SCALD Oral History:
#2 of 3
(Curt Widdoes Alone)

Interviewed by:
Holly Stump

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Holly Stump: We're speaking with Dr. L. Curtis Widdoes, one of the inventors of the SCALD [Structured Computer-Aided Logic Design] System, which revolutionized how electronic products, both ICs and printed-circuit boards, are designed. And we're wondering about your formative years, how you grew to be a Silicon Valley pioneer. So Curt, when were you born and where did you grow up?

Curt Widdoes: Well thank you for those flattering remarks, some of which aren't quite true. I was born in 1952, in St. Louis, Missouri. I was very fortunate, I think, to be born in St. Louis, because everywhere I lived since then has been better. I went to middle school in St. Louis, then moved to the East Coast, where I went to high school at Phillips Exeter Academy, then to college at Caltech in California, and then to graduate school in the Computer Science Department at Stanford.

Stump: So were your parents, either of your parents, technical, scientists, entrepreneurs, educators?

Widdoes: My dad was a nuclear and chemical engineer. He was actually an entrepreneur back in the '60s, building nuclear reactors. That turned out not to be a growth business but yes, he was an entrepreneur. He gave me a lot of energy for that.

Stump: Do you think he affected your creativity and sense of ethics?

Widdoes: Yes. Certainly. My dad played a big role in my life and gave me the drive to do entrepreneurial things.

Stump: So when you were young, were you a good student or were you a troublemaker, kind of an iconoclast, even in those early days?

Widdoes: Well, I was somewhat of a troublemaker up until fifth or sixth grade. My dad cured me of that and got me on the track to good grades with a fraternity paddle that he would use. The bright side of that was that when I got really good grades I got to hit him with the fraternity paddle. That turned me right around. I was getting great grades by about the seventh grade.

Stump: That's an interesting management technique. Did you carry that forward in any of your future endeavors?

Widdoes: Well, I won't comment on that.

Stump: Did you have any hobbies as a child that foreshadowed your work in electronics or science?

Widdoes: I was always interested in science and building things. I built airplanes, rockets and electronic systems. When I was 11 or 12, I think, I worked on a project to bug the house. I put little tiny wires throughout the walls and had a neat system where I could listen to any conversation in the house, including any phone conversation. If it got too incriminating, I could just press a button and it would shut the phone conversation down. I had a lot of fun with that. But my dad found the wires. My dad was a funny fellow, and he kind of played with this. Of course, I had a microphone under my parents' bed and I could listen when I wanted to and make recordings. But he found the wires and microphone under the bed. One night, I was listening and I couldn't hear anything. I went into my parents' room the next morning and the wires had been snipped. So I fastened up the wires again and the next night I couldn't hear anything. I went in again and found them snipped again. Every night, my dad would just crawl under the bed, snip the wires, and that was that. So I did a lot of projects when I was growing up, and I got into computers early. I was fortunate to go to high school at Phillips Exeter Academy on the East Coast, and in 1967 was able to use the timesharing system at Dartmouth. Dartmouth had a system that had terminals at various high schools and throughout the Dartmouth campus. And I was able to program that system as a high school student. It was very unusual to be able to use computers as a high-school student in 1967. I was 15. And then I basically rode the ascent of computers. I was born at the right time and latched onto computers early. I got a summer job programming DEC PDP-8s in 1968 and 1969. The PDP-8 had a 4K-word magnetic-core memory. We did optical character recognition with it. Optical character recognition was very difficult on a PDP-8 with 4K of memory. When I went to college at Caltech, I programmed a Varian 520i, which was a competitor to the DEC mini-computers. The 520i was nice. I've got to go into a story here. The 520i was a really nice machine, actually in some senses better than the PDP-8. But Varian couldn't get the software right, so the text editor didn't work. I worked for the Space Radiation Lab at Caltech, doing the ground-support software for a cosmic-ray satellite project using a 520i. I needed to edit my programs. Since the text editor didn't work, I'd edit the paper tape on the teletype machine, standalone. I'd feed in the paper tape with the old program, I'd turn on the punch, and it would duplicate for a while. I'd get to the bad part of my program and then I would turn off the punch, type in the right stuff, read past the bad stuff and continue duplicating -- a totally manual process because the Varian software was broken. So the Varian 520i was a wonderful machine with lousy software. As a result of the bad software, it didn't go anywhere. Varian eventually stopped building computers. After that, I got to program PDP-11s at Caltech and an IBM 370/158. After that, I moved on to Stanford where I went up to SAIL [the Stanford AI Lab] because they had the best computer system at that time, centered around a DEC KA10.

