free for you so I can learn all about what you are doing, but my goal is then to start a company." I did end up doing some consulting with him and was headed towards starting a company to do energy conservation when Reagan got elected, and I decided-- I was enough of a marketing guy to realize that probably wasn't boding well for my ideas.

Herscher: So where did you take it then?

Costello: So I didn't do that. I'd also started thinking of doing a recycling company. My father disabused me of that idea. But I ended up getting a call right about then from some people at National Semiconductor that I had worked with. And they were working on speech synthesis and speech recognition. And I can't even remember why they thought of me, you know, maybe because of software. And they said, "Would you be interested?" I said, “Yeah, that sounds pretty cool.” So I ended up going down to interview, and actually the guy that I was interviewing with when I got there had this really grumpy look on his face. And it turned out in the meantime, between the time he called me and the time I got there, he had lost the group and the job, and it had been handed over to this other guy, who he called an asshole, Jim Solomon. He had taken over, this coup, this power play, this jerk…he had taken over this group, it was all his and I had to talk to him. And so that's when I was first introduced-- I actually knew Jim from my days as a summer job. Jim was kind of a God in the design world, in the analog design world down there, and so I'd seen him and heard of him, but it was the first time I met him. And we talked and I ended up working for Jim doing this thing in speech synthesis at that time.

Herscher: So how did your time at National progress? What did you work on while you were at National?

Costello: My thing with Jim was, he clearly wanted me for my software skills, it appeared to me. I knew something about doing software and things like that and I said, "Well, on my side of things, I want to be a manager." And I remember he laughed at me when I said that. This first interview and he goes, "You want to be a manager." He said, "Okay, great. But here's the job and some engineer job." I said, "No, no, no. You didn't get it, I want to be a manager now." "Now? Like why, you've never really had a job, Joe." I said, "Yeah I know, I know, but that's what I want. You want me to do software, I want to be a manager." So he said, "Well, let me think about it." And he called me back and said, "Okay, I'm going to make you a manager." And I became manager of this -- there were two groups doing speech synthesis and recognition, and he made me the manager of one of those groups. And as it turns out, I learned later on, it was a very strange situation. There was this tension. This was the group he had inherited. And what he wanted to do was kill the group right away. But the boss at the time, a guy name John Finch, had said, "You can't kill it, you've got to make it work. Jim. You know, no fair." But he thought give this group to this young little idiot that doesn't know anything about managing and he'll probably kill it. And so I remember at this certain point I was frustrated. I came out of a meeting with Jim and I go-- I was saying to another guy, "God, it feels like he just doesn't want me to succeed." And he goes, "You finally figured it out? No he doesn't." So after that I cleared the air with Jim and you know, I did some more things. And then a little bit later on, Jim actually left the company to go start what became SDA Systems. And I remember at the time, when he announced that he was leaving, all of us were in total shock. I mean, not only had he been a God in doing design work and done a bunch of cool things, he was a big manager, he could do anything he wanted inside National Semiconductor, and had free reign. And he was going to go start this electronic design…we would have said CAD company. Now, the reason that was so bizarre was…National was a-- it had a reputation in a lot of ways, not so much in this hardcore analog place where Jim was, but it had a reputation of being kind of a jelly bean company. And so CAD inside National Semiconductor was considered to be low lifes. You know, it was just menial work and the dregs. And the design people were all the kings of the company, and those people were second class citizens at best. Maybe fourth class. And so Jim is saying he's going to go start a CAD company. It was like, “why would a guy with a career like that, who could do anything he wants, why would he start a CAD company? Why would he join these untouchables like that?” It seemed crazy for a person to throw away a career like that. But he did. He left and we had known he had a strange addiction to this CAD stuff because he was always bringing in tools from Berkeley, and making us use them. And so he'd bring in software package after software package of things, and he was excited about this. But we thought, “oh it's a nice avocation, a hobby, but to turn your career into that?” Insanity. Total insanity, and off he went to start this company.

Herscher: What did he tell you as he went and did it?

Costello: Well he was convinced that there were real fundamental roadblocks with the way we've been doing [things]. And Jim had come from a strictly analog side, and had gone into, you could call it, mixed analog-digital kinds of circuitry, and he saw [that] a lot of the future was in the digital side. And when it was simply analog, it was…easy is maybe too strong a word or description of it. It was relatively easy to design these things by hand, because a lot of the -- the reason these circuits were great was the handcrafting and some of the specialties of the circuitry. Not the numbers of transistors, but exactly the design of it. And even sometimes the processing of the semiconductors were made for special analog circuits. Digital, of course, it was starting to multiply the numbers of transistors that were possible to put

onto a given piece of silicon, and the functions that were possible. And he saw this crisis coming where it was going to be impossible to have enough engineers that were capable of designing these things. And as he was transitioning out of being just an analog guy into this digital world, that was the problem that he saw. So he was going off to solve that problem. He believed that automation was the answer, that it had to be done. We were going to hit fundamental roadblocks, and if it didn't get solved, then he'd actually tried to convince the people inside National Semiconductor to do it inside National. And in fact I remember him saying, and then I heard other people say it too, but I remember him saying, that Charlie Sporck who was the president, the CEO at the time had said, "Jim don't do it inside National. We will mess it up, you know. It will be a mess." He said, "If you're going to do this, do it right. Go start you're own company, get out of here. We don't have the right culture, the mental set. The first thing that goes wrong, we'll take the money away from you, we'll head you in the wrong direction. If you're serious, go do it on your own, we'll support you." And National actually put some money into the company at the beginning. But, "Do it separately." And so that's how it got started.

Herscher: So the point at which Jim started the company, what was the state of the art of CAD? When you bought tools, were the tools being acquired, was it just Berkeley software? So, the state of the art at that moment in time when he left.

Costello: The state of the art was bad, it was pretty miserable. Truly, I'm trying to think of CAD that we bought. Now, again, we might have been a little bit different because he had the strong Berkeley connection, so we were getting a lot of free software from Berkeley and trying it out. I think we were the guinea pigs for a lot of the early Berkeley software. And so we were using some of the packages for instance for layout. But the state of the art at the time, in terms of packages, I do believe that they had a DRC checking package that might-- you know, I don't know what they were using, I don't think it was ECAD at the time. It might have been somewhere in the transition. And then they had CALMA as you know, they had CALMA machines I believe they were using someplace at the lab. But then again, engineers didn't use that stuff. And that was another one of Jim's things…that these tools should be tools not for just technicians. That these had to be tools for engineers. That it was going to assist the engineer in being able to design more and free them and allow them to do things more creatively. And not have the huge gaps between a design concept and then this long delay before that got turned into some kind of an implementation that was real. And you had to tighten the feedback loop between those things. So, the packages, that -- it was like CALMA, it was design rule checkers of various differing types. SPICE, we use SPICE in doing some runs. All these things were done remotely on mainframe computer I'll call it, might have been mini computer. We were actually fortunate to get some mini computers in our area, and so we had a more local access for doing some of the simulation stuff. We tried early on and, I'm forgetting the name of the company, we tried a logic simulator package, I remember at the time. Again, batch mode, you'd run these things batch mode on these mini computers, no work stations, nothing real time, interactive screen-based stuff. It was like that. So truly we would draw schematics, we would sometimes turn those schematics into decks of cards that we'd run SPICE simulators. We tried this logic simulation capability with so-so results, because it was kind of painful to get things in, et cetera. Backend side of things, layout was done in CALMA machines by other technicians, and we were still doing ruby lith on some things where you were actually cutting this stuff out with razor knives, right, to make it happen, so it was fairly crude at the time.

Herscher: What year was this that Jim left?

Costello: Jim left in around, I'd say '82, '83, something like that.

Herscher: And who was forming this company with him?

Costello: When we looked at it from our perspective, it was Jim. He was the guy we knew. Now what we didn't know, and what was going on the other side was the Berkeley connection, which is why we were getting all these tools from Berkeley…he had a very good relationship with a couple of professors at Berkeley. I think his prime connection at the time was Richard Newton, and then another of the professors was Alberto Sangiovanni-Vincentelli. There was Don Peterson there who was one of Jim's--might have been Jim's advisor at one point. He certainly was very tight with him. But I think he was mainly the connection to those two guys. And so there was a lot of synergy between [them]. Jim got a lot of lip about listening to those guys. I believe that Richard for instance was a big guy at SPICE, as an example, and so clearly that was a connect point. But Richard was a visionary. He had a lot of these thoughts about what was possible, [what] would need to happen and Jim was an avid student. You know, sp from our perspective, it looked like Jim. Later on as I met the other guys I saw, oh, he was really learning a lot and getting a lot out of that connection with Berkeley and in particularly those two guys. So when he left, we thought it's Jim doing it, and later when you saw more of what had happened. It was really him in connection -- the intellectual inspiration for it came out of Berkeley, came mainly out of Richard and Alberto at that time. So they were the guys that truly formed that company at the time. From a straight business point of view it was Jim who went out, left, raise the money, et cetera.

Herscher: So how did you then get connected into SDA?

Costello: So we had the going away party for Jim <laughs>. It's like, you know, poor Jim, the guy's giving up his great career. Oh, well, you know, who knows. We actually thought that it must be a midlife crisis, [that] must be what's going on. And so he left to do that and we went off to do our thing. It was not long thereafter that I actually left because the whole speech thing…for National Semiconductor speech is a solution kind of a problem that you -- it's not a jellybean kind of chip. You actually have to build the full solution which is multiple chips and software that goes with it in order for your customers to actually build that out into something useful from an end-customer point of view. And I made a very strong pitch to the management at National that you got to invest more broadly. You got to go to a bigger picture, a full solution here if you're going to play it big time in those kinds of application areas. And I'll never forget I went in a ball of fire, actually, we were using UNIX and doing what today you'd call a PowerPoint presentation before you had any of that kind of software. And it was slick and cool and we had the arguments. We go to John Finch, who was the president of our division, laying out the case for him about, you know, got to get big or go home buddy, I mean this is it. And at the end of it…he seemed to be attentive the whole time, he's nodding…Jim was with me and he seemed to be giving me positive feedback. I was the guy doing this presentation and at the end John goes, "Joe, that was really good." He goes, "That's one of the better presentations I've gotten from any of the team in the last year or so. Very, very, nicely done, it's a hundred percent clear. I understand this way better. And it's also 100 percent clear we got to get out of this business." <laughs> What? I never thought that bringing it to that crystal clear point would have yielded the negative answer to it. But for him it wasn't, it was probably right. It was probably not in National's DNA at that time so that got killed. I stayed a while longer. You know, they asked me to actually be the leader of the digital signal processing group. And I said, are you kidding, digital signal processing is a worse version of speech…it's a bigger application and you got to get even more serious about that.

