
# LSI Logic Oral History Panel

Robert N. Blair, Wilfred J. Corrigan, James S. Koford,
and Robert M. Walker

Moderated by:
Doug Fairbairn

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**Fairbairn:** Well, good afternoon, this November 30, 2011. We're here with some of the early founding team of LSI Logic. LSI Logic is a semiconductor company founded in 1980, and still in 2011 a growing and vital concern in the semiconductor industry. We'll ask each of the participants to introduce themselves, and talk about their background and how they came into the LSI fold, and then we'll go into a more in-depth discussion in terms of how the company came to be, and why it came to be, and why it was so successful in its growth. So first, I'm going to just go down the line here. First off is Robert Blair. And Robert, just tell us a little bit about your background before coming to LSI and the roles that you took on when you arrived at the company.

**Blair:** Okay, thank you, Doug. Originally, I'm from Europe, from the UK. My background originally was in the physics area, and semiconductors. I started out with a company called Marconi that was in the semiconductor business, or thought they were at the time. I then moved to Germany and spent a decade with Fairchild Semiconductor which set up Europe in 1969. They separated from SGS at the time we were representing them. I then went briefly back to the UK for a couple of years, and came to the US still with Fairchild at that time. Got to know the Fairchild US team. And then after Wilf left, then I followed some of those folks across to LSI in 1981.

**Fairbairn:** All right, so you came through the Fairchild path.

**Blair:** I did. I spent a decade there, and most of that was in Europe. And most of that was in Germany.

**Fairbairn:** A common path for many people in the semiconductor business.

**Blair:** Right.

**Fairbairn:** Okay, Wilf Corrigan, the founding CEO of LSI Logic. Wilf, you have a rich and varied background, but why don't you sort of boil it down and tell us how that led to your taking on the task of founding and growing LSI.

**Corrigan:** Well, I left England when I graduated. In fact, I still hadn't gotten my diploma. I didn't stay around for that. And I went to Transitron in Boston, who at the time was number three in the semiconductor industry.

**Fairbairn:** What year was that, Wilf?

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**Corrigan:** 1960. I only stayed there six months. And I'm a chemical engineer or was. And so I moved to Motorola in Phoenix in the materials department, making raw silicon and so on. And in '63, they made me the Transistor Division Manager. And then, which I did until '68. And in '68 we had this notorious move from Motorola, which is called "Hogan's Heroes," if you remember the TV program of the time. And C. Lester Hogan came to be the president of Fairchild. And I came with him. In '70, Hogan moved me up to be the General Manager of the Semiconductor Division of Fairchild, which was about 80 percent of the business. And then in '74, they moved me up to the CEO of Fairchild. And I stayed in that position until '79 when we had a hostile takeover by a company called Gould. And at the time most of the stock options in the company were at ten to fifteen dollars. So we were finally able to find the White Knights. And so we got a price of $66-a-share from the oil field services company, Schlumberger. And once that was done, it was obvious to me that I really was not going to fit with the oil field services guys who were a combination of French guys and Texas Roughnecks, neither of whom knew anything about the semiconductor business. And [Jean] Riboud, who was the Chairman, said, "Why don't you borrow my plane, and go and visit some of my guys in Texas and Louisiana and so on?" Which I did. And I went to various oil men's clubs with these guys, and I asked all of them the same question, "Why do you want to buy a semiconductor company? From my standpoint, shareholders came out good, employees came out good, the price is right and so on. Why do you want to do that?" And they said, "We don't." So I said, "So why is it happening?" They said, "Well, because the boss wants to do it. And we generally do what he says." And so that was it. So I said to Riboud, "You know, I don't think it's going to work out. But I'll be willing to stay around for six months," because we had a lot of military business, and we had to set up kind of a company within a company that had kind of an artificial board of ex-generals and so on to theoretically manage the business. So once that was done, I said, "Well, I'm out of here." And they said, "Well, we really would like to get you on a not-to-compete agreement." And as I had a whole bunch of stock options that were going to mature midway through 1980, and I said, "Well, okay." So they kept me at the full salary, and so on. But said, "You don't really need to come and do anything. You just mainly don't compete." So I said, "Okay." So I went to see Larry Sonsini.

**Fairbairn:** Silicon Valley lawyer extraordinaire.

**Corrigan:** Of course. So Larry said, "Look, we'll write it up, but we won't put anything in this about preparing to compete. So you can do what the hell you like. It's only when you actually say you're out there competing." So that was what I did. A year of being well-paid and finishing off my stock options and so on. And I started another company down in LA at that time with a previous friend of mine from Transitron that actually did very well as a private company. In fact, we sold it three years ago. But I also started to piddle around with venture capital. And at the time, Gene White, who was running Amdahl, they were also going to merge out with some other bigger company. And so Gene and I said-- and he used to work for me at Fairchild-- so we said, "Why don't we set up our own venture capital fund?" And we then found Ian McIntosh, who was kind of the English equivalent of Dataquest, and he had just sold his company. So the three of us said, "Okay, let's do a transatlantic thing," because we think there's a lot of European money that feels locked out of the Silicon Valley environment. And we had a commitment for like 100 million dollars from Volkswagen, for one, and we had several others on the line. And then the

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Fujitsu deal didn't work out for Amdahl at that time. And so they had to kind of buy Gene back. So Gene came back to us and said, "You know, they just made me this offer to come back and run the company, because the merger fell through, I'm going to have to back out." And almost at the same time, Ian McIntosh, who sold his Dataquest-like company the previous year, it was starting to get into trouble without him there, so they kind of bought him back. So I'm sitting there with a venture capital team of one. <laughter> And by now I'd talked quite a bit to the venture capital guys. And they said, "Look, why'd you have to come and compete with us? Why don't you start a company, and we'll provide the financing?" So I said, "Let me go back and look at that." So I did. The nice thing was I had plenty of time to prepare. And so I went and talked to a lot of customers. And then--

**Fairbairn:** This was all during 1980?

**Corrigan:** Yeah. So it started to emerge that the custom business is what these customers really wanted. They said, "We don't need another microprocessor guy, we don't need another memory guy." So yeah, that made sense to me. And so Don Bell, who had been the marketing manager of AMI, and I got together. He was a friend of mine. And we said, "Why don't we start a company that will do what AMI does, only we'll do it better." And we were heading down that track. And then suddenly one of the major distributors called him up and said, "Would you be our President and CEO?" And so next thing I know...

**Fairbairn:** Everybody kept leaving you, Wilf.

**Corrigan:** Yeah. So it was-- but by now I was further down the road. And so I went to Bob Ulrickson, and I said, "Bob, I think we need to set up something." We didn't call it ASICs (Application Specific Integrated Circuits) at that time. We called it just "custom." "And you got the connections to the old team at Fairchild." I always thought we did a very good job, and we're on top of that, but it's just the timing was wrong. And so, of course, introduces me back to Rob [Walker]. Then Rob, of course, had all the other connections, and we kind of more or less pulled together the 1970s team, right? So that was really the origin of it.

**Fairbairn:** Okay, we'll get back to sort of pick it up in a moment. Rob, so he came and-- what was your background coming into this, and why did Wilf come back to you to help launch this operation?

**Walker:** Well, thanks, Doug. I'm a local Californian. I was born there across the Bay, and I went to UC Berkeley. And I fell in love with digital circuits and logic design. So clean, so pure, no worries about dB and noise, and all sorts of things. And so I started my career out at Lawrence Radiation Lab, where we built instrumentation for the Atomic Energy Commission. But I realized I really couldn't get very far there without having a PhD in physics. So I crossed the Bay over to Palo Alto, and I went to work for Ford

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Aerospace. And we designed instrumentation for the Manned Spacecraft Center. And along the way we developed...

**Fairbairn:** That was back in the 1960s?

**Walker:** Yeah, and '70s, early '70s. And along the way, the digital integrated circuits came around. And I fell in love with those. And how you use them, how you packaged them, whatnot. And so we actually developed at Ford, a line of plug-in modules, which used as part of them, integrated circuits, both analog and digital. And so I got to know Fairchild, which was the leader in the field. So in the mid-'70s, I went to work at Fairchild. And they were just starting an effort in "custom." They realized that over, say, 100 or 150 gates, the parts would get rather specialized. Instead of just a generic gate, or a flip-flop, it became a counter, or arithmetic logic unit. And then you couldn't at the time really get much bigger, so you couldn't really put a minicomputer on a chip at that time. So you kind of stuck with this gap between the smaller things you could standardize, and the end product, which you couldn't put on a chip at that time. And so we developed first, the first gate-array, 32 gates, bipolar, DTL, as a matter of fact. And then another gate array, this using TTL technology all the way up to 96 gates.

**Fairbairn:** What years was that?

**Walker:** This was mid '70s.

**Fairbairn:** Okay.

**Walker:** But we also had an MOS process. Fairchild had been one of the leaders in developing MOS. And this was developed and we started standard cell development. Again, the first of the standard cell in the industry. And with this we could go up to 1,500 gates. So that we could build a calculator on a chip, for example. And we had chosen P-channel MOS. And unfortunately, it was not as fast as N-channel. And so we were really going down a blind alley in terms of high-performance. And so we got into the custom business. Jim Koford developed many of the techniques that we used at LSI Logic. We developed testers, which became the Sentry Series, the Fairchild testers, a cash cow that carried Fairchild for many years. And but we still had this gap between what we could put on a chip, and obtain high performance. Such that low cost TTL was a good bit faster than we could do, and really no more expensive. So at such time it became apparent that it was a blind alley. We all got out of the custom business, rewrote our resumes and went into other stuff.

**Fairbairn:** So what were you doing when Wilf came back?

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**Walker:** I had just left Intel. Andy Grove and I didn't really get along very well.

**Fairbairn:** What was your role at Intel?

**Walker:** Marketing Communications. I handled all the data books, and all the information necessary to use Intel products. And my background in custom ICs was worthless. Any rate, I was available because Andy Grove had made me available. And so when Wilf called, "Hey, great! Let's go do some "custom" business."

**Fairbairn:** Sounded like an exciting thing. So Jim-- Rob mentioned Jim Koford-- Rob mentioned that he had recruited you to Fairchild. Where were you coming from, and how did you find yourself at LSI Logic?

**Koford:** Well, as a graduate student at Stanford, I had begun to experience Fairchild. You know, we had germanium transistors at the beginning of that period. And I remember once, Ted Hoff brought over these devices from Fairchild, and he had them wired up. Ted used to make things that looked like Alexander Calder mobiles that were actually electronic circuits dangled by power supply wires. And so he had one of these, and he had it on, and he said, "Here, Jim, come put your finger on this." Put my finger on it. "Sst!" "Ted! What kind of a deal is that?!" Most transistors die when they get that hot. Well, of course, it was a silicon transistor. And so I got kind of fascinated, and Noyce and Moore would from time to time come over to Stanford and give talks. So I went over to the R&D lab. And learned a little bit about rubylith, and how ICs were laid out in that period, which would have been mid-'60s.

