Oral History of Gerhard “Gerry” Parker

Interviewed by:
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David C. Brock: Well, thank you very much for joining us and for agreeing to the oral history. I thought if we could spend a little time starting at the beginning of your life story, if you will, and talk about your early childhood, your family. I know that you were born in Bavaria, I think it is, in ’43, which is an interesting and tough time for Bavaria, I’m sure. And then I believe-- were you in Germany until the early fifties? Is that correct?

Gerhard “Gerry” Parker: Yes.

Brock: Just if you could talk about any memories you have of that time, your experiences there, your family?

Parker: I was born in a farming town a little way outside of Munich. Actually during the war we wound up living in Augsburg for a while. And I do remember the allies bombed the crap out of Augsburg one night. <laughs> I mean Augsburg was bombed one time, and the British sent 750 bombers over on one night. and we happened to be in town, which wasn’t too pleasant. But I was young, so I hardly remember anything other than just thrashes. And then we went out on the farm basically to get out of town.

But, we wound up back in Augsburg, and I remember playing and growing up in the ruins. The town was leveled practically. I mean, you know, these pictures you see of towns in rubble. That was hometown. But then my mother basically married a GI in 1950. And so my stepfather, he adopted me, and we came to the U.S. in 1952. And he stayed in the army and so we moved around the U.S. for a while, Virginia, Texas. And then actually went back to Germany to Heidelberg for his tour of duty, and I went to Heidelberg High School at an American high school in Heidelberg through junior year. Then he got transferred to Fort Ord, and that’s the first time we’d gotten to California. And so I finished high school in Monterey. From there I started applying to colleges and wound up deciding to stay in California, and I picked Caltech. I just got a scholarship and it seemed like a good idea at the time. <laughs>

Brock: When you came in ’52 you were a native German speaker. Had you had any exposure to English?

Parker: Not very much. My stepfather didn’t speak English [German?] at all. My mother obviously spoke English and German. And your parents try to get you to learn English while you’re still in Germany. Ugh, forget it. And [we] got off the boat and they put me in an elementary school in Virginia where nobody spoke German, <laughs> and I said, “This is not good.” So I had to learn English in about two weeks--

Brock: Oh, my gosh.

Parker: --just to survive in school. And we never spoke German again. Actually, because my dad didn’t speak German and my mom didn’t, so I just went straight to English as best as I could. And unfortunately what that did to me is I never got a real good understanding of the English grammar. You know how that goes, if you weren’t taught formally a language. I struggled quite a bit with getting decent grades and English in general because, you know, the King’s English wasn’t something I learned in elementary school in Virginia.

Brock: Right.

<laughter>

Parker: So, anyway, but it was fun. We got through it.

Brock: Yeah. When you were in your education through high school, how did your interests in the technical side of things develop? Were there any experiences that really stand out for you or was that through school or through hobbies? How did that emerge?

Parker: Well, school and hobbies, I think. Interestingly enough, the American high school in Heidelberg had good teachers, really good teachers, and so math, you know, and basic science and stuff, the teachers, so I mean I really enjoyed it. The teachers were good. And when I got to Monterey High School, they had an extra class that started at seven in the morning. Basically an electronics class -- a lab where you could build, solder stuff together, and I just loved it. This is great, you know, engineering, science, and so forth. So I guess I’ve always kind of drifted more toward technical, and part of the reason I couldn’t pass a music course if I tried, <laughs> tone deaf, and so I knew music wasn’t going to be for me. So I drifted towards science and of course did my own projects and for a while built some rockets to see if-- just like Gordon, built rockets and things you can blow up.

<laughter>

Brock: Did you have a chemistry set?

Parker: Yeah.

Brock: And did that get you into explosives?

Parker: Yeah.

<laughter>

Parker: I had one of my rockets blow up in the bedroom, and my mother was a little mad.

Brock: <laughs> I can imagine. Well, did you get into radio hobbyist sort of activities, amateur, ham radio, that sort of thing?

Parker: Yeah, but not so much. I mean I think I had one for a while, but I don't know, I didn’t feel like talking to people across the world.

<laughter>

Parker: So I never got into that, but I obviously built the Heathkits and played with that sort of stuff, yeah.

Brock: And growing up in the fifties, did Sputnik go up while you were in high school?

Parker: I think so. Yeah, I think so.

Brock: It was ’57 or something? Is that right?

Parker: Oh, no, well...

Brock: No, ’56? I can't remember.[1]

Parker: Fifty-six, I think, sounds right, yeah. I would’ve been freshman in high school. I graduated from high school in ’61, so it was right around that transition.