So, I actually left and started a company. Well, I shouldn't say started, I joined the company and maybe turned it into more of a company. It was a professor at Berkeley in space sciences, actually, who did this on the side, who had invented the core technology for speech synthesis and recognition that we were using in the original group that I ran at National. And when this wasn't working out he said, "Well, why don't you come join us, and let's see if we can turn this into something really good." And the name of that company we formed was called Electronic Speech Synthesis, ESS. And so I went off and worked on that with that group for about a year. It wasn't the right thing, didn't really work out. It was mainly not a good feel, not the right working environment, didn't have the right sense of camaraderie and energy, et cetera. And so I decided after nine months to a year that I was going to leave. And Jim, who had gone off by then, I know he probably had been two years at it -- at least a year -and-a-half at it, somehow heard about it. And he gave me a call and said, "Joe, I hear you're on the street." I said, "Yeah." And so he goes, "How about coming out and interviewing here." And I mean literally I had no job, I had no money. <laughs> I really needed a job but I remember thinking, geez, you know, I like Jim and he's a friend [so] I can't exactly say, no. He knows I'm probably broke. And to tell him, no, I won't even come and talk to you is like a slap in the face. It's like I'm embarrassed into this, I'm going to have to go talk to him. Oh, what the hell I'll do another interview down there same day or something like that. So I went with no intention of getting involved in this CAD stuff. It seemed crazy.

And so I walked in and Jim and I talked a little bit about it. And then he introduced me to the other guys that were in this company, who helped found it, the technical people. The way I remember it, it was one of those shattering events because I had this image from my National Semiconductor days of these poor untouchables doing CAD work. These poor slogs on CALMA machines and running buckets of cards around and getting yelled at. And here are all these PhDs from Berkeley and guys out of Bell Labs and IBM and Carnegie Mellon and they're all energetic and excited. They've got all these incredible ideas about what can be done. And it was one of these, holy crap, that's not at all what I expected. And so I remember at the end of the day I came back to Jim and I said, "Jim," and it was kind of a goofball thing the way I said it, I said, "You know I'm actually unexpectedly interested." I remember him looking at me like, "Unexpectedly? jerk." But it was true. And so I asked him I said, "Well, you know maybe I can imagine doing something here. What did you have in mind?" Because I was so not into it I never asked him what he was thinking about as a job for here. And he goes, "Oh, oh, you know, I'm not really sure, Joe." He goes, "Let me think about it tonight, we've lots to do. I'll call you tomorrow morning and we'll talk about the job." And so he called me the next morning and he says, "I know what we should do. You are going to be the head of the documentation, training and customer service." And I said, "Okay." And I said, "Jim, why did you select me for that?" And he goes, “I don't know…it seems you're pretty good at teaching stuff and so it needs to be done. Someone needs to do it. We don't have anybody to do that. You do that." So that's how I started. It was my first job there.

Herscher: And what were the hard problems those brilliant engineers were solving as you walked in the door?

Costello: The thing that Jim had staked this company -- I mean they had a very broad vision and that was one of the things that surprised me is that they were thinking about this in a completely different way. It was linked and I could connect the dots backward to some of the things Jim had said when we were working for him and he was having us try these tools. But I didn't see the big picture until he talked to me and I talked to all these other people. And the idea was that in the flow from conception of design all the way through to manufactured silicon there were many, many steps in this process, and there were getting to be more and more steps in that process. And they were getting each of them increasingly

complicated. And so there was a need for, from his point of view and he was clearly right, specialized and very powerful tools at each step of the operation. And that was okay but you also needed a flow for those tools, they needed to be able to work together in a process. It was not going to work to have a set of punch cards for when I'm doing my analog SPICE simulation and the different kind of thing from my logic simulation. And all this being done tediously by hand off of some kind handwritten schematic and then completely disconnected to the back-end layout. His view was that this all had to get integrated into a process. The guys at Berkeley had been thinking about, and I may be wrong about the timing of the wording about all this, but they had been talking about what would be described as CAD frameworks. That there should be a fundamental set of technologies, which in themselves were an important technology -- build an over overarching or you could call it the foundation technology, which in itself had to be a pretty interesting technology, to enable you to carry that design process through from the very beginning through the very end so that the design and all of its attributes could move seamlessly from front to back. And that had to do with obviously a lot of database technology because you had huge and growing databases, increasingly rich. And they had to be flexible to be able to handle new kinds of effects and/or tools that you wanted to investigate and approach. You had to then be able to display those. You needed to have user interface capabilities so you could see into that database. You had to be able to bolt those tools into that database, into those user interfaces and then get that flow working in some kind of logical progression. So that fundamental technology…what we called the CAD, at a framework, was a piece of it. Then the other side of it was specific tools and technologies for breakthrough in certain very difficult tasks along that chain because there were some things that were looming large. One of them for instance was the whole area of automated place and route. As you're going wild with the number of transistors in the digital side in particular and then also moving to the application specific integrated circuits with things like standard cells and gate arrays, an explosion in complexity, you needed something to automatically handle this, the physical design of those things. So that was an example of a breakthrough tool. There were others, logic simulation, synthesis. There were several areas where something was needed. Something powerful was needed to change the game in a specific narrow tool area like that. So there was that foundation piece that needed work. There was the power tools for particular bottlenecks in the process you needed to attack. And then even the environment, the compute environment, because everything had been minicomputer, at best mainframe minicomputer based. And so this had to get more personal…and so this was the time when there was the rise of the engineering workstation. So there was the question how was the hardware in the evolution of hardware going to interact and interface with this new environment, this new software environment that we were talking about. So that was the pot, the mix that was going on at the time when I joined.

Herscher: Terrific, and how were early customers involved in this process and who were they?

Costello: That was one of the intriguing things…and kind of a funny story in the beginning of SDA. So, SDA had been founded by Jim with a combination of, and I can't remember the original description of it, but it was with strategic partners and the partners in the very beginning -- National was one -- it was potential users, potential customers. So National Semiconductor was one. Harris Corporation was the second one. General Electric was the third one. There might have been somebody else but those are the three that I remember certainly at this time. And they were investors and they had this kind of special relationship with the company -- Oh, I know, Ericsson was the fourth one. And so these are guys who had like Jim had when he was at National Semiconductor…had realized there's a problem looming here, we've got to do something. They had each one of them tried to do some things on their own internally. There were at the time, I should also mention the environment, every major semiconductor company, every major system company had a huge group of CAD people. Now, I had my image of it at National Semiconductor, CAD people, technicians, et cetera. And most these other places, no, they were a little

bit like SDA, scientists, very sophisticated scientists and engineers, program software people, hardware people working on complex tools sets to solves these very same kinds of problems, every single one of these groups doing it differently themselves inside each one of these large companies. And so that was the environment in those days. So these companies had faced some of those problems and I think were getting frustrated, they weren't finding the solutions. This looked interesting. Here's a new company with a vision of doing it differently. They've got the strong connection to the Berkeley guys and by then the Berkeley guys were getting quite a reputation in name. Obviously they had been the home — they'd been the birthing place of SPICE which was by far and away the most used electronic designation tool at that time. And so credibility, some history of something, hmmm, let's invest with these guys. Part of the deal is they got to have some of their employees onsite at SDA Systems at the time to work with the engineers and the team and try and do some guidance of the technology as well as be a conduit to bring that technology back home into their companies later on. So that was the original setup. And I remember Jim saying-- at the time when I joined I think there had been something on the order of let's call it $12-million-ish invested in the company…and I remember Jim going, "Joe, it's insane." He's like, "I wanted like two, you know, three, four max." He goes, "I don't know what we're going to do with $12 million." So $22 million later <laughs> which in those days, this is back in the early 1980s, that was real money, 22 million bucks in a startup company like this. So it took a lot more money and a lot more time to get to that end game -- to some kind of successful conclusion.

Herscher: This was 1984?

Costello: I joined in the end of 1984, yes.

Herscher: So between 1984 and 1986 what were the hardest problems that had to be solved to create a company like that as CAD was a new industry?

Costello: So SDA Systems was a new pipsqueak, let's say it was started in '82, I joined at the end of 1984. And I remember shortly after I joined I went to a trade show…might have been DAC -- I don't remember which one it was because I was completely new. None of it meant anything to me. It was just like, wow, you know, this is a whole new world for me. And I remember going, I got the chance. I had a job I was supposed to do but I got the chance to go and spend a few hours just walking the trade show floor. And so for me this was literally really my first introduction to the industry at large other than I'd read stuff in papers about some of the other companies. Like at the time the biggest, brightest company was clearly Daisy Systems, right, that was the big guy, and the up-and comer Mentor Graphics and an interesting one on the side, Valid Logic. I mean these were the names, the comers, the three horsemen, the new hot guys. And so I'd heard those names and I knew a little bit about them. But I wandered this trade show floor and I had taken a pad of paper and I was writing notes. And I remember the farther I went the more my heart was sinking into my stomach because I had joined SDA Systems and I was totally excited because it was such a different world of CAD than I had ever seen and it seemed like what we were doing was so wildly different. And I had with me a copy of our brochure that at the time we were giving out at the trade show and the things that made us great. I don't even remember what was on the list but this was what was cool about SDA Systems. So I come back to Jim and I said, "Jim, I counted when I went around the trade show floor." I said, "I counted 27 companies who said that what made them different was exactly the same things that's on our brochure. I mean exactly." He goes, "No." I said, "No, exactly. It's exactly the same thing that's on our brochure." And I said, "And then there were like 80 or 90 companies that overlapped with us significantly. Not like one thing but significant overlap.