**Fairbairn:** The R&D lab at Intel?

**Koford:** At Fairchild on Miranda Avenue, back-- it's now an office complex. But it was a great R&D lab. I'm sure Rob would concur with that.

**Fairbairn:** What year was that?

**Koford:** That would have been probably '63/'64. And then after I got my degree, I actually went to IBM in Fishkill. And had the good fortune there to go into initially the IBM CAD group in Poughkeepsie, but finished that project. And I got my own project. And we got an old SAGE display, and managed to get the thing working and interface it to a small computer, and it was probably one of the first graphic systems. And we used it to design little IBM SLT modules, which are the little ceramic packages that IBM used in that era. It was the early years of the 360 family of machines. So it really wasn't an IC design system, but it was graphical and it was similar. And I worked for a guy at IBM named Hugh Mays, who had been a classmate. And I think Rob, you recruited Hugh, too, or someone did at Fairchild, because he went there,

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and then I joined him with another colleague named Ed Jones a little later. And so as Rob says, we sort of put together between '66, and about '73 (when I left Fairchild) that early EDA system that integrated testers and place and route. And my main contribution at Fairchild was to write a logic simulation program called FAIRSIM. I think Rob named it. And I think that was an important thing to do, because when I was over at Fairchild, I remembered thinking back in '63 or so, "You know, there's nothing that those guys need to make ICs that can't come out of a computer." And so the problem of getting stuff out of the computer wasn't a serious one. But the problem of getting stuff into the computer was serious. How do you make sure this complicated net list is correct? And it suddenly dawned on me when I read a paper from a guy named Ulrich at North American Aviation that obviously logic simulation was the key, because now you could make the computer a partner in the design process. And so after devouring that paper, immediately set to work. "Well, we don't have one of these things, so I'll write one." So I designed a little language, and built the thing. And initially it was a little bit of a hard sell, because in those days we didn't, believe it or not, had gone backwards. We didn't have graphics yet. We just had punch cards. And the output was a line printer, so it wasn't a display -- you know, by your standards, Doug, a few years later, it was pretty crude.

**Fairbairn:** This was late '60s?

**Koford:** This would have been-- yeah, I came to Fairchild in the Summer of '66, and so it took me a couple of years to write this thing. And so it was probably late '60s, early '70s. But Rob instantly saw what I was up to. And there was another guy who later became an important contributor to LSI named Rich Derickson, and the two of them really grabbed onto that thing. And so we made the computer a partner. And I knew we'd won when one of the engineers came up to me and said, "Explain this to me, Jim. I did this." Always before it had been, "Your program did this." But when he said, "I did this," I said, "Ah-ha! We got 'em." And so then I left, and Wilf mentioned that we were a little ahead of our time in what we did. I think I was a little ahead of my time. I joined a data communications company that was going to commercialize the ARPANET. I think that was about 20 years ahead of its time. But in any event, that wasn't successful, so I ended up at Boeing designing some data communication stuff. And that's where I was on that fateful afternoon when the phone rang, and Rob said, "Are you sitting down, Jim?" And I said, "Yeah, now I am." And he said, "I'm going to join Wilf Corrigan, and I'd like you to come." And I said, "Huh?!" <laughs> Because Wilf had shut down the ASIC thing. And I said, "You know, I'm pretty happy here. I mean, do I really want to get back into that semiconductor business again?" And Rob said, "Trust me." <laughs> And those who know Rob know he would say something like that. And he said, "At least go out and talk to Wilf."

**Walker:** I said it was your destiny.

**Koford:** Yeah, yeah, yeah. We later recycled that. <laughter> Because of the-- Rob will talk about that. Anyway, so I went out, I guess it was in Los Altos, Wilf had a house down in a kind of valley in Los Altos.

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And it was one of those kinds of fall afternoons that only Northern California can produce. A Stanford football game afternoon if I ever saw one. And Wilf was relaxed. And I told Rob, I said, "I don't know whether Wilf even remembers." "Oh, no, no, no! He remembers you!" And Wilf outlined his idea for LSI, or *the* idea, and I instantly thought it was brilliant. And I think I went back and told Rob that I was hooked. <laughs> So then I joined.

**Fairbairn:** So when was that? Was that late in 1980?

**Koford:** Yes. It actually-- getting out of Boeing was a little bit complicated, 'cause they'd set a lab up for me, and we'd done some things that they liked. So it took me a while to do that. And I think what I told Wilf or Rob was, "Okay, I'll come if you raise the money." Which means technically I couldn't be called a founder, although I examined the business plan, and was at the so-called Founders' Dinner. But technically I really wasn't. But Rob called me, I guess it was in January, Rob, or somewhere around there, and said, "Koford, you've got a problem. Wilf put X-million dollars in the bank last night." And I said, "Oh, God!" But it was certainly one of the better decisions I made in my life.

**Fairbairn:** All right, so--

**Corrigan:** You didn't mention how Ed came.

**Koford:** Oh, yeah, well, I actually stipulated I had to have Ed Jones. And Ed came early. Because Ed wanted to get out of Boeing. Ed was ready to move somewhere else. And so he came to LSI, I think in March. And I was a month or two later after that. Because Ed didn't have any "get out of Boeing" problem. So Ed-- and the initial office was at 3211 Scott Boulevard. I remember that address.

**Blair:** The blue-roof building.

**Koford:** And as a matter of fact, I was working with a little company that's in the same office, and they were always amazed I could remember their address. Well, you know. Anyway, so Ed called me after he was there. I hadn't been there yet. And Ed said, "Well, I hope you enjoy *our* office." And I said, "*Our* office?" So we shared an office. Which turned out to be very good. You know, we worked together and that was fine.

**Fairbairn:** So you've all had a background in Fairchild in one way or another. And all knew each other before launching LSI in one way or another, right?

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**Corrigan:** Absolutely.

**Fairbairn:** And so we don't have the complete founding team here. Wilf, could you just sort of-- who were the other individuals who were, just for the record, were part of the founding team?

**Corrigan:** Well, originally, the manufacturing guy was going to be a guy called Bill Baker, who was a very good wafer fab guy. And then he ran the Isoplanar Group at Fairchild. And he was all enthused to come. And but then when he found out what the starting salaries were going to be, <laughter> he said, "I can't handle that." So we'd already put him as part of the founding team. So I had to get somebody to replace him quick. So but the next guy down in the Isoplanar Group, which was the best fab technology we had at Fairchild, was a guy called Jack Higbee. And he by now was very comfortable with the Schlumberger management. Because he said, "I come in to work now at 9:00, and I go home at 4:00. And I find I like this. That's good. So I'm strictly a 9:00 to 4:00 guy." And so I said, "That doesn't matter Jack. That's okay. If you want that to be your hours, that's fine with me." So finally he said, "Okay, all right. I'll come." And I don't-- he would come to work at 7:00 or earlier in the morning. And leave at 8:00 or 9:00 at night. And so he was the manufacturing guy to start with. And then for the marketing, one of my top guys at Fairchild is Bill O'Meara. And by now he'd moved to a company called Synertek, which was probably one of the few other custom guys in the Valley at that time. And he was the Sales Manager at Synertek. And so I called up Bill and I said, "Bill, I'm starting a company. I'd like you to be the Marketing Manager." And Bill said, "Okay." So he said, "What's this company do?" So I said, "Well, it's going to be custom. But I need an answer really quick, because we're proposing to the venture guys." So he said, "Okay, I'm in." And then he turned around to his wife and he said, "Well, I guess I've just changed companies." I guess it was a week later before he got all the details of what it was going to be. By now we were looking for a finance guy. And I said, "Anyone got any ideas?" And so I had to be very careful who I pulled out of Fairchild at this point. So Bill said, "Well, you know, the guy that's our finance guy here at Synertek is Mick Bohn, and I know he's not too happy." And I said, "Well, I know Mick." Because he used to be in the finance department at Fairchild also. So I said, "Okay, let's have him over," and so we brought Mick in. And I didn't know him that well at Fairchild, because he'd been internal audit. But I think that was one of our better decisions. We had a lot of rough corners, but boy, certainly on the finance side, he made a lot of very, very good decisions for us. So, did I leave anybody out?

**Walker:** Nope.

**Fairbairn:** So several of you have mentioned the issue of timing. Rob, you said, "We were doing the stuff in custom at the time, but it just wasn't the right thing at the right time."

**Walker:** That's right.

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**Fairbairn:** And so forth. So here we are, we're late 1980. Wilf, what made you think this was the right time, and what were you going to do-- what did you envision that was different than what this thing, this same operation you shut down a few years earlier at Fairchild?

**Corrigan:** Well, you know, that was the calculator business. And I don't think anyone's ever given the calculator business the seminal position that it should have in semiconductor history. Because you had Fairchild was coming at it from the standpoint, "Every calculator manufacturer wants to have his own custom architecture." And you had Sprague and TI were saying, "We're going to make a standard chip." Intel was trying to find some other way of doing it. And their solution was, "Well, we'll have something," I don't even think they called it a microprocessor in that time. I think this was before the 4004, actually. "And what we'll do is we'll software program it, and everyone can have their own system, but it's the same chip." And so that really was the genesis, I think, of the PC business. And then TI said, "We're going to do just a standard chip." And of course, all of these customers that told us, "We have to have our own architecture," said, "Well, that was true as long as nobody had a standard chip. But now the standard chip exists, we're all going to have to go to that." And so it was almost overnight. But meanwhile, Fairchild was left with a custom capability; Intel was left with the genesis of the microprocessor, which ultimately became the PC. So that was a very important point in history, I think. But I think what I saw, first of all, in the late '70s, the general wisdom on the semiconductor business was all the semiconductor companies that will ever exist are alive today. And from here on out, with the Japanese competition, it's just going to be consolidated. It's going to be impossible to start a semiconductor company. And then after I talked to the major customers, said, "Well, I don't know. Maybe there's a niche here with the custom. The custom type of circuitry, none of the big guys want to do it." And I knew what this team was able to do in 1970, and when Robert and I looked at what was available, really, I mean, for example, the simulator, FAIRSIM, our first approach was to try and license that from Fairchild. And by that then it was almost ten years old. It was still far and away, the best simulator available in the industry. So the CAD capability was frozen in time. Nothing had happened in ten years in CAD. Meanwhile, Moore's Law had happened. And we didn't call it Moore's Law at that time, but you had this doubling every two years or so. So suddenly what was developed as a system for maybe 1,000 gate system, could be 5,000, 10,000 or more. And so we said, "Hm, maybe that's the way to go." And we were just seeing the beginning of the explosion in different computer architectures. It wasn't the PC. This was like 1980. You still had maybe Apple had started at that point. IBM really hadn't come out with the whole idea of the personal computer that they would license other people in the architecture, and so on. So every minicomputer company wanted to do its own thing. And they all wanted to do it with some portion to be custom. And they're all looking at microprocessors. And generally, at that time, whether they were Motorola microprocessors, or Intel microprocessors, the peripheral circuits were like pollution controls on an engine. So that they kind of slow down the microprocessor. So somebody who's building a minicomputer with a microprocessor at the center, could actually develop a totally different performance computer, just by maybe half-a-dozen peripherals. And then, of course, we could see that companies like SUN were kind of in the genesis period, and they really wanted to do the whole thing themselves. And there wasn't anybody able to respond to that. And I think the other thing that really drove us was what's called the VLSI program, where sometime in the mid-'70s, the government said, "One micron," they wanted to drive the technology, and

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they said, "We insist on most military programs have got to use sub-micron technology," which was probably ahead of its time. But the real problem there was nobody could design too well with this stuff. And so there was lots of opportunities burgeoning for-- you know, I showed you the-- we thought we'd be doing the mid-20 million in five years time. Wasn't too ambitious. So we thought we could certainly find a niche like that. But the reality of the 1980s was you had an explosion of computer-- of system companies, whether they were computer companies, ultimately PC companies, the five-and-a-quarter-inch disk drive companies. So it was obvious that there was a lot of stuff bubbling up. I don't think we had a clear marketing [plan]. We knew we had a capability. I don't think early we said, "These are the different markets." That's why we started with ECL. Because at that time, Motorola was in deep trouble on ECL. And again, they were using gate arrays. And so we looked at that and said, "You know, we could knock off the second source of the Motorola gate arrays," and the big computer guys were actually hammering us over the head to say, "Why don't you do this? Because Motorola's got their whole system pipeline screwed up." And so Rob flipped open some Motorola chips, and he saw they didn't have anything in there that had copyright on the chips.