Stump: So you're no stranger to punch cards. Enquiring minds would like to know if you still own a slide rule.

Widdoes: I do still own a slide rule. I used to use a slide rule extensively. You know, my generation did use slide rules. The first calculators became available about the time I was a junior in college. The highest-tech slide rule, the type that I owned, was a round one. You didn't have to shift ends. It was cool.

Stump: So you've talked about some programming experiences in college. Let's go back to your undergraduate days and ask why you chose the college you did and what was the draw there?

Widdoes: You know, Caltech is an amazing science and engineering school. I just never had any doubt about wanting to go to Caltech. And I loved it there. It's a wonderful school. I learned a tremendous amount there. There was just never any question that I wanted to go to Caltech. I can't remember a time when I didn't.

Stump: Did you have any teachers or mentors there who were particularly memorable? Any classes or people that captured your imagination?

Widdoes: Absolutely. For example, a professor named Rochus Vogt, who was a cosmic ray physicist at Caltech. [Professor Vogt headed up Caltech's Space Radiation Lab.] And Bill Althouse, in charge of engineering at the Space Radiation Laboratory, who helped me get started doing the software for the ground support equipment. And I worked with a professor named Fred Thompson, who did research on natural language database access using an IBM 370/158. [Professor Thompson's project was called the REL (Rapidly Extensible Language) Project.] And Carver Mead was there. I took courses from Carver and he gave me free parts for my projects that he got from Intel. And yes, I benefited a lot from mentors at Caltech.

Stump: So after you graduated there did you consider going into industry or had you already determined you wanted to move next to Stanford?

Widdoes: I had no doubt that I wanted to get a Ph.D. in computer science, and Stanford was the best computer science graduate school at that time. So, I applied to Stanford. I didn't apply anywhere else. I started there in 1973. I went up to the Stanford AI Lab because that's where the best computers were. If you were down on the main campus you didn't have access to good computers. SAIL had a DEC KA10; a DEC KL10 was installed a little bit later. I worked at SAIL building a multi-processor called Minerva, a little experimental machine. I did that with the drawing system that was installed up at the Stanford AI Lab, called SUDS. And that led to stuff I did later using SUDS.

Stump: This project, did you get it to work?

Widdoes: Absolutely. From today's point of view it just was a little toy, but it was a neat little system. I got lots of free parts to build it from Bill Lattin and Justin Rattner at Intel, as well as from John Wakerly in the Electrical Engineering Department at Stanford. I learned a lot about logic design, and I published a paper that introduced some new ideas about caches for multiprocessors [L. C. Widdoes, "The Minerva Multi-Microprocessor", *Proceedings of the 3rd Annual Symposium on Computer Architecture*, pp. 34-39,

January 19-21, 1976]. So, it was a useful project. But really, the most important work that I did at Stanford was the SCALD work that I began in 1975 with Tom McWilliams.

Stump: Were there any people at Stanford that were particularly formative for you, or whom you had relationships with that lasted?