And so how is it that anybody can figure this out if you're a poor customer who comes to a trade show like this. What the hell? What's the difference between all this crap? It looks the same, you know, I can't figure it out." I work for this company and I'm looking at this going, "Oh, it's hopeless." And that was for us -- as SDA Systems, this little pipsqueak starting -- that was one of our big issues was fundamentally in this noise because there was money being poured into this. There were the three horsemen that I was talking about, Daisy, Mentor, Valid and tons of other guys getting started out there, everybody with different spin and play on this whole thing. And so for us as a startup company it wasn't so much the technical challenges. We had great technical guys. We had the Berkeley guys. But how do you actually get yourself differentiated from that vast number of companies that are out there at that particular time? And so that was the thing that worried me. Now, remember I was the head of documentation, training and customer service so partly it was a bit of an avocation for me because that wasn't exactly my job. Actually one of the things I always like to point out is while I was the head of customer service at SDA Systems we never had a customer so I had an unblemished record, a perfect job of serving our existing non-customers at the time. But that was I think our most fundamental problem as a company and gaining traction around that. Now, a couple of the critical events that occurred during that time frame -- so one of the big issues and probably nastiest argument we had in the history of SDA Systems occurred during that time. There was a guy who came into our company who was…brought in from IBM. He was the head of sales marketing and I remember…I didn't know sales people and marketing people. I met some of these guys at National Semiconductor but sales and marketing inside semiconductor is not normal sales and marketing and so especially in those days. And so this guy, he's out of IBM and he certainly looks central casting, he looked like he came out of a movie, but as it turned out it didn't seem like he was doing a great job. We were struggling…as I said I was head of customer care I [so] knew how much we were struggling since we had no customers to care for. I did get to do a little training because we started giving away training in hopes that would lure people into being customers of the products. So after a certain point they decided that he wasn't necessarily the right guy to do the job of the marketing, and I think somewhere along the line they made me the acting head of marketing. And it was literally that, you know, let's get him focused on sales -- it was more that. It's like, oh, God, we're not selling, let's go focus him on the sells and really try and make that work…[and] all this marketing stuff -- I got handed that task. And during that stint one of the things we had to focus on was there was this big question at the time all of the main players in the business sold what was described then as turnkey systems which sounds ludicrous at this point in time. But at the time that was the doctrine…you sold software with hardware, specialized software with specialized hardware. And one of the big innovations was that some of these guys like, for instance, Daisy and Valid were building their own hardware. Mentor was radical. They were actually OEMing their hardware from Apollo and adding very little value to it but still packaging it up as a complete system with their software. And we were facing that. We actually started by OEMing hardware ourselves…actually a company called MASSCOMP. I don't even know what ever happened to MASSCOMP but it was one of the hosts of engineer workstation companies at the time. And as I was analyzing it as the acting head of marketing at that time, and I knew a ton of the guys here in the valley…I mean I met the guys when they where founding Sun [Microsystems] and literally within five miles of us there must have been 20 companies that were started to engineer workstations. And then there were the guys in Boston. And I remember thinking that it's insane -- we'll never compete in that it was really a self preservation thing. I thought, how will we ever compete? These guys -- that's all that they are doing. They aren't even thinking about CAD and software. They don't have to have all these PhDs and the Berkeley connection and all that crap. How can we compete building hardware against them? So there's no conceivable way that building hardware is the right thing to do. And so then second question, well, should we buy the hardware and reship it And then my question there was, well (a), what value added and who would you choose? There's like 25 choices out there so I'm not even sure that makes any sense. And where are we at in value and it seemed to me we should actually focus on the place where we added value which was in the software. We had a horrendous argument around that. I mean really

brutal at that time and came to the conclusion, we actually made the decision then, to only ship software. So one of the first differentiators we had is we were the first guy in this space who said forget the hardware.

END OF TAPE 1 / BEGINNING OF TAPE 2

Herscher: So Joe, you just talked about the first really hard problem in the '84 to '86 window for SDA Systems. That wasn't the only one, right?

Costello: No. That was one big break and it was the kind of thing you had to do. Yes, we're going to be focused on our core value, which was software and that's the thing we're going to do. We're going to make or break it on software. And it's different and it's not what other people are doing. That was our decision, which in retrospect was a great decision. At the time it was fraught with contention. That was one thing. But just being a software guy wasn't going to still differentiate us completely. In some ways you could say, some would have argued, it negatively differentiated us. So what hardware am I supposed to try now? Our answer was, "We run on Unix, so you could pick my own." "Pick my own?" Then the question is: What about the fact that there were these 27 other companies who had exactly the same "differentiation" or "benefits" as us. So we went back through and analyzed very carefully what is it that makes us different as a company. We made ourselves software only. I won't get all of the things at the time. The two I remember at this time that were really core, besides being software only...one was the framework. We were about CAD frameworks. This whole notion that you really had design as a process and that you were going to have to manage all of these tools and technologies in a chain or flow from beginning to end. We were focusing on a set of technologies that could really make that work. It was engineering workstation oriented, interactive, because of that foundation -- a database that allowed you to flow through -- software only. Then we picked on a couple of advanced tools. The thing we counted on the most in the early going there for sure was, I felt, the standard cell place and route. It was a huge differentiator. There were people who were doing gate array things out there, but standard cell was pretty new and really well differentiated. So it seemed like there was not much else happening there. Let's see if we can gain some traction with that. In a real nutshell at the beginning, we went out, "Hey, we're software only. We've got this wonderful framework that keeps everything together. It's very interactive, user-oriented stuff. It can grow with what you're doing. We're going to provide this complete solution from schematics all the way through layout. If you've got a serious problem in this area of ASICs, this emerging thing with standard cells, we've got the tool that nobody else has." That's how we went out. What happened during that time -- there's kind of two other things that happened. First of all, we were running out of money. It was interesting, because we actually did. I remember Jim asked me, as the acting head of marketing, to go in a couple of VC meetings with him. I remember Jim sitting at the end of one of these things totally depressed saying, "I don't know, Joe." I think that was it. It was actually Morgenthaler Ventures -- I believe was the last meeting. "I don't know. I think this is it." It was at McArthur Park the restaurant. We finished the dinner and he goes, "There's nobody else to talk to." What actually happened that saved us right then is we did get -- I believe it was Harris Corporation. One of our industrial sponsors came up with some more money at that point in time for us. Their leadership about that kept us going to that next leg of the journey. The venture thing didn't work out, but that did help us get to that next step. But we were still burning a tremendous amount of money. I forget. I think it was something like $300,000 a month or more. Back in those days, that was a lot of dough! In fact, it was more. I think it was $600,000 per month is what we were burning. So we needed to start selling something pretty dang quickly. I remember about this time -- I wasn't a member of the senior executive team. I was director of customer care and acting marketing guy. I remember wandering into these senior

guys who were all talking about this animatedly. I walked in because I needed to get something from Jim, a signature or something. He was busy, so I sat in the back and I'm listening to this. They were talking about "Guys, we've got to do something. The whole idea of the investment partnership worked, but I don't think we can sell that again. Is there something else?" They were talking about maybe this whole idea is good. "Maybe we should do technology partnerships that are like the investment one, but not an investment." They were describing this whole thing. They got to a certain point where they were asking how much they should charge for it. It's like, "Should we charge $1 million or $990,000? The argument was which was psychologically better? I don't know anything about this. I'm just listening. I obviously didn't do any calculation. I thought, "These things sound hard -- to sell one of these partnerships. It sounds really difficult. It was a complicated story and it sounds like it could take a long time. It's hard to sell software. It must be harder to sell that. Let's see. $990,000, that would be like a month and a half, two months at best." Then I was like, "You'd have to sell one every two months." I remember raising my hand at the back and I said, "Hey, Jim." I gave him this thesis that it seemed like it was kind of a small amount of money. It wouldn't last us very long and it was going to be difficult to keep selling those things. My punch line was "Why don't we charge $5 million?" They all stood there looking at me like "What? Get out of here. We were talking about $990,000 versus $1 million and you're talking about $5 million. That's ridiculous." So I walked out. I said, "They're probably right. It makes sense." But I ended up talking with the guy who was head of engineering about it. It was a guy named Larry Rosenberg. He had come out of I think it was General Electric. He knew a lot about internal CAD and how people think. He had been in that meeting. I was discussing with him. "Would this be something people would value?" We were just tossing it around. He said, "I think so. It could be structured that way." I said, "What about the price?" He goes, "I don't know. I got your point. Your point is valid about that. I don't know if you really could get millions of dollars." So interestingly, what happens is that a company comes along who is kind of interested in something that might be this, but I forget. It was a European company and it was kind of flaky. Larry actually went to meet with them and tried $3 million and they laughed him out of the room. So he came back and it was like, "See? This idea of $3 million is ridiculous! We should have said $1 million. Maybe we'd have $1 million if we said $1 million instead of $3 million." Larry was kind of chastened about the whole thing. I'm not Sergio. They were certainly not open to this idea. I said, "Yeah, but were they open to it at all?" He said, "I don't know." So it was about a month or a month and a half later and Jim calls me and says, "Oh Joe, this afternoon these Japanese guys are coming to the company and none of us have time to do it. Can you take these guys on and have a meeting with them? Somehow they had a partnership with the guys at General Electric who's our partner so they're swinging by on their tour of the West Coast. Deal with them." "Okay." So I went in and met two guys from Toshiba. We sat down and we had this conversation. I'm listening to them and what they're doing. They have a huge CAD group. I don't remember if it was 200 or 300 people in their CAD group. Wow! That's a lot. We had 80 people in this company. They've got like three or four times our number of people. They were struggling mightily. They were trying to do standard cells, which is right up our business. But they were also trying to figure out how to get this stuff to work. We just started talking about this partnership thing. They got somewhat interested in the general concept. I went back to Jim and I said, "These guys are pretty interesting." The lead guy was, I believe, the head of the semiconductor division, as it turned out. I didn't really know that at the time. This guy name named Igawa-san [sp?]. So I said, "Do you mind if we follow up?" It was kind of a throwaway. "Sure, go ahead." So we started having some discussions and Larry Rosenberg and I actually went on a trip, the first time I ever went to Japan to meet with these Toshiba guys and talk about this potential partnership. To make a long story short, we got over there and we started talking about it. We didn't have much of an idea about what was happening. But as we talked more and more, it was clear they really wanted the framework idea. They wanted some of these advanced tools. They were looking for someone who could help them out. I'm saying to Larry, "This is really valuable to these guys. In my opinion about it, if you think about it, look at all the things they're asking for. They wanted people onsite and some specialized customized work and a