**Walker:** No copyright notice, no nothing.

**Fairbairn:** So you initially-- when you wrote the first business plan, your initial product was ECL, ECL gate array.

**Corrigan:** Well, ECL gate array sold to the mainframe computer industry.

**Walker:** Yeah, that was-- but we also had a CMOS sector, where we were going to start off with second source products, and then move to an advanced product that would be unique to us.

**Fairbairn:** A second source product to whom? I mean, for the CMOS.

**Corrigan:** CDI.

**Fairbairn:** Oh, you were the second source to California Devices.

**Corrigan:** We went to California Devices and said, "Hey, why don't we second source you and we'll pay you all this money, but give you this," I think it was five percent, "Royalty and so on."

**Fairbairn:** Mm hm. California Devices was a gate array company that had been around for some quite some time doing hand-based design, hand-layout and that sort of thing, right?

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**Walker:** Bob Lipp's company.

**Corrigan:** And I remember a year later, Bob Lipp, I saw a quote where he said to his marketing guy, "Why is it that LSI Logic is doing four times our revenue on our designs?" <laughter>

**Koford:** That's another thing that happened, too, that Rob can comment on. In this whole period, TI threw us a forward pass that we caught with the TAD-20.

**Walker:** TI had a--

**Corrigan:** I think that was about a year later.

**Koford:** Yeah, but it was sort of in this period.

**Walker:** They had a custom product that was bipolar. TI, like most semiconductor companies had these two separate groups that really didn't talk to each other. The bipolar, and the MOS people. And they would have competing products. And the bipolar people had come up with a scheme to hold the power down in a bipolar gate array, which unfortunately, had no noise immunity at temperature extremes. And so the customers kind of found that out, and then TI found it out, and they killed the project. Leaving all these customers who were planning on using this gate array without anywhere to go.

**Corrigan:** That was a year later.

**Fairbairn:** Okay. Yeah, let's back up now to sort of getting the company off the ground. So Wilf, when you went to the venture capitalist, you proposed a plan that called for gate arrays?

**Corrigan:** It was an ECL gate array company.

**Fairbairn:** It was an ECL gate array company.

**Corrigan:** I had good relationships with all the major customers at Fairchild, we were the main supplier to Burroughs, Univac, all of the major computer guys with gate arrays, which were ECL gate arrays. But I knew we couldn't knock off the Fairchild gate arrays. The only other guy in the business was Motorola. And I'm just looking at the date here, 1980 and '81 was a real down year in the semiconductor business, and the computer business. So suddenly, Motorola problems disappeared as the demand slowed down,

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they had no trouble meeting the customers, they were desperate to meet the customers' needs. And so we got the company funded on the basis it was an ECL gate array company, and, "Look at all these commitments I've got from the mainframe computer guys," and by the time we were ready to service them, they said, "Hey, sorry guys, we don't really need you now. Motorola is supplying everything. It's going to cost us a lot of money to qualify a second source. So forget about it."

**Walker:** "And in addition, we're about to go out of business ourselves."

**Corrigan:** Yeah.

**Fairbairn:** The computer companies.

**Walker:** If you think back to these guys, they were mainframe and minicomputer people and they were a few years later, they were out of business.

**Fairbairn:** Okay. Robert.

**Blair:** If you come back to California Devices for a minute, the LSI CMOS business plan was based on two-layer metal process for the simple reason that that could be as fast as TTL. So ultimately, we had to replace the TTL that Rob was talking about earlier. And two-layer metal could do that. Single-layer metal couldn't, ’cause it was one poly, one metal, and it's too slow. So the California Devices stuff was single-layer metal. But before Rob could get the two-layer metal product built, we used the California Devices product line as, "We got a product line." It was something to go out and sell, even though it wasn't where we were going.

**Fairbairn:** But so how much money did you raise, Wilf, in the first round?

**Corrigan:** Six million.

**Fairbairn:** Six million. And that six million was raised purely on the basis of ECL. Did you mention CMOS?

**Corrigan:** Oh, yeah, we said, "That's our plan further down the road," and so on. And then finally when we got our act together, ’cause we hired away the key people out of Fairchild for this, right? So we had a great ECL design team, and so on. And when we finally had our act together, we said, "Okay, we'll go around now to the customers. Last time I talked to them, desperate for us to be in the business." And so

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we did around the country trip, called on all the key customers, and customer after customer said, "You know, that was true six months ago. But we don't need you anymore. It's slow time. So and so." And we all got on the plane in Chicago, I remember, and when the plane took off we were an ECL company supplying to the mainframe computer industry. By the time it landed, we were a CMOS company selling to the Winchester Disk Drive business. And the reason for that was a good one, because the semiconductor was a hard sell to the mainframe computer guys. Even the minicomputer guys -- because they were mainly electronics guys didn't really believe you could simulate stuff, didn't believe any of this. But remember at that time there was an explosion of five-and-a-quarter-inch disk drives. Really copying our local IBM facility. And lots of disk drive companies. And all of them had the same problem. They got a five-and-a-quarter-inch disk drive, and they've got a circuit board that's this big. So that's the form factor of their product. And so we went to them, and the guys who ran these companies were mainly mechanical engineers, not electronic engineers. And we said, "You know, it'd be real easy for us to just shrink this down into CMOS, and by the way, there's going to be no power. You'll be able to put your finger on this CMOS chip, and it will hardly be at room temperature." And they said, "Really? You really can do that?" And we said, "Yeah, we can do that." They said, "Okay. How much does the R&D cost? Fine, okay. What's the ultimate price going to be? Fine, that's okay." And we were in business. But when that plane landed, that was the business we were in. And you know, I don't ever remember telling the venture capitalists that we'd really changed the strategy. And it went very fast from then on.

**Fairbairn:** So let me back up. So Jim, when you were-- you sat down and you said, "This is interesting." So you thought this was an ECL gate array company, and you were going to develop software for the users to use, that was your task. Tell me about what role that played and sort of what part of the strategy that...

**Koford:** Well, we knew at the time that we had to get this thing in business pretty quickly, vis-à-vis the design system -- because that was the gating item. And it's true it was an ECL company, and but we could make-- we felt, anyway, we could make the CAD system relatively agnostic in the core. Now there are certain peripheral functions that are different, obviously, with the two technologies. But fairly early on, a guy named Ven Lee joined us, who had been at IBM, I believe. And Ven was very, very high on what was called HCMOS at the time. So even though some of the good chip designers that we had hired from Fairchild, in particular a guy named Dan Wong, had actually done an ECL library, and Jonesy and I were working laying out and simulating those ECL parts, I remember that at the time we began to drift to-- sort of have to support both. Which is essentially the period during what Wilf has just been describing what was going on. And it was fortunate that we-- that both Rob and my strategy was to be somewhat circuit agnostic in what we were doing. And so a lot of the infrastructure that we put together at that time, could be ported to CMOS fairly quickly. And in those days, there were some advantages to CMOS. It was actually, in a way, a little easier. Of course, you didn't have the thermal problems in those days. And so as I remember, we just sort of swung it over. But since we had, you know, clearly we're starting as an ECL company, but it wasn't too long before we were all watching CMOS. Of course, it's true, at the time, CMOS had the reputation for being, you know, "That's what you make watches out of. It's slow and klugy and doesn't work very well." But by the time we got onto the slightly more advanced technology nodes, it

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was clear that HCMOS was going to be big. And you know, then I got to thinking about big IBM mainframes with water cooling. You know, you used to have to run water through the packaging system to cool the things. And great big bus bars. They even had problems in the power supplies which would develop low-frequency oscillations with the regulators and things like that. So I became pretty much an advocate of HCMOS, and I guess if you're an advocate of something it isn't too hard to do it.

**Fairbairn:** So Wilf, you started out, you raised six million dollars. Who were the major VCs that backed you, and was it all VC-backed? Were there any companies?

**Corrigan:** All the usual suspects. You know, at that time, it was really a closed group. So it was like Sequoia, Kleiner-Perkins, IVP. And a couple of the other guys. In retrospect, we didn't need six million dollars. We could have done it with a lot less. And when I've gone over it in history, I could easily have raised three million from non-venture capital sources, and we wouldn't have had to give away 50 percent of the company. Remember, the government cooperated at that time in that we had our six million, and we had 18 or 19 percent interest in the bank. So the main topic at board meetings was, "When are you going to start spending the money?" And I said, "Look, we've got about ten or so software guys. Until they've develop a system, we don't have a product."

**Fairbairn:** So the critical path was the software. That was fundamental to your launching the business.

**Corrigan:** So we still had six million at the end of the first year.

**Fairbairn:** Because interest was generating enough to--

**Corrigan:** The $100,000 a month interest was more than enough to keep us fed and so on.

**Fairbairn:** So what was your manufacturing strategy? You had a strategy for ECL. So how did that evolve, and what was your...?