Widdoes: Well, I need to mention Lowell Wood, who was a very important mentor for me. I met Lowell while I was at Caltech. He was interviewing for the Fannie and John Hertz Foundation, and I won a Hertz Fellowship. He was my final interviewer. In fact, I still remember the interview. It's funny, but I think Hertz Fellows usually remember their Hertz interviews. He asked me physics questions. Anyway, I met Lowell in the Hertz interview and I went to work for him that summer after graduating. I worked for him at the Lawrence Livermore Laboratory, where I got to program the CDC 7600. At that time, the 7600 was the fastest scientific computer in the world.   I wrote an optimization program that they used for studying laser fusion. So I worked for Lowell during that summer and I got to know Lowell a little. Later, Lowell played a big part in my life. Lowell was a physicist, Edward Teller's right-hand man. He was very close to Edward.   At that time, Lowell lived in the loft of a barn a mile or so from the Lab. In the main part of the barn, under the loft, he had stored an IBM Stretch, which wasn't running. He was hoping to get it running at some point. I thought that it would be a fun project to help get this thing running, so I let him know that, and I kept in touch with him after I left Livermore at the end of the summer. It turned out that he had some other plans that eventually led to me meeting Tom McWilliams, and led to the two of us starting the S-1 Project and developing SCALD. So, Lowell was a very important mentor to me. He's a great leader and he has mentored a large number of young scientists.

Stump: So you actually had interned at Lawrence Livermore Laboratory before you got your Ph.D. Was there any question in your mind that you wanted to go back there? What happened after you graduated at Stanford? What were you thinking at that point you wanted to do?

Widdoes: Well, there's a long time between when I started at Stanford in 1973 and when I graduated from Stanford in 1980. I worked at Livermore most of that time. I worked on the S-1 Project, designing and building the S-1 Mark I, and I worked on developing SCALD. Simultaneously, I worked on stuff related to my Ph.D.; I finished my Ph.D. on the SCALD Physical Design Subsystem in 1980. At the time that I finished my thesis, the plans had already been laid for starting Valid Logic, and I just went and did that and left Livermore. But from 1975 to 1980, I was an employee of the Lab and also a Ph.D. student at Stanford.

Stump: So, when you look back on your early days, your work with SCALD, Valid Logic, and some of the subsequent companies, what was the most exciting period or project of your career? What do you remember the most?

Widdoes: In my whole career up to now?

Stump: Up until now.

Widdoes: Oh, brother, it's hard to say what's number one. A very important, exciting project that I worked on was the S-1 Project and SCALD. That period in my life was probably the most productive of my entire life. And then I founded Valid in 1981. Again, that was a very productive time, and exciting. We built the Valid proprietary workstation and the operating system software and the CAE software, and we built the business and went public in 1983. That was a very, very exciting time. And I invented hardware modeling while I was there. I started a company based on hardware modeling in 1987, Logic Modeling, a wonderful company. And we sold Logic Modeling to Synopsys in 1994. I would hate to say one of those periods was the most exciting, but certainly the time of the SCALD development and the S-1 Project was a very, very exciting and productive time for me. I think that period counts as one of the most important in my career.

Stump: Just in brief, at this point, can you take us through the flow of SCALD and the different tools involved?

Widdoes: I think we should postpone that and do it when Tom joins us in the later interview.

Stump: Okay. Shall we talk a little bit about hardware modeling, that technology?

Widdoes: Sure. I'm always happy to talk about hardware modeling.

Stump: Great. I'm intrigued by this concept.

Widdoes: So, let's see. There's a story behind that. When we started Valid in 1981, one of the angel investors was Bill Davidow, Executive V.P. of Marketing at Intel. He invested $100,000 before we got funding from Sequoia, and he joined the Board [along with Don Valentine]. Valid developed tools to allow ordinary engineers to use graphical entry and structured design -- the kind of stuff that we had done for the S-1, but more refined and more finished for the public market. And we introduced those tools in 1982, after about a year and a half of development. But there was a big problem. At that time we had a simulator that you could use to simulate your ASIC-based designs. People were building systems containing complex VLSI chips, like the Motorola 68000, for example. But you couldn't simulate system-level designs containing chips like the 68000 because there were no simulation models for those chips. Nobody could write software models for complex chips. So we worried about that. Now, Bill Davidow had been in charge of the in-circuit emulation [ICE] business at Intel, and he kept calling me. He said, "Curt, for in-circuit emulation we use the chip to emulate itself. Isn't there a way you can do the same thing for