special thing to make this work, people onsite to help them there. This is a big deal they're talking about." I said, "I think this could be really worth something." "But remember the $3 million? They threw us out on our ass. Are you sure?" We went for a couple of days having these good discussions. The fourth day finally -- they kept asking, "What's the price for this thing?" We don't know. So I remember going up to the white board. I drew this matrix. Years was on the horizontal and the vertical was all the different things they wanted. I said, "Are these the things you wanted? "Yes, yes." I said, "It can't be short term. It's like several years." "Yes." I forget if it was four or five. I just started filling in numbers. Each one of the things in the matrix. When we added it all up, it was $27 million. They were like "flbpp." A few months later we closed that technology partnership for a five year deal for something on the order of $20-plus million bucks. And it was the lesson for us about that -- partly because we were scared and didn't know what we were doing, we listened a lot. We just listened to what they wanted. Everything they said, we just kept writing it down and seeing if it was matched to what we were up to and what we were doing. That partnership thing really got us off the ground and rolling. On the flip side -- in fact I was on our trip to Japan that most of the sales force left. When I came back, we didn't have a sales force. I walked into Jim's office and I said, "Do you want me to take over sales?" Jim looks at me and says, "You've never been the head of sales. You haven't even been a salesman. That's ridiculous." I said, "Well, if I'm not going to do it, then you're going to do it." He says, "Well, that would be a point. Maybe." So the next day he said, "Yeah, why don't you take that on for a while until we figure out what the hell we're really going to do in sales?" So I took over the sales organization and we got very rigorous about the focus on the things that we thought were differentiators for us. Software running on these interactive workstations, the framework, and we focused then on standard cell as the tool. I said, "Listen," and we put everybody to work. Application engineers, marketing people, the sales people that were left. There were still a couple left. "Look, your job is just to go knock on doors where that could be a fit and if they say no, don't worry about it. Go to the next door. We are in deep, deep shit here. That's all we can focus on." That was the quarter when we finally turned it around. We actually turned a profit for the first time that quarter and we never looked back after that. That fundamental focus on some of those things, it was the right time. We hit enough of the differentiators. If it hadn't been the time when standard cell was going to take off, it might not have worked out. If it hadn't been right that moment with the workstations, it might not have taken off, but it did. It was perfect timing from that point of view. And we focused on our strengths and the strengths were well timed.

Herscher: What quarter was that? What date?

Costello: That was the summer of '86. Actually, the quarter ended on October 31st. We had a weird quarter that was offset.

Herscher: When you were working for Toshiba, what size of designs were you working on? How many transistors?

Costello: Then, wacko designs that people talked about were a million, like wacko. Most of what we were doing was 50,000, 100,000, things like that.

Herscher: So '86-'87, your role changed.

Costello: Yes. That was great. We did this technology partnership earlier that summer. Then we had the quarter which was kind of the turnaround. The company was doing better. At that timeframe, interestingly enough, the board had decided to look for a CEO. Actually, they had found a guy. I don't even remember where he came from or his name, but I met him once I remember. They pretty much decided on this guy. They made him an offer to come in and take over for Jim. That was fabulous. They wanted Jim to stay in this kind of joint role as being the chairman of the company. Maybe this guy was going to be president and he was going to stay CEO. Jim was almost a CTO and customer emissary. He was an invaluable guy and doing all kinds of things. They wanted a guy to come in to just run the operation from a business point of view. So they made an offer and it was a pretty good offer. He actually declined, not the company, but he was tuning or tweaking the offer. This is the story I heard later on. He was negotiating the last pieces of it. It wasn't a huge thing, but there were some things he didn't like about it. In the middle of it, Jim made a decision. I learned about the decision. He called me into his office one morning and says, "Hey, Joe. Have a seat." He had kind of an ominous look in his eye. It was like, "Okay," he said, "I want you to sit down, because I've got some news." I said, "Yes?" He said, "I've decided I want you to be the president of this company." I actually laughed. I thought he was teasing me. He goes, "No, no. Don't laugh. I'm serious." He explained why he thought it was a good idea. I said, "We were going to hire this guy." He goes, "I just don't think he's the right guy. I think if he comes we're going to lose all the good people in this company. He doesn't feel right for this company and where we are. I just have a bad feeling. I went to the board and I said, 'I don't think it's right. Between Joe and I, the two of us together can really run this. Let us have a shot at it. Make Joe the president. I'll stay the CEO and we'll do it.'" After some conversation and a little bit of dissention, they came around and decided that they were going to do that. Actually, what I was told later on was that there were a couple of dissenters. At the time, Larry Ellison was on our board. At a certain point in the meeting, he said-- I really in some sense owe it to Larry that I became president. He goes, "Listen, fine. If you guys don't want it, I'll hire him and make him president of Oracle." Then they all said, "Okay, okay. Let's give it a shot." That's how I became president some time at the end of 1986 or early 1987. It was in that timeframe. I can't remember precisely when. I think it was early 1987. I told Jim at the end, "I'm flattered. Surprised, for sure. But I'm also not sure I'm the right guy to do it." I was honestly pretty scared. I hadn't been thinking about it. I forget how old I was, maybe 32 or 33. I really thought I should think about it. I told him I'd get back to him in a week or two, after I had some time to discuss it. I didn't know exactly who to talk to about it. I remember I had met a guy named Floyd Kvamme at National Semiconductor. I don't know where he was, I don't know if he was still at National because he ended up at Apple and a number of other places. I don't remember where he was at the time. I called him up. I think he was at Apple. I said, "Floyd, I don't know if you remember me." "Oh, yes, I remember you." I said, "I've got a weird thing. I need some help here and I don't know who to talk to. I need to talk to someone who's got some perspective." I told him the story and he listened very carefully. He said, "My opinion about how I choose people when I'm promoting or making something like that happen, I pretty much look at the guy who's already doing the job, more or less, even if they're not in the position. That makes it easy. If I was sitting in Jim's shoes, just given everything I asked you and what you've shared with me, you kind of are doing that job. Whether you want to acknowledge it or take responsibility for it, maybe it's your fears that are keeping you from it, but you're doing it without the title and maybe the responsibility, but I'd urge you to step up." Actually, it was that conversation that made me go, "You know, he's right. It is me being chicken about it. In a sense, I am doing a lot of the things, but scared to take the full responsibility for it." That was when I went back to Jim and said, "Yes, I'll do it."

Herscher: So you're running the company. You get through the fall of 1987. What size of company was SDA at that point?

Costello: This is into 1986, early 1987. We're probably, in 1987, we're on maybe a $4 or $5 million a quarter run rate at that time. Things are going well. By the way, we ran the company by month. We didn't run by quarter. We ran month by month. Because we had gone through such harrowing times, we said we're just going to stick really rigorously to that month to month profitability so we don't ever get ourselves in trouble again. We were doing well. We were profitable every single month. It was heady times. Again, for me I didn't know any of this. The investors in the company are going, "Let's take this public." "What? Public? Whoa! That's wild."

Herscher: At $4 or $5 million?

Costello: Yeah, exactly, $4 or $5 million a quarter. But it was hot times. That was a hot market and a hot IPO market for technology companies. This was an up and coming space. They said, "Let's go for it." We talked to some bankers and they said, "Yes, we can do this." We started getting prepared during the summer and went on our road show and did all of that stuff during the summer of that year. In September, actually. We had done everything -- we were supposed to go literally sell the stock on October 19, 1987, which was the day of the crash. It was kaboom! Crushed. That was the end of our IPO dreams. In fact, I remember the day it actually happened. We were supposed to go public. Everything was all set. There was a little nervousness in the marketplace. I remember that. The bankers were like, "The window. We've got to be careful about this window. It could close. Let's get this thing out here." In fact, the market had gone down. I think it was a Monday. I think the market had gone the Friday before. We were driving into work and I was listening to a rock station. The D.J. on the rock station talks about the stock market. He says, "Oh, it's down 600." I thought, "What an idiot! He doesn't know anything about the stock market. The stock market is not down 600. He doesn't even know the numbers." I got to the door and there at the door is my CFO, Len LaBlanc [sp?]. His eyes are wide. He goes, "That's it. It's over!" He says, "The stock market's down" whatever it was, 700. It was the end. We didn't go public. For me, it didn't mean a big thing. It was an upper that we were going to go public, but we had cash. We were cash positive. We had cash in the bank. We were doing great. We were growing. It didn't make so much difference to me about it. So we just kept plowing ahead. But interestingly at that time there was another small company. It was a company called ECAD, approximately the same size. They had actually gone public about a month or so before. So they'd gone public and then I think their stock prices offered $10 to $12 a share. Then the market crashes. Their stock gets crushed. It's like $3 a share. There's no trading anymore in technology stocks, these over-inflated, tiny technology stocks, which were hot. They're crap now. So bad times like that make people get creative. We actually got approached by an investment banker who was representing the ECAD guys. He said, "It's kind of weird times and things aren't so good. Would you guys consider maybe doing something with ECAD?" We said, "Doing what?" "I don't know. It seems tough for these small companies. Maybe we should think about merging or getting together." That's how we started the discussions with those guys. That was at the very latter part of 1987 around Christmastime. I think the discussions really started to get serious in January and February. Then we decided that was the right thing to do, put the two companies together. At the time, the beginning of 1988, that was wild -- mergers and acquisitions always have kind of a reputation, not always positive. They're difficult. They can be tricky. In technology, they were not the thing. Since then, they've become much more of a thing in technology, but then nobody did them in technology. So it was kind of a wild thing -- there's no way ECAD would have considered it, I don't think, had they not gotten crushed and the market and gotten flattened for small cap technology stocks like this. It was one of those things that the times made this a possibility. Then both sides have to have the guts to really do something like that. Our guys could have said "we're fine." We were fine staying alone and separate like that. But the truth was if we really wanted to play, it looked like a brilliant idea. If you went back to the fundamental of what Richard Newton and

Alberto and Jim had talked about regarding a full flow of tools and technology working uniformly, seamlessly from front to back, you looked at what ECAD had for a set of software tools. It was almost 100% complementary to what we had. It allowed us to offer a much fuller suite. We got to be much larger. We could get some economies of scale, much bigger profile in the customer base to boost ourselves. It made a lot of sense. It seemed like a really super logical way to break the paradigm inside this marketplace. That was the driving thing behind putting the two companies together.