**Corrigan:** Well, the strategy was, "We'll do metallization," which is a much cheaper part of the fab. And we'll also find other-- because at that time-- see 1980 a real down period in the semiconductor business. There was almost every semiconductor company in the world had excess fab capacity, were almost desperate to supply stuff. And so we talked to most of the big American guys, and but then particularly Japanese guys. And once we got talking to the Japanese guys, suddenly, I think that also accelerated the CMOS, because the three-micron CMOS suddenly we find the magic five nanosecond gate delay, which was TTL gate delay. So once we saw that, it was, "Boom." This was like a huge revelation. And then I was talking to Toshiba, and I knew all these guys, because we'd been negotiating the semiconductor

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trade agreement with them for years, so I knew all the top guys. And NEC, in particular, was a Fairchild licensee. And so there was very easy communication with them. And when the Toshiba guys said, "Well, let's show you what we're doing now with two-micron CMOS," and once you saw two-micron CMOS in the gate delays, it was no contest. And then you could just extrapolate that with Moore's Law, and you said, "Hey, it's all over. Most people don't realize this, but it's all over." But nevertheless, we could break the ice with the three-micron CMOS, and that was-- then we would go at that point.

**Walker:** Before we leave Fairchild, I've got a Fairchild story for you. Fairchild MOS custom. A year or so ago, a young man called me up from Sandia down in Albuquerque, and he said, "I'd like to come visit you. Can I come?" And I said, "Fine." I gave him directions. Came to the house, and we started talking about the long-term reliability of those Fairchild silicon gate Micromosaic arrays, now 15-years-old, right? And so I'm wondering why is he this concerned? And I said, "Well, what is the environment? Do you have temperature extremes?" He said, "No, they're in a controlled environment. There's no moisture." And I said, "Well, they should work. What's the application?" "Well, they're the arming mechanism for our nuclear arsenal." All our nuclear weapons out there are armed with these old Fairchild gate arrays. <laughter> So that gives me pause.

**Corrigan:** We had a lot of stories like that. Like one time we had some series of admirals came to see us. Said, "We need to talk to you guys." And we said, "Okay." And they said, "Okay, so where is your secure room?" "We don't have a secure room. We don't even know what you're talking about." And they said, "Well..."

**Fairbairn:** This was at Fairchild?

**Corrigan:** No, no, this is LSI. So I said, "If we can't talk unless we have a secure room, I'm afraid we're going to have to go someplace else. Maybe we'll go over to one of your military installations." And they said, "No, we don't really want to do that." They said, "Okay." And this admiral says, "I'm going to declare this room a secure room." And we said, "Okay. So what is it you want to talk about?" And he said, "The US submarine fleet cannot leave port until you finish this design." <laughter> And I think we were only a couple of weeks late.

**Walker:** Yeah, we later developed a classified design facility and cleared our people.

**Fairbairn:** Yeah, I want to get into the military thing, because I think that's an important piece. But let me make sure that we've got the right-- so I just want to make sure that we have it clear. So you raised the money on ECL, "We're going to do custom. It's going to be ECL. And we're going to have new innovative design tools, and we're going to get the customers to do their work."

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**Corrigan:** Yeah.

**Fairbairn:** Is that sort of the key? And, "We're going to use somebody else's fab to do the core wafer fabrication, and we're going to do metallization."

**Corrigan:** Yeah.

**Fairbairn:** And that was the core strategy proposition that you launched the company on, is that right? Sort of covered that?

**Corrigan:** Yeah.

**Blair:** Plus from beginning to part on the table was going to be 12 weeks, not 12 months.

**Fairbairn:** And so what was different from whatever existed at that time was faster turnaround time, user-friendly design tools, that they could actually do the design themselves with simulation and all. And what else?

**Walker:** Mostly attitude.

**Fairbairn:** Mostly attitude.

**Walker:** The people that had the good technology, wanted to be in the standard product business. They would do customs, but very reluctantly. They wanted to build high-volume standard products. The people that were in the custom business mostly had very poor technology. Old, several years old. But we were unique in that we had Toshiba technology. And we were only in the custom business, so we wanted their business.

**Blair:** We coined the catch phrase to go along with Rob's customer-generated testing design of, "First time right." Meaning that if it passed this simulation test, it was a pretty strict, here's the rules. There are no other rules. You don't do it your way; you do it the LSI way. If you pass the LSI test, we're willing to say it will be first time right. And if it isn't, we'll pay for the fix. So the first time right in 12 weeks was pretty dramatic at that point in time.

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**Corrigan:** Nobody believed that simulation really worked. I remember with Univac, I was very close with Univac. I'd been doing business with them for years, and we had a meeting with them, and they said, "Yeah, we'll give you business. But what we want you to do is before you actually make the circuit, you've got to make a hybrid. So show us where's your kit of transistors and diodes and so on where you're going to make us this hybrid." And we said, "We don't need to do that. We believe in this simulation. We'll be able to do the simulation. That's the whole point." They totally disbelieved. And these are computer guys who did not believe in a computer.

**Walker:** Who shortly thereafter went out of the computer business. A bunch of incompetents.

**Fairbairn:** Okay, so you...

**Koford:** But there's one other thing that we did that I think is very important is we really did automate as much of that design process as we possibly could. The simulation was the entry vehicle, and it was the design verification vehicle. But then the database from the simulation went on to the layout system, and went on to all the other parts, and it was all checked against that. Now, in any real operation, it wasn't totally automated. We had some people in the back room who were fantastic. Dotty Heim in particular. But the whole idea, Doug, was to make the design process as easy and as foolproof as possible. And I think all of us just seemed to be on that sheet of music in LSI at that time. "If there's a hole in this thing, let's put it in the software, so designers can't do this. And the software won't let them." And so that caused us to develop a design environment that if you followed Rob's rules, which were documented, too, which were very carefully documented and taught, you got parts that worked. You basically were guaranteed to get parts that worked.

**Walker:** We were doing a design a working day at our peak. You got to have strong rules.

**Fairbairn:** I'd like to move now to talking about you have these ideas. You have a minimal team onboard. You went out and talked to some customers and found out that, gee, what you expected isn't quite what you thought. So I want to now talk about, "How did this evolve? Where did the initial customers come from? What did that very first customer look like? And if not that one, what were the customer or customers that really put you on the map and put you in business?"

**Corrigan:** The military. I think it was Hughes Aircraft.

**Fairbairn:** So hold on. The plane ride back where you changed the business plan, when was that?

**Corrigan:** That must have been early '82, I would think.

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**Fairbairn:** So you went through '81, no-- you didn't ship anything? Is that...

**Corrigan:** Basically, I don't think we shipped anything.

**Blair:** Not in '81, I don't think.

**Corrigan:** Well, except the CDI chips.

**Fairbairn:** Okay, so you had started doing some CDI second sourcing?

**Corrigan:** Yeah, and also we did a couple of licensing deals. We licensed a number of people on our early software.

**Koford:** We did ship something. Yeah.

**Fairbairn:** Okay, Jim, what did you ship in 1981.

**Koford:** Well, what we said about Mick Bohn is, "If you got it, Mick will sell it." And so we sold software to people. And I think we did some of that in the first year, Wilf.

**Fairbairn:** Some of this software that you were developing, that...

**Koford:** Yeah, yeah, yeah.

**Corrigan:** Oh, in fact, we persuaded the distributors, we even sold software to the semiconductor distributors so that they could resell it.

**Fairbairn:** What did a software package consist of, and how much were you selling it for?

**Koford:** Well, we had something that sort of worked. We had something called LDS-1, and that was enough.

**Fairbairn:** What was in that package?

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**Koford:** Well, it was essentially a manual version of what we had later. I mean, some of the things, it had a simulator, it had...

**Fairbairn:** Schematic capture?

**Koford:** Yeah, and it had a program that was called "The Design Verifier," which did the delay prediction. And the simulator we were using, because we wanted to get the thing running quickly. So rather than develop another simulator, when we couldn't get FAIRSIME, we chose a simulator that was available on the market. And the company called TEGAS. And the company that did that put in the capability for back-annotation. I think it was the first-- it was called TEXSIM [ph?], and I worked with a Bishop Brock [who had developed it]. And I thought that was really neat. And in the meantime, Rob was characterizing the cells, which is another story. And I was able to take that characterization data and compute the delays and the performance of the cells and then back-annotate the simulator. So with that running, you could do simulations which were using reasonably accurate [delay] numbers.

**Walker:** TEGAS was famous, in my view, because the simulation control language contained no conditional statements. If you wanted to do something 50 times, you had to write it 50 times.

**Koford:** I spoiled these guys. Because I put a compiler-like language in front of my old simulator.

**Walker:** Many, many years early.

**Koford:** Which could do loops and branching and it could do conditionals on the state of the logic network. So you could say, "If A equals 1, where A was not a defined variable in language, it was a signal state." So you could run through a logic network conditionally as the simulation control language was running. And that turned out to be something pretty valuable at that time.

**Fairbairn:** So when you said you sold your system, you were actually reselling TEGAS along with some other software...

**Koford:** Yeah, we had licenses to do all that.

**Corrigan:** I'm trying to think. Did we use Silvar-Lisco for the layout?

**Koford:** We went through a sort of abortive Silvar-Lisco period, where we were going to use that for the layout, but for various reasons, which I won't go into, that didn't work out. But we had enough of it

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working, that that front end was useful, people could start designs with that front end, you know, the TEGAS and the delay predictor. And there was enough of the layout system. And there was interface with the CALMA environment, so LDS-1 was enough of a system to actually, you know, if you know what you were doing.

**Walker:** Good old working silicon.

**Koford:** Good old working silicon. And then the one with back annotation that allowed a much more effective automatic delay prediction, was called LDS-2. And Rob always said, "Well, LDS-2 is LDS-1 that worked." <laughter>

**Walker:** But as to our first customers, they were Wilf's friends.

**Fairbairn:** So you're going along, who was that first customer? Did you ever get a customer to design an ECL circuit? Or did you ever only do CMOS in actually customer designs?

**Walker:** Yes. Fairchild Systems did an ECL design which worked, which they put in their Sentry System. And our first customers were these flakes Wilf brought in. <laughter>

**Fairbairn:** Okay, Wilf, who did you bring in?

**Corrigan:** Well, this was, you know, Halfon Hamoi, who had been an applications manager at Fairchild, and he had-- what was the name of the company?

**Others:** 3H.

**Corrigan:** 3H.Industries

**Blair:** They were brothers.

**Corrigan:** And he just wanted to give us the first design. It's a little bit like when you're buying things in the East. If you're the first customer of the day, you can always negotiate a much better deal. It's the same idea. The other way around, he just wanted to be the one that would have the notoriety of giving us our first design.

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**Fairbairn:** And when was that?

**Corrigan:** That would have been either late '81, or very early-- might have even been the middle of '81.

**Koford:** It was after we'd moved down to Milpitas, I think.

**Corrigan:** Yeah.

**Walker:** Yeah. At any rate, he had three circuits he wanted to integrate. And I took a look at them, and one of them could be done with an MSI part, standard MSI part. So I started to explain to Wilf this was a very bad application. <laughs> He says, "Shut up!" This is going to be our first order, and I'm there saying, "This is a bad application." <laughter> So.