simulation?" I said, "No, that's impossible because the complex chips are dynamic, they can't stop to wait for the simulator to figure out the next input." Then, I'd forget about it and work on other stuff. But he'd call me back. Eventually, he made me think about it long enough that I figured out how we could actually use a complex dynamic chip like the Intel 486, or the Motorola 68020, to model its own behavior [U.S. Patent No. 4,590,581, "Method and apparatus for modeling systems of complex circuits", and U.S. Patent No. 4,635,218, "Method for simulating system operation of static and dynamic circuit devices"]. So we built a device that allowed you to use actual silicon as a model in simulation and it really opened up the system-level simulation business. [See *CAE: A Survey of Standards, Trends, and Tools*, Stephan A. Ohr, John Wiley & Sons, 1990, pp. 150-156.] The first unit we marketed was called Realchip. [The Realchip sales demo that we put together showed the simulation of a circuit containing an Intel 8086 connected to memory and running a program that computed Fibonacci numbers. It was easy for the customer to see that the results were correct!] Eventually, I developed four generations of hardware modelers -- two at Valid and two at Logic Modeling. In 1987, we founded Logic Modeling to market hardware modeling, and that was very successful. [At Logic Modeling, we developed greatly improved technology for sampling the outputs of the complex device (U.S. Patent No. 5,353,243, "Hardware modeling system and method of use") and made the hardware modeling unit available on all types of simulators and to all users on a local area network ("Hardware Modeler Spans Multiple Environments", *High Performance Systems*, April, 1989, pp. 24-40). Our first product, the LM-1000, performed so well that we ended up owning 100% of the hardware modeling market.] All together, counting all generations, we sold more than $100 million of that kind of equipment. And I got my first two patents for the fundamental technology of hardware modeling. It was a very successful idea. It allowed us to broaden the simulation market in the mid '80s. Of course, now that type of product is obsolete because people design mostly for new silicon, and they want to simulate before they have any silicon at all.

Stump: All right. So Logic Modeling grew and flourished and was acquired. What was your next frontier?

Widdoes: Well, I've done three companies and I'm happy to say they were all successful – my investors made money in all three. Valid went public in '83. Eventually, it was acquired by Cadence. I think it was '89 when Cadence bought Valid. [The principal early CAE companies were Daisy Systems, Mentor Graphics, and Valid Logic. They were called the "DMV". Daisy eventually went bankrupt. Mentor is still in business. Valid was acquired by Cadence in 1989.] Logic Modeling was acquired by Synopsys in 1994, like I said. Then, in 1996, I started 0-In Design Automation with my business partner from Logic Modeling, Steve White. Our mission at 0-In was to make formal verification practical for mainstream HDL designers.

Stump: So, after Logic Modeling was acquired by Synopsys, you founded 0-In Design Automation. Tell me about that company and the technology that it was based on.

Widdoes: I founded 0-In with Steve White, who was my business partner at Logic Modeling. What we did at 0-In was to develop a technology that a design engineer could use to do formal verification of assertions in HDL designs, for example, designs written in Verilog. Using formal verification, you can verify that various properties of a design specification are true across all possible simulations. So, as opposed to simulation, which exercises only a single possibility at a time, you can exercise all the behaviors of the design. Anyway, there was a revolution in formal verification technology in the '90s and we capitalized on that with 0-In. We founded the company in 1996. The technology was extremely difficult and we spent a number of years trying to massage it into a form in which ordinary designers would be comfortable using it. We were relatively successful with that and sold the company to Mentor Graphics in 2004. Mentor is still pursuing that product line. In fact, I believe that Mentor is the market leader in assertion-based and formal verification of HDL designs.

Stump: So it seems as though a lot of the companies you've been involved with were technology leaders. I'm interested in your comments about how that played out for these companies?