Herscher: So you were able to integrate verification into the flow and the framework. Did any other new technologies come out as a result of putting the two teams together?

Costello: I think that probably the biggest things – it was the complementary piece. We then did some things about taking some of those technologies and making them interactive, as opposed to batch mode, which they'd been in. That was another thing that happened in that. Our place and route, we had focused a lot on the standard cell. They had been thinking more about block level place and route. That was another set of ideas that they had that we had been working on. Those were some of the things. Some of their team actually went off and did other things inside the company, too. There was a great team of technology guys.

Herscher: Once you put the two companies together, who were the key people that were driving the technical strategy at that point in time?

Costello: It was kind of an interesting thing. On our side, we had the two -- they were CTO's, but they were different than that. We had Jim and on their side they had Paul Huang [sp?] as kind of the two patriarchs [which] is almost a better description than CTO's. They were more than just a CTO, either of them. They were the driving force. In fact, the reason I became the CEO of the combined company was Paul Huang, pretty much because during the combination -- the big thing once you decide to do it is: What's the price and who's going to run it? The guy who ran ECAD was older, more experienced. He had been a CEO before. I don't know, probably 50. During all these combinations we got the price worked out and then there was the discussion and it was a funny discussion because it was the investors all talking. The bottom line, they came to me and said, "Joe, we're sorry. It's the other guy." I said, "I can understand that. I'm just a kid. I get it. That's the way it is." I remember my CFO, Len, was "Are you sure you want to do this? We have a great company. We can go a long way. You're going to lose your job. I don't mean CEO job, you're going to be gone fast. This guy's not going to keep you around." He said, "I've been around this stuff before. You're out of here. You are out of here, buddy. Are you sure?" I said, "Yes. I don't think so." He goes, "You're naïve." He said: "You are out." I said, "But it such a great idea, Lin. This is the right thing. It's the right thing for the company, for my stock and everything." He goes, "Yes." We'd say he's going to be the CEO. I remember I had my first meeting with him after the new CEO afterwards. He says, "Hi Joe. Great. Thank you very much. It was very gracious of you" and all this kind of stuff. I said "What do you think about me? What job are you thinking about? What would work?" He goes, "I'm not sure, but I want you to know I will make you the vice president of something very important." I remember thinking right then, "Len, he's right." I've never seen that job function -- vice president of something very important. In any case, I still had hope and who knows? The next week after we announced it, we were supposed to get the two management teams together to start thinking through what we were going to do to make this thing happen. The other guy, the new CEO, leaves to go on vacation to Hawaii. I remember thinking, "That's weird. This has got to be the most critical moment in the history of these two companies." I remember thinking, "Maybe that is it. Maybe that's a CEO thing to

do." We get together and we were having this meeting. It's Paul Huang, the patriarch on their side, Jim Sullivan, patriarch on our side. We're talking about all kinds of things, about technology, the teams and who's the best technology guy and this and that and where we are complementary and how we should map these things out and culture things. It was supposed to be an all day meeting. Two or three hours into it, there's this pause. Paul Huang looks at me and says, "Joe, what do you think of the CEO?" I looked over at Jim and Jim goes, "Answer him truthfully." Jim knew Paul. I trusted Jim, so I said, "Well, I don't really know him that well, but honestly he kind of seems like a bull-shitter. He doesn't seem like he really knows what's going on here." Then Paul, in his way, is a very calm guy. He erupts with, "Look, one of the reasons that we wanted to do this deal was to get rid of that idiot and we wanted a real CEO." To make the bottom line, they had a revolution and they fired the guy in Hawaii. That was when I got made to be the CEO of the combined companies. Then I took the task of pulling these teams together and make things happen. There were lots of great people on both sides. The beauty was since there was so little real heavy overlap, it wasn't so difficult to bring these teams together to get them going. I would say there were some cultural differences between the companies that had to be worked through, but in terms of the product and the technology, not as difficult.

Herscher: At that point, you have Cadence up and running. It's the merger of SDA Systems and ECAD. You've got a framework. You've got standard cell place and route, layout verification. There's a piece that you're missing and you go into an acquisition.

Costello: Yes. Actually, it was interesting. It worked pretty well right away. You could feel this is working well. There were two sides. Mergers don't happen instantly and you can't say instantly they're working well, but it worked fairly well and the energy was good. But most important, the customers, it was great. Each of our two companies were growing, I don't know, 40% maybe, something like that annually at that time. When we put the two together, the combined company growth rate went to 100%. If you step away from that and think about that, it was like you doubled the size of the company and then you doubled the growth rate, because it was such a powerful concept for the customers. When you see and feel that, when you're with the customers, because it started to give them -- they were like those people at that trade show I was talking about. Nothing stuck out. They didn't know what to decide. Suddenly, there was this coalescence happening here. Ah-ha! This framework and now more tools and technology, best of breed being put together. I can start to coalesce my thoughts and my investments on these guys. So that was very powerful. It had been the original vision of Jim and Richard and Alberto. But here you could see it in action. I was the operational guy who actually saw it happen with the customers and the sales force. Right about that same time, it doesn't take you long to go, "What do people complain about that's missing?" I would go to customers and say, "If Cadence were your dream company, what would we have right now? What other tools and technology would we have?" They made the shopping list, by the way, for us. It was completely obvious. The first thing that happened was there was this company called Tangent. Tangent Systems was a company that had been invested in by Intergraph, so it was partially owned and kind of controlled by Intergraph. They had invented this incredible technology for gate array. Of course, that was what we hadn't done. It wasn't clear that gate array was the future in this space. But the rumor was they were going to come and do something in standard cell and they had some really compelling technology, we heard from the customers. So I felt like the last thing we need right now is to have that whole marketplace get divided up and they have some really compelling technology. We went and knocked on Intergraph's door and that was an interesting story in itself of how we negotiated with Jim Nedlock [sp?] and the Intergraph guys and acquired Tangent. The other thing that people said at that time. There were two other companies that every customer wanted us to own at that time. The first of them was Gateway Design Automation, which was doing essentially HDL language and simulation associated with that, the Verilog language and

simulator. Then Synopsys, who was doing synthesis -- the two of them, everybody said those two kind of in one breath; Gateway and Synopsys. They were like twin brothers. It became instantly obvious. They should be part. We had been more of a backend. If you looked at us, we had this framework and we did schematic entry and all of that stuff and we linked to a simulator tool, but we were more of a backend than a front-end company. Clearly, if we were going to accomplish the vision of the original founders, we had to have it all. I approached the guys that ran both of them. It was at the Design Automation Conference, whichever year that was. Maybe it was 1989. I approached the CEO's of both--Purbu Goh [sp?] and Harvey Jones. We were at a crap table in Las Vegas. I said, "Guys, don't you think it would make sense for us to do more than play craps together?" I can't remember. Purbu was a very straight engineering guy. Harvey is more of a marketing type. Purbu says, "What exactly do you mean by that, Joe?" I said, "Let's get all three together." He said, "Do you mean?" I said, "Yes. Let's merge all three companies together." Interestingly enough, my prediction about approaching these guys -- I had never thought I would approach them at a crap table, but my prediction about it was that Harvey the marketing guy would get it and go "Yes. This is going to be killer" and that Purbu, who is more of the technical guy, would go "This sounds scary and weird." Harvey and Synopsys were on the West Coast and Purbu was in Boston and there's geographical differences and cultural things maybe. As it turned out, it went exactly the opposite way. Purbu was really into it and said, "Let's do it" and Harvey and Synopsys we weren't able to make that happen right then. We got one of the two. Had we gotten the other one, the end of the game would have happened right then and all of the design automation for all of history. <laughing>

Herscher: I can relate to that. So you get a lot of simulation. You bring the Verilog language into the environment. We're now at 1989?

Costello: Yes, 1989-90.

Herscher: Things are rocking and rolling. At what point does analog become such a strategic asset for Cadence.

Costello: Interestingly, that actually happened-- my dates are probably a little screwy. When we did the ECAD, when we formed Cadence, Jim was the CEO. I think he was like co-CEO's with Glenn Antol [sp?], who came from ECAD. I was only the president, because they were still a little bit leery about the kid. "This kid is going to run this thing?" I had my probationary period during that time. After six months or so they made me the CEO. But Jim played the role, I think he was chairman at the time. Maybe Glenn was chairman for political reasons and he was vice-chairman, whatever. It was a time within about a year and Jim started to say, "Joe, I'm not sure what my role is here anymore in this company. It's changed so much. You're running it." I was horrified by the conversation. I didn't say that to him, but I remember thinking, "What? What are you talking about? Are you abandoning me?" He was saying he was starting to think. I said, "Jim, what do you want to do? What is in your heart? Why don't you think about it? You can do anything you want, really. Anything you want. What is exciting? Do something exciting? Why should you feel down or like there's no place for you? Yes, it's like we're on a new vector here, but what would you love to do? You've got the freedom to do anything. You don't have a job like me. I've got to make the quarter every quarter. You don't have that job anymore." He came back and said he'd been thinking about everything we had done. He said it was somewhat ironic, because he'd come from the analog world and then he'd gotten into this digital world as he saw the future, and then it seduced him into the EDA universe and he'd focused all of his tool stuff on the digital side. He said, "I've been looking at this and I realized we haven't really done diddly squat for the analog guys. They're still using Spice, for

god's sake." I said, "That's actually a good point." He said, "I'd like to think about that." I said, "That would be fabulous." Then he came back. I remember him thinking, "Yeah, but Joe, you run the company. What am I going to do?" I said, "Why don't you just start the company inside the company? You go form this division. You run it. You be the president of the analog thing. You just go do it. You started this company. What the hell? You start that company. We've been great partners. I'll be your partner on the marketing and sales side, like I was the first time. You go make this happen." That's how we got the analog division going. It was him first trying to figure out what he's going to do, then thinking about his roots and he really was very rooted in analog design and realizing not much had been done there, and decided that this was the time for him to do something new and that was how we got going on the analog side. We didn't write a business plan about how big was it and the market size. It was instinct. It felt like the right thing. He had a passion about it. We set it apart as a separate group and got the thing rolling.