**Fairbairn:** So you took the order.

**Corrigan:** We took the order.

**Fairbairn:** Did he enter the design using the software? Or did you enter the design?

**Corrigan:** I think we did the whole thing.

**Walker:** Yeah, yeah.

**Fairbairn:** So you didn't have to put the software in the hands of the customer.

**Koford:** There wasn't really much to it.

**Walker:** Yeah, it was very simple. <laughs>

**Corrigan:** But the important thing was his VP of Sales, and Founder of 3H also had been my sales guy at Fairchild for years. And so we could use him as a reference. And then after that when a customer said, "Do you have any customers that we could talk to?" And I said, "Yeah, this is the guy you talk to at 3H," and so on, and then he'd give a glowing testimonial without revealing it was three MSI circuits. And,

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"Worked right the first time, it's beautiful, production's great," and so on. And then after about three months, he said, "Look, please, could you find another customer that could give you reference?"

**Walker:** That was John Duffy.

**Corrigan:** Right, yeah.

**Fairbairn:** And was this a CDI gate array?

**Corrigan:** No, no.

**Fairbairn:** This was your own...

**Corrigan:** I don't think so.

**Walker:** I think it was our version.

**Corrigan:** It might have been a CDI.

**Fairbairn:** Your version. So a single-level metal.

**Corrigan:** Yeah.

**Blair:** Yeah. It's a pretty slow application.

**Fairbairn:** Okay, so we're into '82. You've managed one customer. How are the investors feeling? Is this sort of...

**Corrigan:** Oh, they were feeling pretty good. And by that time we actually made a deal with Toshiba. And remember, that's another story.

**Walker:** A big story.

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**Corrigan:** We were going to make a deal with Fujitsu. And Fujitsu-- don't know if you ever dealt with them, but certainly in those days they were run by a guy called Dr. Yasufuku, who was a very intransigent Japanese. I knew him, actually. And so we talked to him. And we said, "Okay, well, we're willing to do a second source deal. You've got to make the base wafers for us. And then we have the two-layer metal. You'll be second source, and we'll transfer the software to you, and we explained the strategy, that we would put the software in the hands of the customers," and he said, "Well, you know, if you do that, you're going to be very successful." So I said, "Well, why haven't you done that?" Because they had software. I don't think it was as good as ours, but it was actually reasonable source software. And he said, "No, we couldn't do that. It's too valuable. We wouldn't expose ourselves to it, but we do realize that if you're successful in exposing your software to the customer, and putting it in the customer's hand, you have to win in the marketplace." So this seemed like a very strange sort of rationale. And so I sat there with them for about six hours, and I thought, "I'm not getting anywhere with this negotiation at all." And after about six hours, one of his guys got-- they just conducted everything in Japanese. Very occasionally communicated with me. And finally they came over with a piece of paper and said, "There." And it was an agreement. And signed by Yasufuku. And by now I'm starting to say, "I'm not sure this is going to work with these folks." And I said, "Well, I'm going to have to think about this. This is very important to us, so I'm going to have to think about this." And then the next day, I visited Mitsubishi, and they were also going to do a deal with us. They were a little bit more flexible. And then the third day I went to Toshiba. And I met Kawanishi, that I'd never met before, who was the top guy. And totally different environment. There's all these guys there. It was like a US startup. The younger guys could chip in and they could argue, and have ideas. And I thought, "Hey, well, this is interesting." And then he said, "Well, let me have our technical guys come and present to you our three-micron CMOS, and this is what it does." And of course, it easily did the five nanosecond gate delay, which is our main criteria. And they said, "But let me show you what we got right behind that, which is the two-micron." And the two-micron, I think it was two nanoseconds, right?

**Walker:** Yes.

**Corrigan:** And I said, "This is, oh!" So I get back to the hotel, and the guys at the other end-- this is like a very crucial thing for all of us-- and I said, "Guys, I think we're going to change the strategy here." 'Cause they're all waiting for me to tell them that I've got the Fujitsu deal. And I said, "Yeah, I do have the Fujitsu deal, if I want to sign it. But I think I got a better deal, which is Toshiba." And they're saying, "Toshiba?" At that time, they knew nothing about Toshiba. And I said, "Believe me. Just trust me. This will be better." And we had an agreement with Toshiba that was about four lines on a piece of paper, which governed the whole relationship for years! And I'd say it was the most successful relationship of that kind I've ever experienced. And most of the guys involved felt exactly that way.

**Walker:** They had the best CMOS process, hands-down, in the world, and we had the best of everything else.

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**Corrigan:** See, CMOS at that time, I think even Intel was still not on CMOS. They were N-channel and P-channel, NMOS and PMOS. And CMOS was regarded as toy technology. "It's okay in a watch, or a toy. But you wouldn't do serious computing with CMOS."

**Walker:** Too slow.

**Corrigan:** Yeah.

**Fairbairn:** So when did you sign this agreement with Toshiba?

**Corrigan:** I think that was right at the end of '81. And so that was-- you know, they gave me samples and so on. And so we said, "This is the mother-load here."

**Fairbairn:** So going into '82, you had some software that was kind of working, you could sell it to people and so forth. You had an agreement with Toshiba. Had you actually designed your own gate arrays at this point?

**Corrigan:** Yeah, oh, yeah.

**Fairbairn:** So that had been going on for a few months.

**Koford:** I think we delivered and LDS-I to Toshiba about that time, too.

**Corrigan:** Yeah.

**Koford:** So we did...

**Fairbairn:** It was part of the agreement.

**Koford:** Because the software deal was part of that.

**Walker:** But you know, Doug, how easy they are to design. I mean, the base arrays go...

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**Fairbairn:** Yeah. Okay, so you're going into '82, you've got this first customer doing a few MSI circuits that provide you a reference, but it was hardly a major-- didn't exactly put you on the map in terms of LSI integration. So where did the momentum build? What was the first major customer? The thing that kind of really said, "Now we're really in business."

**Corrigan:** Two things. The Winchester disk drive, because it wasn't just one guy. You know, there were disk drive guys across silicon valley. And of course, our strategy, which we didn't really mention up to now was we realized in talking to the military people, which wasn't that much different actually, when we delved into it with the-- I mean, traditionally what you'd do as a major standard products guy, you're almost doing a custom circuit as a favor. And because they're big computer companies, and they got big volume. And so you charge them a very nominal engineering fee. It had nothing to do with what your real cost was. You would-- like we had a big ECL design department, and that would be X-millions of year of cost. And we'd just go out and get designs, and we'd know that--

**Fairbairn:** That was back at Fairchild, or...

**Corrigan:** Yeah. So someplace in here we got the idea we could actually charge real money for doing a design. And I think we got that idea first from the military guys, who by law, or regulations, they have to bid out the design phase, and then way later, they bid out the construction phase. And so in a lot of cases, they were having trouble getting people to do the designs for them. Because they said, "Well, we don't know whether you're ever going to go into production with this," whatever. We said, "Well, supposing we charged you $300,000 to do a design?" and they said, "Well, we can't really commit to you what the volume's going to be." And we said, "We don't care. We'll do it just for the engineering business." Now reality is once you've done the design, if they get the production contract, they're not going to start all over again and go to somebody else. So I mean, essentially, unless their contract doesn't happen, and they weren't going to do this design anyway-- if they didn't know it was going to happen, you were going to get the production. And so the-- we said, "Well, maybe that applies in other areas as well. And so we then started to test that on customers." And you probably had more experience of doing that. And it was a bit of an alien concept to begin with. But pretty quickly people did that. So a lot of our revenues in the early months were based on NRE.

**Fairbairn:** Yeah, as I remember, the majority of your revenue, at least for the first at least couple of years, was NRE, right?

**Blair:** One thing we did was to, you know, with these commercial guys, as well as with the military guys, as Wilf said, we said, "Well, look, here's the engineering price. If you don't order part one, that's okay. We're not going to feel bad about it. We understand that production didn't mature, and so on," and that was fine. "But if production does mature, and it's only ten pieces, rather than ten-thousand pieces, the price for your ten pieces is this. The price for the next ten pieces is a bit lower than that. And the price for

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the next ten pieces is a bit lower than that." I'm sort of exaggerating. So there was this price curve, so that our gross margin on building just ten of these damn things would be okay from the manufacturing point of view. But if it ever got to ten or a hundred-thousand units, then the price was the ten- or hundred-thousand unit price. But we weren't hung up on pushing the customer for the hundred-thousand unit order before he was ready to place it. We just took a hundred piece order at ten times the price, and delivered that on time at gross margins that were acceptable to the factory. And everybody was happy. So the business model worked very well.

**Fairbairn:** So as I remember...

**Blair:** And we also-- sorry-- we also charged customers for computer time. So when they went into Rob's shop and sat down and started simulating, it was so much per MIP Hour, because we were on mainframes that were four or five MIPS. So you sat on that mainframe for an hour, and then you got charged this much for simulating. And that was a separate invoice on top of the NRE.

**Fairbairn:** So that charge, between the NRE and the computer charges, those were pretty substantial...

**Blair:** And a couple of licensing deals. I mean, we actually went public on NRE, computer time and licensing, not on component sales.

**Corrigan:** Yeah.

**Fairbairn:** Right. And as I remember, you were charging like $1,000 per MIP Hour.

**Blair:** Per MIP Hour. Exactly right.

**Corrigan:** Believe me, we got some designs where we literally got a million dollars for just the computer time alone.

**Fairbairn:** Right. And customers were okay with that? That was...

**Blair:** Ninety percent of them.

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**Corrigan:** Ninety percent. Occasionally, I'd get an irate CEO come in. And I'm saying, "We told you what the thing is," and they said, "But this goddam engineer was sitting on the computer." And, "We didn't know he was burning up money at this rate per hour." And we said, "Hey, that's tough."

**Blair:** We had to give a couple of discounts. But most of the money stuck.

**Koford:** We made sure that the software did very good audit trails which would stand up in... <laughter>

**Fairbairn:** Right.

**Koford:** Under inquiry.

**Fairbairn:** So you started writing the software for the IBM mainframes. Jim, was that an important part of the strategy? Did you envision moving it to workstations?

**Corrigan:** Workstations didn't exist at that time.

**Koford:** We didn't, yeah.

**Fairbairn:** I was wondering whether you envisioned that as a following step?

**Koford:** We did, we did. The strategy did change as the workstation industry matured, but...

**Corrigan:** The other thing Jonesy was nervous about UNIX.

**Koford:** Yeah. Jonesy, by the way, is someone we should mention, because Ed is a truly brilliant guy. And he eventually automated all the layout stuff. And did so, I always felt, very, very, very competently. But the reason we chose mainframes is we look-- you know, from our Fairchild experience...

**Corrigan:** Well, they were cheap.

**Koford:** …was on mainframes. We knew we needed MIPS, Doug. We needed MIP hours. I mean, we were going to do this as effectively a quasi-public operation. And when you looked at the-- you know, the VAX just-- we had a lot of DEC experience in Boeing, and I liked the machine, I liked the software--

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everything about it was great. But the biggest VAX you could get was a MIP. And you know, these three and four-MIP, five-MIP IBM monsters, and also Amdahl monsters, we, you know, were expensive, but they had the horsepower. And as Wilf says, and he's absolutely right, you know, that was the era of Amdahl, and IBM and a couple of other people, in that business. So we had a range of vendors from which to choose. And in fact, we started the company with a [National Advanced Systems] machine.