Brock: Did that whole world make an impression on you?

Parker: I mean other than, wow, this is great. I mean it didn’t change the direction or anything. I kind of always wanted to do science.

Brock: Okay. And it sounds like that early morning electronics lab must’ve been the passion project of one of the teachers presumably coming in early and facilitating it.

Parker: I think so. Monterey High School is really a great school, and so they tried to put in extra courses. I mean you had to take six classes a day or something, whatever the number is, and they would put in a seventh one and have different topics, obviously. But I picked the one that I was most interested in. and, you know, you have to be passionate to go to school at seven in the morning in high school.

<laughter>

Parker: It’s not the sort of thing you willingly do.

<laughter>

Brock: Well, you must’ve been good at it and done well in school because it seems like you had some good choices to make at the end of it. Can you talk about that end of high school experience, figuring out what you wanted to do next, your kind of picture of where you wanted to go at that age?

Parker: Well, I obviously wanted to go to college, and so I applied to the usual schools, Berkeley, Caltech, MIT, and so forth. And I knew my parents couldn’t really afford the tuition, so I was fortunate that I managed to get a scholarship from Caltech. I also got a separate scholarship, I think B of A or something. You know, there were some small scholarships, and so the cost to my parents was minimal. But even then, I wound up borrowing some money to pay tuition. But, yeah, I liked it. And actually I think part of the reason I went to Caltech is because they actually send faculty members out to talk to the students before they accept them. It isn’t just a paperwork scheme. I mean you have to have good SATs, you have to have good grades and so forth, but they specifically wanted to talk to somebody, which probably helped me because I did lousy on my English SATs. <laughs> Never did get a hold of English properly.

[1] Actual date was October 4, 1957

Brock: So, you would apply, and then if they were interested, they would come talk to you?

Parker: They would send somebody up to come talk to you.

Brock: Wow. Do you remember who came to speak--

Parker: I don't remember the name, but it was a faculty member and just wanted an interview. And I think they wanted to make sure they got fairly rounded people, so obviously it worked out fine. But I was impressed with that.

Brock: Yeah, I would be, too, I think. <laughs> Interesting. And the scholarship, they let you know when they accepted you that they were off--

Parker: Yeah.

Brock: Wow, that’s great. Had you been to Pasadena and Los Angeles and seen the campus before you arrived?

Parker: I think so. I’m trying to remember. That was a long time ago. <laughs> I’m trying to remember. I’m pretty sure we toured the campus. I don't remember if I went back to MIT or not to look at the campus. Maybe. I don't remember.

Brock: Well, maybe we could move to a description of Caltech and the Los Angeles Basin and Pasadena as you found it when you arrived in ’61. What were your impressions?

Parker: Terrible smog. <laughs>

Brock: Oh, smog, yeah.

Parker: I mean smog was unbelievable. You know, I had done some track at high school and got to Pasadena. I ran around the track and almost couldn’t breathe my lungs started hurting so badly.

Brock: Really?

Parker: I said that’s it. It just didn’t work. I mean it was unbelievable how bad. From Pasadena you couldn’t see the San Gabriel Mountains, which were only about three or four miles away, and so it was just smog city. So I said, okay, this was a good idea. <laughs> But you pretty much get busy with studies right away, and so you just, okay, live with it.

And, actually, I joined ROTC because my dad had been in the army and I kind of felt, okay, that’s a noble career and a noble thing to do, and so I was actually in ROTC. And I dropped out of it actually senior year because they changed the rules. They had originally said that, “Okay, if you go through ROTC and then you want to go to grad school,” first they said they would pay for grad school, which was a big deal. And then they changed it. “Well, we’ll give you a three-year deferment so you can go on your own.” And then they changed that and said, “No, we’re not gonna give you a deferment at all. You might get a six-month deferment or something, but then you’re going to be in the draft.” Well, okay, guys. I mean you can't

change the rules that much on me. So I dropped out of it, said screw it. And you’d probably still have the four-year obligation after that. And so then they countered and said, “Well, we’ll send you to Wright-Patterson Missile Guidance School for a year and a half to get a masters.” I said, “Okay, well, that sounds interesting.” “But for that year and a half, you owe us three more years plus the four years you signed up for.” I said, “You’ve gotta be kidding.” I mean I’d be in there--

Brock: Now you’re in for seven?

Parker: --seven, eight years for a masters? Forget it. And meanwhile I had applied to Stanford and Caltech for grad school, and once again, Caltech came through and gave me a scholarship and a teaching assistantship and a one year masters program, so I said, “Here I am.”