Herscher: What was the approach to analog? Was it more layout system simulation? Which old tool were you trying to replace with the new generation of solution?

Costello: When he started it -- it was a similar problem the way he approached it. He looked at it and said, "Look what we've done for the digital designer. We've looked at the entire problem set and we've tried to build this foundation and a way to attach the complete set of tools and fill in all those various different tools so you have a suite." I remember when he did his first presentation about it, "Now you're an analog guy and you've come to the Cadence suite of tools. What do you do?" It was ridiculous. It was a sarcastic presentation, to a large degree. It was basically -- what a crappy experience. It was maybe worse to be an analog designer inside the Cadence suite of tools than it was to be outside the Cadence suite of tools. He said, "We need to build a similar view of the world, but from an analog guy's view." It was very customer-centric. Think of a solution from an analog designer, but every step of the way, you need something different. You're not exactly super excited about logic synthesis or logic simulation or Verilog. It's not a great language for analog design. On the backend side of things, on the tools, do you need gate array, standard cell place and route? Crap. That's not very useful. You need to do custom layout tools there, but you need automation in that space. You need it both at the leaf level where you're building cells. So they started building some tools for automating and compacting cells there and doing it in a DRC correct way, so you took the grunt work and the sweat labor out of that kind of thing and automated at that level. Also routing tools needed to be different there, because analog routing is very different than standard cell place and route. You still needed a route, but very different, much more like the ECAD guys, their block routing kind of sense of things. On the front-end side of things, what are you going to do there? First it was just a better integration of the existing tools that were out there in terms of simulators and the like. But then it was "Let's start working on a next generation, a better set of tools in that space." So that was the approach. It was build for the analog designer the same kind of a full tool suite, thinking all the way along as an analog guy.

END OF TAPE 2 / BEGINNING OF TAPE 3

Herscher: So we're now in a situation where Cadence is really rocking and rolling. You've got analog. You've got digital. You've bought Tangent. You've bought Gateway. Synopsys is an up and coming

competitor. The industry is exploding. Everybody's growing, and you hit a wall. Talk about that experience.

Costello: Yes. And we had a couple [of] little -- we had some hiccups that I would say just along the way, maybe a little bit in India or something like that, where just the growth and trying to pull everything together was -- When I say hiccup it was like everything didn't go swimmingly smooth, but we got back on our feet. On the flip side of things, we were continuing to look at what do we need to do to fill out completely the set of tools and capabilities. Now, we had started as an integrated circuit design company, and I remember it was really funny. I remember once presenting when, I believe, we were still SDA Systems, I don't think we were Cadence yet, presenting at a conference, and the guys from Mentor Graphics came in and listened to the presentation -- it was one of these industry, investor kinds of things. And at the end of it, Gerry Langler came up to me. There might have been another, or one or two of the Mentor executives, but I remember Gerry coming up and going, "Yeah, pretty, pretty interesting stuff. I mean, we'd be really interested in acquiring you guys if you weren't such a niche." And it was classic, right, because, yes, it goes back to sometimes you get lucky and your focus isn't really important. We happened to focus on the burgeoning part. That part of the industry was growing like a weed. Now, on the flip side, our vision had always been and, in fact, even in the early days when the Berkeley thing and Jim and all of those guys were talking about it, when they started their early brochure wasn't just integrated circuit focus. In fact, that was one of the things that we did. They actually were talking about being able to do things for board level system design, everything, you know, they were going to do it all. And so back in those days, one of the things we did is threw out the non-integrated circuit. We said we're going to just focus on that. That was one of those early focus points. But we did think that over time you got to cover it all. You've got to be able to take the chips and put them into the systems, in board level and system level products, as well as even do system level design top down into chips and boards and special customized chips. So we had been looking at how we could angle into that, and that led us in, I think it was '93, approximately, to the acquisition of Valid. And that was the worst acquisition I ever did. And it was one of the things that, why was it? What was the problem? The truth is we'd done a bunch, and we did the ones that we talked about in terms of acquisitions. We did, I think, in total over 15 acquisitions across the whole span…in the 10 years when I was the president of the company, from SDA to when I left. We kind of got into a science about it. We had a set of rules that we used. One of the things about why mergers work or don't work is the very first thing -- you'd better make a good choice at the front end. Pick the right candidate to merge with or acquire. And we had four rules, and our general sense about it was that you could get away with a violation of one rule, but two, you were dead. It would never work, and even one had to have some super compelling reasons to do it. And so our [rules] were pretty simple. The very first one is it had to be strategic from both sides. Everything was bi-directional. Both companies had to see it strategic. And what I meant by that is that if you were looking at the strategic plan, and while you were thinking where you needed to go with the products and technology or marketing distribution, there was a hole that you had identified already, and when you said, hmm, and that other company fit that hole, because too many mergers are opportunistic. It's either cheap or it comes up, and you go, hmm, I guess. "Oh, I never thought of getting into that business. What the hell." Those are the ones that go south. Valid, we had been thinking Valid was in the system level side of the business. They weren't so good on the IC side. But on the system side, they would have been much stronger there in the board level design, system level design. So that was Rule 1. That was okay. And on their side, they didn't have much on the IC side, and had been trying to figure out how to get into that. Rule No. 2 was minimum product overlap. And by minimum we had this rule that if you get more than 10% product overlap, you've got trouble. And that's a pretty high standard, but in technology, all the problems, and I have a deep theory about all of that, but all the problems come from the product overlap, and it's very deep in there. The Valid thing, even though they were a system design company, and had board level products, in the end there was more than 10%, more than 25% product overlap, because they

had built schematic capture and simulation products, and they had some things in ICs, and so it was nastier than that, so that one was certainly a violation. The third one was the culture had to be a fit. And, you know, that sounds kind of goofy and airy fairy, but it's not. Actually that's operationally what can screw you up. The two operational things that will kill you, or one or two, or two or three, either the product overlap or the culture thing. And they were not a good cultural fit with us. They had a very different [culture], and you could tell. You could say, well how do you know about a culture? Well, watch the management teams. Watch, study them for a little bit. Watch how they interact with each other when they interact with you. They were different. And so the last one has to do with it has to be a fair price on both sides. That one was actually good for both of us. So two were fine, but two were not good. And because I was so anxious to grow this company and have all the pieces, and it seemed like, ah, that's the biggest merger, I fell prey to that -- It's the size. It's the mass that can get us there very quickly. I fell prey to making that mistake, violating my own rules about that out of really greed from the point of view…like I'm going to get there faster. And that was a mistake. And so that set us up. When you have a bad merger like that, it causes hell inside the company. And so we just struggled, and…it was all around the product overlap, the cultural things around people. So their guy came in. Their CEO came in, and he was president and he wasn't a good fit. He had a completely different view of running things and there was a clash between us on almost every, single topic. And I had to get rid of him fairly quickly, which is a good thing but, of course, still disruptive. So it was a mess. And that, in turn, was a big one. So it was a big merger. I really struggled, and it led to a couple of bad quarters for us. And it wasn't instantly. I think it was like maybe almost a year later when we really had that difficulty. So it was a wakeup call. And, in fact, I remember one Friday afternoon, I get a call from the chairman of the board, and one of the other board members. And they said, "Joe, why don't you block out three hours for us this afternoon?" I was like, "I think I know what this meeting's about." And bottom line, they came to I think essentially fire me. They came down to say, "I'm not sure you're the guy to run this thing anymore. I mean, it's been great, you've had a good run, but look, we're in a mess and maybe you're the problem here." And I guessed that. I mean, I hadn't guess it before the call, but they said they were coming. I thought, "Uh oh. That's probably what they're coming for." And I felt really strongly at the time that, and I thought about it. And it's true. I thought about it every step of the way, even when we did the original merger to make Cadence. Am I really the right guy? When they asked me to be president the first time, I would always ask myself, am I really the right guy? Is there a better guy to do it, because honestly if there's a better person, what the hell. Have them do it. I'm a big shareholder, so it'd be better to have them do it, and I can do something else in the company or outside the company. So I thought about it right then. I said maybe it is the right time. And when I thought about it, I thought the job, on the flip side, well who would you get to do this job? Who would know who to do this job better than I know how to do the job right now? And I had a clear picture of what needed to be done at Cadence and in the industry, and the next steps to take. And, yeah, I had screwed up by doing this merger and getting ahead of myself and too greedy and violating my own rules and precepts about it, but on the flip side I had a very good, fundamental feeling about where things were and what needed to happen next, and what was going to make the difference. And so when they came, I said that. I was passionate about it. I said, "Look, fine, who do you want?" Harvey Jones was running Synopsys. I said, "Go. One of the guys in the industry? They couldn't run this company right now. There's nobody out there that could do a better job, even going far afield, I bet you. If you can find somebody, I would be happy to step down, but you're not going to, and really I am the guy that is the right guy to do it." And so I convinced one of them. The other guy wasn't as convinced, and he ended up leaving the board. But, yeah, because I think it was an important thing. It was the right discussion to have, but then you got to decide. Am I it or not? And I felt I was, and I think I was right about that, and of having the vision. And then the vision actually about where you're coming, had happened, had started to happen before the Valid situation, the merger and all of that. And it had been evolving. And that came out of conversations that I'd had with some of our customers. I loved going out in the field talking to customers, seeing what was going on. And increasingly I found with