**Blair:** National Semiconductor machine.

**Koford:** National Advanced Systems machine.

**Fairbairn:** So you got competitive prices between them.

**Koford:** Well, we got very-- well, with Mick Bohn negotiating, you bet we got good prices.

**Corrigan:** And there was an important marketing issue there. Is we had a big glassed-in room, with big monstrous computers in it. And we'd bring a customer in, and he'd say, "Boy, this is no little company. This is serious company, you know, with this big clean room with the computers in it, and so on." At seven gigabytes of memory.

**Walker:** All the engineers wore coat and ties. We looked like IBM. I mean, talk about a façade!

**Koford:** Yeah, you should have seen under that raised floor. <laughs> Poor Joe Z had to move that room, and he came in once and said, "Jim! What in the heck were you guys doing?" Hey, and I said, "Joe, it worked!" <laughs>

**Fairbairn:** So in the original business plan, you did not envision all this NRE as a critical part of the...

**Koford:** I think we sort of did. Bob always felt we could make money on that.

**Corrigan:** We didn't see it as the magnitude. Because eventually when you're handling-- first of all, it was one design a day. And I remember being in one of the Silicon Valley restaurants, and it was in a booth, and there was somebody in the next booth. And he said, "You know, there's this new company, LSI, they're talking-- it's ridiculous-- they're talking about they're going to do one design a day." And I'm thinking, "Boy, that's pretty good. We're getting notorious here." You know?

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**Koford:** But the other thing was, Doug, just to kind of tie a ribbon on this story, I was kind of watching what you guys were doing over at Xerox PARC, and there was something called a 3M machine in those days, a megapixel, a MIP, and a megabyte of memory. And you know, we were beginning to see Apollo's and other-- you know, I didn't like machines that couldn't address memory, but you know, there were getting to be some serious machines. So when SUN got going, SUN Microsystems, I had hired this guy from Stanford, who was a classmate of Andy Bechtolsheim's, Doug Boyle, and Doug brought SUN in. We had serial number 450 of the SUN machines at LSI. And also there was this little graphics company that Wilf and I visited the CEO, named Jim Clark.

**Fairbairn:** Who occupied the building that we are currently in! <laughter>

**Koford:** Yeah, exactly! This was an SGI building.

**Corrigan:** This is one of his buildings.

**Koford:** Anyway, after that meeting, Wilf said, "Jim, you must have really been excited about that! I couldn't get a word in edgewise!" And we got serial number two of Silicon Graphics. So we were moving in that direction. And by the late '80s, early '90s, we basically were able to shut off the mainframes, and we went on to a server farm, and using SUN machines.

**Fairbairn:** Okay, so let's go back to 1982. You got this initial design done. You said you started talking to the military. What were those designs or customers that started generating substantial business?

**Corrigan:** Oh, I'd say the disk drive guys.

**Fairbairn:** The disk drives.

**Corrigan:** Because they didn't care. "You show me that it's going to work, and I can use a box for the disk and that that's about the same size as the five-and-a-quarter-inch disk, and that's fine." And then they all went that way. And you know, Rob didn't talk about-- some time after that, when Digital Equipment came into it. And that was an interesting story. Because again, I knew them pretty well. And I'd been doing business with them since I was at Motorola actually. So I'd known them, even at that time for close to 20 years. And so they gave us the time of day, so that we could go in and make presentations, and so on. Which they did, and they produced the right people. And they'd say, "You know, it's all very interesting, but we couldn't build-- you know, if you got ECL gate arrays, we'll look at it. But right now, we're doing this thing with Texas Instrument," which was I2Ltechnology?

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**Walker:** <nods>

**Corrigan:** So it was polite, "No, we're not going to do that." And then we got the phone call from-- they were down at Dallas, and Texas Instrument had just told them, "We're killing this whole program."

**Walker:** Right. It had no noise immunity. They had so lowered the voltages in order to keep the power down, that it had no noise immunity. And so TI realized it, and pulled it off the market. And DEC is there with all these plans for these custom circuits, and nobody there.

**Fairbairn:** So then they came to you, and you did designs for...

**Koford:** Tell them the story, Rob.

**Fairbairn:** In what technology?

**Corrigan:** CMOS.

**Fairbairn:** No, what two-micron? Three-micron?

**Walker:** Two-micron.

**Corrigan:** Two-micron.

**Walker:** Yeah, two-micron.

**Fairbairn:** And when was this? '82, late '82?

**Corrigan:** Yeah.

**Fairbairn:** So what's the story?

**Koford:** Well, you know, how you guys got that design done, and put Steven Chan on a plane.

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**Walker:** Yeah, well, again, we had to prove ourselves. And so we, for DEC, we did a design for them, I think the first design, which was not associated with the TI fiasco, but the first design, and we did the layout in a day. Julie Chen working around the clock, first layout, and presented it to them. It was great.

**Corrigan:** They had a policy at that time that said they had to get at least two bids on any job that they put out. And so they said, "Okay, we like you guys, but you're going to have to respond to us in two weeks and give us your quote, and then, of course we'll compare it to the other quotes." And so we put our heads together and said, "Look, why instead of giving them a quote, we'll hand them the quote, and we'll also hand them the design, the finished design."

**Blair:** Big plot.

**Corrigan:** We couldn't get them the chips at that time, but we could in two weeks, we could do the design and show them the layout. And so we just packaged that in with the quote, and we said, "There it is."

**Walker:** "It's done."

**Corrigan:** "It's done."

**Koford:** And by then, Jonesy had his act together, you know, in layout, so we were pretty automated. He could pull that off.

**Corrigan:** And from then on, Digital Equipment said, "Okay, that's where we're going."

**Fairbairn:** Okay. So Digital Equipment became a major customer. And at this time you were also starting to gear up with the military folks?

**Corrigan:** Oh, yeah. Remember, it's mainly design, because the military moves slowly. But then also, just before we were ready to go public, which would be a year later, IBM wanted to come out with the PC Junior, and they decided to do all of the peripheral chips would be in our gate arrays. So we were able--then we were going public, which was '83, we were able to show a long list of customers by that time with all very good names. And Bob had most of the big European names as well. But PC Junior was the big deal. Because the PC was a big deal in '83. And the fact that IBM was going to go with us with all the peripherals was big stuff in that offering.

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**Walker:** Well, peripherals. Very interesting story. Intel was really a manufacturing house and a memory house. And they did the first microprocessors they did with a couple guys as customers, by the way. Both 8008 and 4004 were custome jobs. So all of a sudden, the 8080 takes off, but there's no peripherals for it. But all the competition, their competition, wanted rights for the 8080. So they said, "Okay, we'll trade you this. You design this peripheral, and we'll give you the rights to the 8080." And they did that with like ten companies. And so all of a sudden, there's all these peripherals applied.

**Corrigan:** And a lot of them were TTL.

**Walker:** Ah, no. No, no. I'm talking, most of them were MOS.

**Corrigan:** MOS?

**Walker:** They had some drivers, they had some bipolar drivers. Anyhow, these folks were not very good designers either, and in fact, they had a trade agreement that was based on how large the chip was. And they would pay more for a larger chip, assuming it was well laid out. So the AMDs of the world, just made them big. And so, then they were worth more in trade with Intel. So there's all these crappy peripherals out there, and what did the customers want from us? They wanted Intel peripherals that worked , they could integrate several. So we reverse-engineered all the Intel peripherals. We went out and figured out how they should work. We bought some parts. We made a test tape. We plugged it in, got a green light, "Aha! We've got a true second source now, functionally." And so we had reliable Intel peripherals when Intel did not! And then when Intel went into the ASIC business, everybody thought, "Oh, man, they got all these designs!" Yeah, they got them on yellowing blueprints from ten different companies. They don't have them in some neat digital logic scheme. And so we stayed ahead of the game.

**Fairbairn:** So during '82, you were doing all these designs, still not much production. When did the first production, and what was the first production, you know, when you really had-- when it was significant, relative to your total revenue?

**Corrigan:** Our first profitable quarter was in '82. And I think we did a total of five million dollars in '82? It's got it there someplace. And then it grew very rapidly in '83. We got through the first year with the six million not used. But once we got into the second year, we knew we had to put in place a state-of-the-art facility to make the two-layer metal. So we knew we had to do a second round. So I talked to the venture capitalists, and they said, "Okay, we'll give you a three-time step-up." So that the first round, let's say it was a dollar a share. So we'll do a three-times, three dollars a share. And I said, "No, we want ten." They said, "Nobody will give you ten." I said, "Okay, well. Let's think about that then." And so and then in parallel we went and talked to Johnson Controls, which was another guy-- I knew the CEO of Johnson Controls-- and they were an investor in Synertek. So I called-- they're up in Minneapolis. So I said, "Fred,"

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Fred Breneel his name is. "I'm going to be in Minneapolis, I'd like to stop by and see you." So he said, "Fine." We went to his country club, and so I said, "Fred, your competitor, Honeywell, is invested in Synertek. We think that's a crazy investment for them. Synertek is going to fail, for a lot of reasons I won't go into, and it's going to be a difficult thing. But I'm sure that there's got to be people in your company who are going to be saying, 'If Honeywell is doing this, we should be doing it. We should invest in a semiconductor company.'" And he said, "You know, you must have been reading my mail. My board of directors keeps asking me, 'If Honeywell's doing this, why aren't you doing it?'" So I said, "Let me give you another alternative. Why don't you come in on my second round and buy a position. It doesn't have to be big. But if you'd give us a lease line guarantee for ten million dollars on equipment, your total downside is if we go out of business-- and we're not going to go out of business-- you might be stuck with having to resell this equipment, which probably would be pretty new, and you might get a 50 percent discount on it. But I don't think that's going to happen. So that really, all you're dealing is you're backing up some data here for me, and you can invest as much as you like in the second round." So he said, "I like that." So he sent down his CFO to see us. And in fact, that CFO ended up being the CEO of Johnson Controls. And stayed on the board right until 2005. So then I got on a plane and went to England, and started talking to venture capitalists there. And basically, they were willing to come up with the money, as long as the Silicon Valley guys took 25 percent of the deal. So then I came back to the next board meeting, and I said, "You know, I still think we could get a lot higher than three, but I've researched things. And you guys are right. It should be higher than three. I think it should be eight. And I really think we could get a second round at an eight-time step-up." And of course, Don Valentine and Tom Perkins said, "No way. No way. No way." And I said, "Well, look, if you're so sure about that, why don't you just give me a month to see if I could do that. and but if I am able to get somebody else in that you think is a very high price, well, at least would you come in for 25 percent?" So finally, Valentine was a little bit adamant, and Perkins finally said, "Hey, Don. Let's agree to this. It ain't going to happen. So let's do it." And so Valentine said, "Look if you can raise the money at an eight-time step-up, we will erect a statue in your honor," and Perkins said, "And I'll gold-plate it." And I said, "Well, that's good. So get started on the statue, because I've got the other money already." <laughter> I've still got it. The next board meeting, they got a fiberglass stature of Buddha that they've painted with gold paint. <laughter>

**Koford:** It stuck around for quite a while.

**Fairbairn:** When was that? What was the timeframe?

**Corrigan:** That was in mid-'82. So we had enough to go around.

**Fairbairn:** How much did you raise in that second round?

**Corrigan:** We raised ten million.

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**Fairbairn:** Ten million, plus the then million backing from Johnson Controls.