Widdoes: That's an interesting question. You know, I've always been interested in developing cool new technology. That's just what I gravitate to. I don't gravitate towards developing new marketing plans for old technology. I like to help advance the underlying technology, so sometimes I get into things a little too early, before there's really a great market for them. In the Valid case, it turned out that we hit the market window dead on. And in the Logic Modeling case, we were pretty accurate too. I think 0-In was a bit early. But I've always given a technology focus to my companies. Valid was absolutely the CAE technology leader, up to the point when revenues lagged because we didn't support the Sun platform. Valid had the most advanced graphics editor, the most advanced hierarchical design, the most advanced timing verification, the fastest simulation accelerator, the first hardware modeling system, and so forth. Logic Modeling developed the most advanced hardware modeling technology. And 0-In pioneered assertion-based verification. So I've always pushed my companies to do advanced technology. Sometimes that approach doesn't lead to billion-dollar companies but it's important and it's a lot of fun.

Stump: Well, in that context, if you could change or redo a decision that you made in your career, what would you change? Or would you?

Widdoes: Well, I'd have to think about that. I'm pretty happy with the path that my career has taken. In hindsight, I think we could have done things slightly better in each of the companies. At Valid, we could have jumped over to the Sun platform earlier. At Logic Modeling… It's not clear what we could have done better at Logic Modeling. That was a great little company. At 0-In, we probably should have made the technology a little more acceptable before we ramped up the company. It turned out to take longer than we expected to get the technology to the point where it was actually marketable. Anyway, I'm pretty satisfied.

Stump: Well, you have certainly changed and grown as a person from the old Heathkit days, through being a patent holder and technologist, and then into very successful entrepreneurship. What was that transition like for you? Do you have any advice for people who might want to follow that path?

Widdoes: Well, I would just tell them that building a successful company takes a lot of people skills. And if you're a technologist and inventor, you may need to team up with somebody who's got good people skills in order to cover the needs of the company. You need to create a culture that good people enjoy so they stay there and so they're happy and productive. Making a company successful involves much more than simply developing and perfecting a technology. A lot of the smart people that I've seen who start companies think that it's just the technology. There's a lot of company building that's necessary to give a positive return to investors and make a company that you can look back on as a success. That's one thing I would say to inventors - you've got to cover the people side. I was fortunate to have good mentors in that respect. At Logic Modeling, Renn Zaphiropoulos, [founder and CEO of Versatec], was a wonderful mentor for me on the people side. He had monthly one-on-ones with me, he gave seminars for the whole company and he taught us all how to treat people and how to build a great company. I learned a lot from him.

Stump: Do you see these days in electronic design automation the same tendency for companies to be formed around technology the way they were in the early days of EDA? Or have the founders changed it all?

Widdoes: Well, the world is different now. [Although there is far more money spent on EDA today than in there was in the '80s, there is substantially less innovation today, and fewer promising new EDA companies. These days, it is much harder to get the customer base to adopt new technology.] Outside of EDA, there are a lot of new companies based on new technology, a lot of good companies. But there are also a lot of companies that are based on new approaches to marketing existing technology. And some of the most successful are based on that approach. Take eBay, for example. eBay is a very successful company that started out with a system that would send email telling you that somebody had junk for sale. To me, that's a marketing-oriented company based on old technology. And there are a lot of those, some very successful. That's not my orientation. I'm a technologist. I like to build new technology and see where it goes. But some of the biggest investment successes have used existing technology and have innovated in marketing.

Stump: Do you ever think about how much the EDA industry that you helped found has affected the semiconductor industry and how much semiconductor industry revenue depends on that?

Widdoes: I do. And that's actually why I joined the Board of the Computer History Museum. The Computer History Museum had been collecting a lot of computer stuff, but there wasn't much EDA history being collected. And to me, those two things [computers and EDA] are married to each other. You wouldn't have any of the advanced computers we have today without the EDA tools that have been

developed. And, of course, as the computers get faster, we're able to build better EDA technology. So the two things are synergistic. So now, the Computer History Museum wants to make sure that it collects the EDA history as well as the computer history.

Stump: All right. Is there anything, Curt, that I've forgotten to ask you?

Widdoes: I don't think that there is. I think we covered my history pretty well – SCALD, then Valid, then Logic Modeling, then 0-In. Currently, I'm retired. I'm an investor. I live in the San Juan Islands in Washington State and I have five wonderful kids. The youngest of my kids is 19 and in college. And I'm very happy with the contributions that I've been able to make in the EDA world.

END OF INTERVIEW