customers, I would go to, a lot of times, would be invited by our salespeople to go unhappy customers and find out why they were unhappy, and see if I could help smooth things over. But I was always curious about well, what's the essence of why they're unhappy? And there was a theme, a resounding theme, that came through over and over and over again -- the truth was we were throwing technology at these guys, and more and more technology, a faster router, a more complex thing, more features and functions and capabilities, a new simulation feature. And the bottom line is they had never really caught up with the changes in design methodology, because what had happened over the years is that in order to accommodate and handle the incredible changes that were going on on the silicon side, you had to change design methodologies. You had to do this. But there weren't like schools for these people that were training them to become oh, gee, I used to be a schematic guy and I used to do my simulation by hand or in my head, or with a bunch of logic tables. And now I've got to do it Veralog or VHDL, and I'm using the behavioral level simulation and then doing synthesis, and then gate arrays, or standard cell kind of stuff. And I have to do a special kind of timing analysis and, no. And they aren't. If they've not gone to school, there isn't a school for that. So a lot of these people were stuck in an old methodology. They're trying to use a new methodology with old approaches. So there was that issue. And then there was the issue of they didn't know how to implement these things. They actually didn't even know how to tape these technologies, even if they could train them. How would you make a new flow that would be effective and productive? And so I heard this consistently several times, and I started to think we're missing a bet here. And the other data point about it was I was watching just from a macro point of view our application engineers. When we started out, we had one application engineer per sales person. By the time this epiphany hit somewhere around this '93, '94 timeframe, we had 4.5 application engineers per sales guy. And like what the hell? Why is that? And it was going to go up again. And the reason was we were throwing tons of our people at the problem that the customers didn't know how to use the technology that we were stuffing down their throat. And that was crazy. And we were patching it up. And, in fact, I remember another one of the epiphanies around that. I remember asking, "What are those two engineers? You said you need these two application engineers for the next six months at this customer site. I don't get it. What's going on there?" And they said, "Well, there's a big chip that's being taped out." And I said, "Yeah." "Well, they're doing it." In order for them to buy our tool, we had to give them the engineers to use the tool, because they didn't know how to, and they would never be able to figure it out in the timeframe relevant. And I said, "You're kidding." And we went around to start seeing how many of our application engineers were doing the same thing. Our sales people were selling our tools for this high price, and giving away people to run the tools. Insanity. Insanity all across the board. There needed to be a restructuring of this. And so I started to believe very strongly -- I had another example of this, which was this situation with, I believe it was with Ericsson in Sweden, where we had sold a million dollars of our software, and I got a call from the president and this long letter delivered by Federal Express, that he told me why he was sending it back, and he wanted his money back. And so, yie yie yie. And what was the essence of the problem? And the bottom line about the essence of the problem was their people…I sent some guys over there. "Go check it out." And they said, "These guys don't have a clue how to use this stuff, and that's their fundamental problem." And the reason it was so deadly, they had made some guarantees to a customer with ten million dollar penalties associated with missing dates. And they were going to miss them because they had no clue how to use this technology. And so I said to these guys, "Why don't you let us, let's rethink this." We've completely restructured it. Instead of us selling you just this technology, we'll send a team. We'll do the chip design, at the same time we're doing the design, and we will be responsible. You don't have to pay us diddly if we don't make those dates. Only if we make the dates do you have to pay us any money. And then we'll, at the same time, train your people, and we'll even tell you which people can make it and which people can't, so that we can hold your hand to the point that you really do get to the point you've got a robust team in process that can make this modern technology work. It was some of those experiences and thoughts that had gotten me on this path. We need to change this company, and we need to change it from being a

straight, product sales company just dumping technology on people to being a full service solution company, who could go in, help the customers just like the normal consulting companies do in other areas, like ERP and traditional IT areas, go in and help people analyze the situation. We'd assumed, because they're technology people, well, they can do all that. They're smart people. They'll figure it out. They can't. They're just like those people. Who is it that's got the time to go out and analyze all this advanced and sophisticated technology, and how the hell you implement it. It's a big problem. And so we decided we needed to start supplying that. We needed to supply the set of services to help people analyze, understand, rebuild their design process, train their people to do that, and even do the work for them if it was, in fact, an appropriate thing to help them -- train them like a mentor in that design or two, and sometimes they would just outsource it to us. And so that was the bent that we were on, and that was what I felt was the next, important wave in this industry, to move from just technology to making sure that you made your customers successful. And I was on that path, and I had started down that path, and I knew there was nobody else who was going to be able to execute that like we were. And I felt strongly that was the most important next step for our company and for the industry. And so that was why I felt, when these guys came to fire me, that I should keep my job for at least a little while to see if I was right or wrong about that.

Herscher: The customers, their complexity was doubling almost every year, every 18 months. So you're starting to look at consulting as a way to solve the customer's problem. What was the size of designs that your teams were having to take on?

Costello: In those days, we were up into the -- we'd gotten out of the 50,000, 100,000. Now we were truly in the millions of transistors, millions of gate kind of designs that people were doing. And the other thing that was compounding the problem was the shortening up of the design cycles, so that in the old days when some of the products that people were building were going into non-consumer products that were not fashion and time driven so much, well, you know, cycles of three years in telecommunications, computer, three, four, automotive, five-year designs. No sweat. But in consumer products, which were by definition -- by the way, this is another one of these things, by definition it was going to have to be the consumer market, because the semiconductor industry had gotten so big the only market that would create growth would be consumer markets. They couldn't stay in any of these sub niches anymore. And so those consumer demands were going to put the pressure on timeliness of these things which, of course, was compounded by the fact that you were having these enormous chips with, as you point out, this exponential growth and the complexity of things. And the complexity was even worse than exponential, because it was exponential, as you say, compounding every 18 months by a factor of two. But at the same time that would happen, as you changed the circuit dimensions on things, it changes the actual fundamental design problem, so it's worse than just having to deal with twice as much every 18 months. You also have to deal with a new set of fundamental problems about timing, interactions between things, the physics that you could ignore before that all of a sudden becomes important. And so you had really a rat's nest of problems there. So that was the environment that the customer's living in, and no wonder, yeah, their job is they're supposed to be translating customer needs into electronic stacks, and therefore deliver these chips. And at the same time, they have to completely recreate a new design methodology and implement that, and train their people on it. That's a little bit big. And that was why there was an opportunity for us to help them with that whole transformation.

Herscher: So you had Cadence very much recovered, on a roll. Things are growing fantastically, and then a dark period started. Somebody stole some.

Costello: Ah. Yeah, that was in -- when was? The actual stealing thing, when it actually happened.

Herscher: In '95?

Costello: Yeah. I'm trying to remember the exact dates of when all of that went on. But I believe it was in the summer of '95 when we had some -- There were some things that had happened that caused us concern and were some flags about this. And this was when there was a group of ex, actually it was ex ECAD uh.. engineers that had started this company. I'm not sure it was originally called Avant!, but eventually it was.

Herscher: ArcSys.

Costello: ArcSys, exactly right. And then it later changed the name to Avant!. And so there was some funny stuff in the early goings, some things that were bothersome -- but you know, we kind of ignored it. And then the trigger event that happened is that there was a guy named Gerry Hsu, who was the head, he was the general manager. He started out as the head of engineering, and was the general manager of our IC group, started out in place and route, managing that, and then the IC group. And he abruptly left the company under strange circumstances, and told me -- he had this long, elaborate story about how he had wanted. This was weird. It was bizarre. He was hoping to do something bigger and I wasn't going to give it to him, and it had crushed his spirit, and he was going to have to sit on the beach for months, maybe year. Maybe he would never work again productively. And I heard a rumor five days later that he was the new president at ArcSys and Avant!. I said, "Really? He recovered very rapidly from the psychological damage that we supposedly did to him." I had a chat with him. I said, "Gerry, this isn't right. You cannot go from running in place and route in that group in business in our company to a direct competitor without using stuff you shouldn't use." And he basically didn't answer, and so we went to his board. I went to a member of his board and made the same kind of argument, and basically he told me, "Bug off. I love this guy and he's going to make my investment worth something." And so we went and filed suit and we actually got Gerry to not go there for a period of time. But, boy, the red flags were up. I mean, there was something funny about this whole thing. And then it was in the summer of '95 I came back from a trip to Taiwan actually, and I was met in the office by one of the early Cadence employees. He had called my assistant and said, "I must see Joe." It was like a Friday afternoon. "I must see Joe when he gets back. I must see him." And he's shaking when I come in. And what he said, he was at a customer site, actually, and the customer was trying to help him understand this methodology and he was using some of these Avant! tools for place and route. And he says, "Well, let me show you what I'm talking about. I'll just show you on screen so you can see the problem I'm having with the Cadence name. I'll show you it in the Avant! thing, and you'll get what I'm talking about." And he said the thing that shocked him, he saw on the screen literally a bug in the user interface that he had written into the Cadence software. And he even remembered when he had fixed the bug. And he said, "Wait. Do that again." And again and again. He said, "Can I come back here this afternoon?" And he brought his boss back that afternoon. He told the boss what had happened, he said, and they collected a whole set of bugs from that time. And they checked five or six of them, identical pixel for pixel, the bugs in the software, in the Avant! software running on the screen, that had been in the Cadence software that these two guys had written into the software some number of years before. And so that set off red flags that, whoa, all of our worries and suspicions, there was something really here. And we launched this intensive investigation into this, and found that, indeed, it was one of the most incredible stories of corporate espionage and theft, and brazen theft, that you can imagine. They had literally set guys up in offices

nearby, and traded cash in parking lots, and were doing dumpster diving on things. I mean, it was truly an amazing story of theft, fraud, corporate duplicity, etc. And so we went off and sued them and attacked. And we took a lot of crap for it, and a lot of people said, "Oh, they can't win in the marketplace so they're suing these guys in courts." And nothing could have been further from the truth. We were competing in the marketplace with our own software, and so why theirs was good was because they had stolen from us fundamentally, and put slightly different coding on top of it.