**Corrigan:** Essentially, we had 20 million available, even in debt and cash. So we were in pretty good shape.

**Fairbairn:** Right. Okay, so you then started in earnest building up manufacturing capacity. Robert, you went off to Europe at some point to...

**Blair:** Yeah, after the IPO. The IPO was May '83, by that time I was sort of the international guy, was one of my jobs. And we'd rustled up a couple of orders from a couple of brand-name guys in Europe. They would come over to California to do the simulation work. We scored a big hit with a company called Nixdorf Computer that was trying to replace a bunch of TTL for the German Bundespost. And it was a 3,000 gate chip. And they sent their guy over for a month or so to work with Rob's apps engineers, and get the simulation down to, you know, a fine art. And we built the chip, they signed off on it, we built the chip. No one at Nixdorf, let alone the German post office expected the chip to work. So this was another case of, "We don't trust these simulators, but go ahead anyway. So this chip came out. We sent it over. The socket was waiting on the PC board in Germany for this thing. They plugged it in and, "Oh, my god, it worked." They were blown away. And so just like in the other case, so Nixdorf became a pro LSI customer, and we started to do multiple designs after that. So after the IPO, Wilf's got all this money now, and he says, "Fine, why don't you go and set up Europe using the same model. We want a design center in London, a design center in Germany, a design center in Italy. Blah-blah-blah-blah." So we went and put all that stuff in place. And of course, now Nixdorf had its local design center. In fact, it went further than that. It licensed the LDS software. So it had an in-house design center, because now they were married to doing a whole bunch of designs over the next year or two. So they licensed the software. And so I packed my bags and went back to Europe fulltime for four or five years. And cranked up LSI Europe, basically as a clone of Jim's stuff, and the wafer fab stuff. And another guy, a Japanese guy did the same thing pretty much in parallel in Japan. So all of a sudden, LSI has an operation in Europe and an operation in Japan that essentially mirrors the functionality and the technology that we had in the US.

**Fairbairn:** Let me come back to that in a minute. I want to-- because we're getting ahead of ourselves. So you get through '82, you've raised some more money. Things are starting to click on the design side. You're actually starting to see some production, initial production was from the disk drive? Was that the biggest piece there? You go into '83, and you went public in May of '83. So when did the process for that start, and did you ever believe that you were going to be able to go public so quickly, essentially on design revenue and so forth? So tell me about that process.

**Corrigan:** Well, if you look at the data, you know, and Silicon Valley exploded. We certainly didn't see what was going to happen in the '80s in Silicon Valley. And suddenly, there was dozens of startup companies. I mean, talking to the venture guys in the late '70s, they didn't have anything to invest in. They

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had the money in a lot of cases, but you know, were doing very few IPOs and so on. Suddenly, things started to move, and in fact, your company, VTI was one of the first ones. You were ahead of us on that.

**Fairbairn:** Right. A few days ahead.

**Corrigan:** Yeah, and so we knew that you were out there. And I remember we had a board meeting, and we invited Bill Hambrecht, of Hambrecht and Quist, into the board meeting. And my two major venture guys-- well, there was three of them, Reid Dennis was there as well. Even though he wasn't on the board, he had kind of observer status. So I had the three major guys in Silicon Valley were like sitting in one room. And it was really starting to move, and one of our strategies was to always have our numbers in a form that we could go public, or present the data correctly, even if we only had 30 days notice, or less. So, the big discussion was, "Well, when?" We felt that the IPO window was opening, "When should we do it?" And I said, "I think we should do it right away. We don't know how long it's going to be open." And Bill Hambrecht was there, and Bill, I always remember this, he said, "The ducks are quacking." <laughter> "Oh," I said, "Really?" "Yeah." So I pulled my financial guy out, and I said, "Just excuse me." So go out of the room. And I said, "What the hell is he talking about? The ducks are quacking." He said, "Well, I think he's saying that there's a lot of money out there that's ready to invest in startups." So I go back inside again, and I said, "Yeah, I think we should push ahead with this. I think the opportunity is there. We're going to kick ourselves if we get to the fall and the window's closed, and some of these other guys like VTI have already gone out," and so on. So reluctantly, they all kind of agreed. And so we went out. And we took it public, and that in itself is a whole chapter, I think, and so on.

**Fairbairn:** But you made the decision sort of, "Go for it," when? Late '82, early '83?

**Corrigan:** No, no. This would be in the middle of the first quarter.

**Fairbairn:** Middle of the first quarter of '83. "We're just going to go now."

**Corrigan:** Make sure we get all the numbers, ’cause we only had five million dollars of previous year's revenue.

**Fairbairn:** Right, so you had five million. What was your projection for '83? What did you go out selling?

**Corrigan:** Twenty million.

**Fairbairn:** Twenty million.

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**Corrigan:** And we did that, actually. And they-- but the price, we had Mick Bohn sitting in the lobby of the SEC for about three days. And at that time, from a company standpoint, you could not go upstairs and talk to the guys. You could only talk to them on the telephone. So he camped out in the lobby of the SEC, you know, for three days. And it was starting to get a little tenuous, because, as you know, when you sold the deal, and we had a book that was probably close to 200 million. And remember, this is 1983. That would probably be worth, twice that, three times that today. And it was just being delayed a day-- and each time it delayed, the commitment was coming down. And the price was coming down. And so finally, it did go through. And so we raised about 160 million at $21-a-share. And deal was done.

**Fairbairn:** And this was far earlier than you ever dreamed of when you started the company, right?

**Corrigan:** Oh, yeah, sure.

**Fairbairn:** Yeah, that was some time in the future. So the conditions were just right. You had some momentum. You were able to get out when they iron was hot.

**Corrigan:** In fact, that summer, I know on the road show when we were out there, we got to one of the major potential funds who were going to invest in Southern California, and all on the rest of the road show. They'd all been younger guys across the table from us. And we get to this particular institution, and there's all these older guys. You know, when I say "older" like maybe they're 45, maybe 50. <laughter>

**Fairbairn:** At that time.

**Corrigan:** And so I said to Mike Shannihan, who was the guy running it, I said, "You know, one thing I observe, how come you got all these older guys doing this part of the action, that wherever I've gone, on the East Coast or Midwest, wherever, they're all younger guys? Like guys in their 30s and so on." And he said, "You know, the problem is that we," the top management, "Know that the market is getting hot. And the young guys who've only been with us in the '70s when," which was a very quiet period. "They don't know how to buy. So we had to go back and hire these guys," that they used to call "The Gunslingers" from the '60s, who were the financial guys that were aggressive and so on, "Because they know how to buy." So I'm saying, "Well, what you're really saying is you've decided you're going to buy, right?" And you just want to say, "Yeah, you want backup from the guys with the gun." He said, "Yeah, that's really what we're doing." And so it all went very well. We got the 160 million, and so on. And that summer, I would guess, probably after we'd reported our quarter, we went back to New York to talk to some of the people that had invested. And a lot of them showed up. These are senior firm managers and so on. And we give them our presentation. "This is what we're doing. Actually, our numbers look pretty good." And this one older guy puts his hand up and says, "Could I ask you a question?" He said, "What exactly does this

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company have to do with Gatorade?" <laughter> And I said, "Excuse me?" He said, "I remember we invested, and it was something to do with Gatorade." Right? And I said...

**Fairbairn:** Sounds like a consumer product company, right? <laughter>

**Corrigan:** I says, "This is gate arrays," you know? But I mean, "That's how they were buying in the first quarter. They didn't know what the hell they were buying. They just knew if it's from Silicon Valley, it's got to be something we should invest in."

**Fairbairn:** It's hot. Okay, so when a company goes public, that's a pretty exciting time for everybody. Rob, what did it feel like? You were back there still trying to book orders, and get stuff out. Was this-- you knew fully what's going on?

**Blair:** Well, yes and no. I mean, it was still a pretty small team, right? And it was in one building. And so you'd hear what was going on and so on. But basically, the whole IPO thing, as Wilf said, happened pretty quickly. I mean, it wasn't something that was planned years ago, and we were creeping up this, you know, curve. It all sort of seemed to happen. And the financial guy, Mick, sort of was absent from the plant, you know, floating around New York, and so on and so forth. And then the news came down that it happened. And there was champagne all around. It was Friday, May the 13th.

**Fairbairn:** <laughs> Friday the 13th, huh?

**Blair:** Friday the 13th. And so it was a good day all around, and probably a good weekend all around. And then next week it sort of became a little bit of a different company. I don't remember particularly Monday morning. I'm not saying that. But all of a sudden, we, this small group of people seem to have found a product and a market that's working well, and all of a sudden, we've got all this money. And if it's going to work pretty well in the US, it should work elsewhere in the world. And so right after the IPO, I think the company took on more of a global kind of coloring, rather than just being a Silicon Valley company with some scattered customers around.

**Fairbairn:** Now did LSI go off and raise money in Europe as well?

**Blair:** Oh, we did, yeah. We raised some money in Europe. Not as much.

**Fairbairn:** Through a secondary public offering or a separate, how did that work?

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**Corrigan:** Well, what we did, one of the concerns we have, I mean, everyone's heard of the book, "1984." But people forget about 1992. 1992 was going to be the time when Europe was going to raise the barriers around Europe, and duties were going to change, and there was potentially a very protectionist environment. And so we just said, "We better get some manufacturing capability within Europe, so that if that happens, we can actually do everything within those walls." And also, now that we were kind of a proven success, we said, "You know, guys like SGS and Siemens and a number of other established European companies, are likely to just copy what we've done, get out there, and the customer is not going to realize that we were the originator if we're too slow in growing and becoming a factor in Europe. The fact that we're the originator doesn't count. It's what they saw." So we had a great sense of urgency to grow very rapidly in both Europe and Japan. And we said, "Well, why don't we do that by going the IPO route?" And so we raised a second round of money, so that we could, like Bob in Europe, and ...

**Fairbairn:** So you created a new company, a European subsidiary.

**Corrigan:** In fact, three.

**Fairbairn:** That raised--

**Corrigan:** And the intent was that we were going to go public in Europe, go public in Canada, and go public in Japan. In reality, for a lot reasons, that didn't come to reality. And so eventually we had to kind of like buy out the minority shareholders, and so on. But at least we'd made that next step up. But we did go public in Canada, actually.