Herscher: So what happened with that in the end?

Costello: So in the end, I don't remember the exact, how many -- I think there was a criminal -- We had gone to the Santa Clara County prosecutor, and thank goodness for him. We were in Silicon Valley, and there is such a person that's kind of technology oriented prosecutor here. And his first question about it was, "Are you for real?" He said, "because so many people come here pissed off and then they all give up." He said, "If you want, it's really a wrong thing." And he says, "I'm just tired of -- he didn't say it quite this way. "But I'm tired of all these people's false starts and they don't really want to carry through. They just settle and move on." I said, "No, no, no. We're dead serious." And he was dead serious. And he took this case on. We filed the complaint, and he took it from a criminal point of view. We took it from a civil point of view, and so we ran these things in parallel. And in the end, I don't remember -- It was between six and eight of the executives and key engineers at Avant! were indicted, and I think six of them, I think, were found guilty, maybe seven. And several of them actually served time in jail for it, found guilty of definitely direct theft of our intellectual property. And I remember at one point there was one of the criminal investigators, one of the cops for the people, the DA's office, said they found a notebook of one of the engineers, one of the original ArcSys engineers, and it was a gold mine. And he said, "It is by date. It was when he [was] still was working at Cadence, and by date he recorded what he was stealing every single day." And he goes, "Only a God damn engineer would actually write down exactly what they were stealing day by day, and leave that record for you to see."

Herscher: It is an important thing for intellectual property in Silicon Valley, because the product never got an injunction, right? So even though people went to jail, the technology still lived on.

Costello: Yeah, it did, which is, to me, it was so important to do something about this. I remember we had a discussion at the board, because it was a big thing to say you were going to go and fight this to the teeth. And I said, "Look, if you can't win this fight, you can't win any fight. I mean, really, if people are literally stealing things and copying it, and they have logs of what they're stealing and it's in the code, pixel by pixel, bug by bug, there's records of these people paying people off in parking lots and bank accounts and, I mean, everything was done like that. If you can't win a case like that, then there is no intellectual property protection in Silicon Valley." So the positive side of it is the DA in Santa Clara County, and the police did an incredible job, and our lawyers and team did an incredible job prosecuting this thing on the civil side and on the criminal side. And people had to pay for it, and yet, yes, the intellectual property survived, and then in the end was acquired by Synopsys and lives on in another form, never was taken off the market that way, which is -- that's not right.

Herscher: You also chose at this point in time to actually set up a separate division to pursue your vision for services?

Costello: Yes.

Herscher: What was the business idea that you had a vision for. You went big at some point. What were you thinking?

Costello: The fundamental seed idea was the thing I described, which was we needed to provide more of a solution, both in helping people get themselves set up with a new process, so business process reengineering you might call it, but this case in the engineering discipline, and then actually outsourcing. So we had those two major pillars of what this organization was about. And what we learned very quickly was that trying to run that as a part of the normal product sales organization was a disaster, because it's just a different mental set. And to try to sell technology and product and at the same time sell services, you're either one or the other pretty much. And, in fact, 80-plus percent of the people who were successful technology product sales people, never could make the transition to sell a full set of services like that. And so we separated that group really from a go to market point of view about what it took, a different kind of person, a different approach to the customer. That's why we made it a separate entity. We'd done the experiments. We tried some things, and we realized, no, it needs to be separated if it's really going to get legs and work. So that's why we built that separate group. And it grew. I think by the time I left, we were almost doing a billion dollars total as a company when I left. Not quite, but very close in 1997, and the services at that time was something on the order of a quarter of that.

Herscher: So you left in '97, but you kept your hand in with small companies. What interested you about the way the industry was evolving?

Costello: Interestingly, it was more about -- I grew up in electronic design automation. I knew a lot about it. I didn't want to run Cadence anymore and keep doing that. I wanted to try something different and new, but on the other side of things. I certainly knew a lot about it, and more important than that was people. So almost everything that I did after I left Cadence had to do with individual people, personal connections, than it did with me wanting to do something more myself personally in that space. It was much more about helping people that I would see as a young entrepreneur or a team that was trying something new and different. And I thought they deserved a shot, and maybe I could give them a little bit of a help, whether it was me investing in them or sitting on their board to advise them. And it was in some ways just a helping hand. In some cases it was a very personal connection. It was somebody that I knew, and they'd asked me to give them a hand to help them out on something like that. And it was an area for me that was not so hard, because I had been in the industry. I knew a lot about what was going on, at least for a period of time. And so I could be, without a huge investment, I could be somewhat helpful to these people hopefully.

Herscher: So here we are. It's Friday, May 16th, 2008. What are your predictions? I know you're not living and breathing electronic design automation anymore. What are your predictions for the next 10 years?

Costello: Electronic design automation? <laughs>

Herscher: Yes. Knowing what you know, seeing how it's shaping up, what are the big problems, particularly technical for our customers, or in terms of infrastructure, that you think need to be solved for the industry to continue to serve the design community?

Costello: It's interesting, because recently the truth is in the last few years. I stayed on some boards, and I kept my hand in electronic design automation for at least another six or seven years. And then in the last few years I've done less and less, and so I've been less in touch with it. Every once in awhile, I'll connect. Someone will talk to me about something. I'll connect with a company that they're working on. And I have been asked, some people said, "Why don't you come back? The industry is sluggish right now", which it appears to be from an outsider. It appears today to be not growing so rapidly and in a bit of a funk, I guess it feels like at this point. And it does seem like there needs to be a breakthrough again, another vision to take the industry forward. Now, I will say, I don't think that the services vision that was my vision when I left Cadence, and I thought it was a vision that was firmly enough established that it was more of an execution issue going forward, but I think I was wrong about that -- I don't think it had gotten deeply embedded enough either in Cadence or the industry culture to make it the kind of self sustaining thing that I had envisioned about that. And so there is that side of things…I still think there is a bigger opportunity around that to change the game on things. There are always technology things. There are always new [things], as you push forward in transistor count and size and power requirements, and core powers will be increasingly important for people. There's always things in architectures. There's always going to be interesting tool sets that are required. At the macro level, though, you know, is there a chance to make a big change and reinvigorate the industry? My personal guess, is there still is an unaccomplished set of objectives that could be done to more fully create a set of services around this for people. And then the second thing that has struck me from a distance is that the marriage between the manufacturing side of things, and the design side of things, people talked about that for years, but instinctively it would appear to me that that might be the time, that we might be in the era where that combination can bear a lot of fruit by putting pulling those two things together, and maybe in combination with a better set of services for people.

Herscher: So we've walked through the last 25 years of electronic automation. If you look back at your time in the industry, what was the most exciting thing you did? What was the most exciting day, or were there too many? Pick a couple of moments where you saw the industry unfolding in front of you.

Costello: Yes. And so that, you've hit it on the head. It truly was, for me…my time was really joining SDA Systems to leaving. That was end of 1984 to end of 1997, so 13 years there. And there were many points in that that were electrifying for it. And I always look at it that, for me -- there were three pieces, three phases for me and Cadence and the industry, to some degree, in that period of time. And the first one was us finding our essence, that first piece. Who were we really? And that's an evolution for any company, but that's a super important thing for any startup company. And that was a very exciting, painful in many ways. I think I described some of those painful conversations and discussions that were had, but very, very exciting period of time. When you get to the essence of what makes it different and interesting, that's the touch point. That's what lights a customer on fire. It's when you see it light up, and we did see that. In those early days when we actually started selling, when we actually got to that core essence of who the hell we were, which is, yeah, we're software, about integrated circuits, and putting together a framework design flow with this cool stuff, or these new kinds of things, standard cells. That was different. It resonated, and you can tell. That's an exciting moment. That merger between ECAD and SDA, I mean, it was interesting intellectually, but when the sales started to take off, and you saw the customers coming to it. Whoa, that resonance with customers. Ooh, that was exciting. I would say the

same thing for the services piece, for me, when…we got some of those first deals done, the Ericsson -- The guy wants to send in my -- He was angry with us. He hated us. I felt bad. I mean, you feel like crap if you're taking a million dollars from someone and he hates you. And then it turned to they thought we were fantastic. You know you're on to something. It was like, my God, we took a horrible situation into something that is pure bliss for this customer, because we saved him tens of millions of dollars in penalties. But those were the moments, to me, when you knew you were on to something. We hit a really core thread, a core vein in the market place. And those were the times that were really, really exciting.

Herscher: Fantastic. Anything that you would like to add that I haven't really touched on?

Costello: It was for me a fantastic period of time. Truly from a professional point of view, that was my growing up period of time, and so it was wonderful, exciting. It's intellectually, I mean, electronic design automation is, if you're an outsider, a lot of people look at it and go -- Steve Jobs once said, "All you ever do is sell geeky tools to geeks." You know, it was like, yeah, that's a way of looking at it, I guess, but the flip side of it is it's those tools that make all of those iPods and Mac's possible, iPhones possible. And it is, the cool thing about it for me, from my background, which was physics and math, is that it is deep. It is a deep set of technologies, and it's very intellectually challenging. And the kinds of people that are around and surround that, that make it successful are exactly -- you need the PhDs. You need the driven people. You need the people that love the science and the physics and the math to make that happen. On the flip side, it's a very core business. It's a fundamental piece that fuels and makes all of electronics and consumer electronics that drives things happen and possible. And I was fortunate enough to be there during a time when this industry was emerging and maturing, and got to play with new business models, whether it was merger and acquisition, or trying to morph a product company into something that was services. So tons of excitement around it, but I think there still is. The core is still there. It's still a fundamental piece of what needs to be done going forward. And I'm sure, though I'm not in it anymore, when you see a business like this that's core and fundamental like that, that is maybe going through a period of stagnation or drifting a bit, there's got to be a breakthrough. And I'll bet there is on the business side, some kind of a change that can be made that can make this thing erupt once more.

Herscher: Thank you very much.

END OF INTERVIEW