**Blair:** But certainly, the important thing from the customers' point of view, even though we didn't actually IPO in the UK or Japan-- or Europe and Japan-- the important thing was the credibility of what we were doing, and the local presence. I mean, European customers only tolerate the nine-hour time difference up to a point. If you're not willing to have design centers and so on and so forth in Europe, where the engineers can get their work done, and where management can come in and kick the tires, and be comfortable with everything, then you're going to be a small player in the market. So basically, our strategy was to sort of storm the market physically, have design centers in all the major capitols, through in some Amdahl's with the glass screen in front, nice front door, name over the door. We now had an IPO behind us, so we were very public in the press. So we had a reputation of rich parents back in the US. And so we got the credibility up. We hired a bunch of pretty good people, all local nationals pretty much. We didn't bring over a load of Americans, with a couple of exceptions. And we just turned up the knob as fast as we could in the local territory.

**Fairbairn:** So Rob Walker, by the way, were you profitable in '83, the year you went public?

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**Walker:** Oh, yeah.

**Fairbairn:** You were profitable.

**Walker:** We had our first profitable quarter in the fourth quarter of '82.

**Fairbairn:** Okay, and then '83 you were profitable. Okay. So Rob, what was your memory of the IPO event, and the effect that it had on the company.

**Walker:** Well, the effect it had on me was to vindicate the approach, the principles that I had come up with back at Fairchild. "Hey, it worked. This is the way you should do it." And I was right all the time. But for the company, it meant increased workloads, more designs, more construction. So we were just growing like topsy. And remember, this occurred-- the first quarter had been like and end of recession. And all of a sudden this comes along as the recession ends. So everything is pointed upward.

**Fairbairn:** You mean the first quarter of '83?

**Walker:** '83.

**Fairbairn:** So everything exploded in second quarter, and things took off. Jim, how did the engineering team...?

**Koford:** Well, we were very, very busy during this period. Because once the IPO was done, as Bob Blair points out, we started installing design centers, literally all over the world. I used to say, "The sun never sets on LSI Logic." Because we had design centers in Japan, we had a design center in England, outside of London. We had them in France, Italy, and Canada. And some of those were very, very major design centers that had-- Bob had an Amdahl mainframe. And...

**Blair:** Yeah, we had Amdahl's in Germany, UK, Paris.

**Koford:** And then, of course, the experience I'd had at networking was useful even though we didn't have any internet or anything. We had our own private network that tied all that stuff together, so that you could send designs back and forth among these various design centers, or among the design centers in the home base, because the final parts of the design were done-- a lot of that work was done in Milpitas. And the other thing was, you know, we had installed these satellite design systems at places like Hughes Aircraft, and Nixdorf, and DEC, Digital Equipment Corporation. And I think we installed some design

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center in Korea. So we had an extensive network. And that began to really keep one busy, keeping all that stuff running, and all of the communication system running. Because once it went down, boy, you heard about it. That was not okay! And I was building up the organization-- I had a guy named Dennis Anderson, who was excellent, who ran all that stuff, we were cranking out a lot of documentation. I had a lady named Patricia Rohrs who did that. Because I always thought documentation-- Rob agrees, I know-- is one of the best labor-saving devices ever invented. Good, clear documentation. And we were-- the customers were beginning to number in the hundreds, if not the thousands by then. We began to put together a Help Desk. There was a lot of this customer support activity that had to be done. And in the meantime, you guys were constantly challenging us. So we had-- you know, I hired a graduate student from Stanford named Doug Boyle, who took over my stuff. And I mean, there's this club around, and that is people who have taken over Jim Koford's stuff, when he goes and does other things. And there are two or three members of that who-- I don't let them all be in the same room with me at the same time. And so we built up the CAD group where we could do test generation, and we did a new behavioral simulator. Another thing that happened, Bob would regularly collect us over in Europe, because he didn't want to be an outpost. And of course, we liked to go to Europe, because Bob always had things for us to do. And one--

**Koford:** There was-- Europe was a fun place to go, yeah. <laughter>

**Blair:** Good restaurants.

**Fairbairn:** Good food; good time.

**Koford:** One time Wilf was there, and we were visiting Nixdorf, if I'm not mistaken in Paderborn. And there's not much to do in Paderborn. And so we went over there, and I remember we were sitting in this sort of hotel room or something, and Doug happened to be over there, because we were installing something that he was responsible for. And we both said, "You know, we want a microprocessor. We want to have a microprocessor at LSI that we can now incorporate it into our product line." And of course, by then, Wilf had built a fab, and we had the manufacturing capability to do standard cells, so why not have a microprocessor? And I think we cornered you, Wilf, and you said, "Okay." <laughs> And so we licensed the Spark and the MIPS microprocessors at that time. And another thing we did was we started a lab at Stanford under Abbas El Gamal, who had been a friend of LSI's. And he brought in a lot of really bright, you know, graduate students. And the reason for doing that-- and you'll get a kick out of this, Doug-- I wanted to make sure I understood all this Carver Mead stuff, and it was important for me to get educated. It was a little vicarious, because I didn't work there. But I thought it was really important, because I thought what you guys-- you know, what the Carver Mead branch of the business was doing was very interesting. And so these guys started developing compilers for us, and other applications. And I think Wilf always thought that lab was a pretty good deal. We got some good people out of it, and we expanded the product line considerably.

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**Fairbairn:** Okay. So Jim, you were just talking about earlier, the thing of bringing microprocessors onto the chip. And this really sort of concludes the stage of the company that I wanted to focus on, given the team that we've assembled here. But I'd like to ask Wilf to sort of carry on. You were with the company for another 20-odd years after the 1983 IPO. And we've talked about how you got to there and what the strategy was. Sort of summarize that position you got yourself to and how., And then just very briefly, if you could, talk about the major developments in LSI after that. Sort of how did this LSI custom gate array focused company evolve over the next couple of decades?

**Corrigan:** Well, you know, the decade of the '80s essentially was dominated by TTL. And even though we switched to CMOS, as far as these trained engineers, and we're talking about how many of them are there? But it was in the range of 100 to 150,000 around the world, this is all they know to design in this. So if you can let the computer do the transmutation into CMOS, so they don't even-- all they know is the power gets much less, the complexity can be much greater, and the design is easy. And you're designing in a methodology that you understand, you know about. So that's really what made the '80s for us. But the '80s in parallel you had the PC coming along, which was the idea of a standard piece of silicon, and you then customize either with peripherals or with software. So you can make your computer look different to the next guy's computer, with essentially using the same core silicon. That was a very important development. And but then we start-- Jim mentioned the microprocessors, originally, because we were very close to SUN, and when Andy Bechtolsheim wasn't too happy with the main design for SUN, he said, "Look, I'll go off and I'll fund my own development of a competitor Spark station. And in a year, if you want it, you can just pay me what money I've got in it, and that can go back in." A year later, the main thing that the army of engineers of Central SUN had been working on really wasn't doing very well, which was designed on Fujitsu gate arrays, they turned to Andy's total design, and suddenly we were at the center of the SUN universe. Which, you remember that?

**Koford:** Oh, yeah, we reverse engineered that Fujitsu set and walked in with a design.

**Corrigan:** And so I think that was typical of the sort of wins that we would get in that time period. But then suddenly that computer becomes a module. And we're very close to SUN, and I'd been talking personally with Scott McNealy. And we had huge trouble. He wanted us to be the core guy. But I think he really wanted to get TI as a big brand name semiconductor guy to kind of force standardization of his architecture. So he just kept stalling us and stalling us. So finally, we said, "We can't wait any longer." And so we went and licensed the MIPS architecture. And we ought to do that at a very favorable rate, because they were a little desperate at that point in time. As soon as we announced that, I get a phone call from Scott McNealy, and said, "What the hell are you doing? You were going to do ours." And I said, "You just waited too long. You ran out of time." And he said, "Okay, what would it take for you to take ours as well?" So we said, "Well, we'd have to double-up. And will you guarantee us some other business that will cover all this heavy cost that this is going to incur to incorporate your architecture?" So they said, "Yeah, whatever we have to do." And so now that's how we ended up with two processor architectures. And both of them were very effective in their way. But that was kind of the beginning of where we saw the

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handwriting on the wall. That sooner or later we were going to have to move into a much more serious relationship with cell-based. And we could start to see that with other companies were coming on with cell-based technology. So we had to then put on fabs. And we did two fabs. One in Japan, and one in Oregon. And so that was right at the end of Rob's book, that I just read again. And it said, "Oh, my god, what's happening to the company?" in '91/'92? And we don't know...

**Fairbairn:** This Rob's book, "Silicon Destiny" about the whole story of LSI Logic.

**Corrigan:** What does the future hold for this company, you know? And I'm still he still owns stock in the company, and he's wringing his hands on the outside. But we had all the start-up costs, and then we had to switch. And that was a huge engineering task to suddenly, instead of just dealing with gates. And we had to also add applications people, because suddenly you had to understand the end markets. Whereas, before that, we were like a guy that was in the brick business, as opposed to an architect. Now suddenly we had to understand about architectures, and so on. Which we did. So the gate array business kind of peaked that year, and we did $690 million, I think, in '81. And then the next year...

**Blair:** '91.

**Corrigan:** And then the next year we were down one...

**Fairbairn:** '91, yeah.

**Corrigan:** '91-- one little notch. And that was also a down year for the semiconductor business as a whole. But we were investing heavily in the whole cell business. And so we almost had like a second life. This was like "Chapter 2" was the cell business. And by 2000, we're now up to two billion a year. So that when you looked at the numbers, you can see the gate array went almost in a straight line, independent of the recession in '85, where Intel was in such tough shape that they had to have IBM come in, and buy 20 percent of Intel. We didn't even see that. We just steamed right through it. So we had a clean ten years of just everything going up. So that was an adjustment to us to have a couple of flat years. But then the cell-based business, you know, we went from almost nothing to being Number 1 in that business in about three years, right? So I think this was the graph that I showed you.

**Fairbairn:** So the line along the bottom and then going up was the cell-based business, and that continues up. Meanwhile the purple line going down is the gate array business falling off.

**Corrigan:** Yeah, yeah. And so I would guess by the mid-'90s, we were almost 100 percent cell-based. And with that came-- we had to get experts on storage, we had to get experts on networking. And also

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guys like Cisco in the networking business didn't exist in the '80s. And now suddenly, a lot of the PC companies, must have been a hundred PC companies, suddenly got down to half-a-dozen by the end of the '80s, and now suddenly you had the networking companies, you know, dominated by Cisco, but then there were 50 networking companies. And all of them needed cell-based ASICs. So that was like the Second Act was cell-based in the '90s.

**Fairbairn:** Okay! Well, I think we've told the story as far as we can do. And I think it's a great tremendous success story. Congratulations to all of you. And thank you very much for joining us in this conversation today.

**Corrigan:** Well, thanks for having the patience to listen to us.

**Group:** Yeah, thank you, Doug. Appreciate it.

END OF PANEL

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