<laughter>

Parker: And at that time, they were still giving college deferment, so I could at least apply for that every year. Then once I got the masters, I had run into Carver Mead as an advisor, and I just thought he walked on water. It was great, and I said, “I would love to stay for a Ph.D. here,” and so he helped me stay for the Ph.D.

Brock: Were they changing the terms of the ROTC commitment as the American involvement in Vietnam was deepening?

Parker: Yeah, I’m sure that was part of it. Yeah, I’m sure that was part of it. But I suspect they haven’t changed them since then. I don't know. And it was probably too good a deal.

Brock: Right.

Parker: But, yeah, I’m sure Vietnam was just ramping. It hadn’t really started but it was ramping up, so I suspect they were anticipating some issues.

Brock: Right. Well, there’s a lot of different ways to go. <laughs> Sorry.

Parker: No problem.

Brock: Maybe you could describe as an undergraduate, were you EE when you walked in the door or did you discover that?

Parker: No, actually, at Caltech the first two years, it’s everybody the same.

Brock: Oh, that’s right. That’s right.

Parker: Physics, math. And I remember actually being relatively unhappy at times. The reason is I knew I wanted to be an engineer, but you had to take the math and physics basic courses with all the guys that really wanted to be mathematicians and physicists. And I would say, “I don’t care, guys. It’s okay. <laughs> Don’t try to flunk me out. I don’t wanna be a mathematician or a physicist. I just wanna get an EE!” <laughs> And so the first two years were pretty miserable because you’re competing with these

guys that really want to be physics, really chemistry, and those are the hard courses. And we had Feynman for physics. I had Gallamine for math and Pauling for chemistry, okay? And they had the best TAs that were just mean as skunks.

<laughter>

Parker: And so finally junior year is when you could start to select, and I said, “Engineering, EE,” and then the courses were great. I loved it. <laughs> My grades went up. I was able to finally work on something I wanted to do with guys that were interested in being engineers and not try to compete with the mathematicians.

Brock: Those are three very impressive teachers to have as an undergraduate student.

Parker: Oh, we were incredibly lucky. I mean our class, we went through the Feynman Lectures, which were a big deal, when he was first doing them. And he’s great. So, anyway, but he really made it interesting.

Brock: I’ve heard from other people that Pauling’s approach to general chemistry was to come in and talk about whatever he had been thinking about on that particular day.

Parker: Yeah.

Brock: Was that your experience?

Parker: He was a little--

<laughter>

Parker: Really, the problem-- Feynman was really kind of the same way. Feynman wanted to do these great lectures, but the problem was the book they gave us was Halliday & Resnick[2], and all the tests were out of that book, and the TAs and everything was based on that. So you’d walk out of a Feynman lecture like, “Oh, I got this.” Then all of the sudden you’d see a test that had nothing to do with what Feynman talked about. I said, “Why am I wasting my time listening to Feynman? I’ve gotta go get that Halliday, Resnick book out and study!” <laughs>

So it had its ups and downs. And Pauling was the same way, you know, a grand lecturer. He’s wonderful to listen to, but then when it came time for the test and everything else, it was out of a different book or out of no book, and the TAs were making up the tests. So it was an interesting experience, shall we say? <laughs>

Brock: Well, once you got out of the maw of that and got into EE, what was electrical engineering like at Caltech then? Was there a relationship to computer science and exposure to computers?

[2] Fundamentals of Physics, Halliday, Resnick and Walker

Parker: Well, you know, they really hadn’t started computer science in those days.

Brock: Okay, yeah, simple enough.

Parker: I mean in those days, math, physics, chemistry, you know, EE, whatever. What I found so fascinating was that the equations that govern electricity are really no different than what govern mechanics. You know, if you think about it, a spring oscillator versus an electrical oscillator, and so the underlying mathematics for all those things are actually very similar. And so then you start to say, oh, this is kind of interesting, how it all relates. And so that was sort of the big aha. And then you could get into that and you actually developed a better understanding because, okay, electricity flowing through this isn’t some mythical thing. It’s no different than a spring or a pendulum or water flowing, so it was kind of fascinating. But I found the last two years, junior and senior year at Caltech great because I was finally in <laughs> what I wanted to do. So, anyway...

Brock: Was there a lot of hands-on lab component in those two years?

Parker: No, not so much. Senior year we had some labs, and I think that’s where I met Carver Mead, because he was teaching a course. It was kind of solid-state electronics at the time, you know. Transistors were really just kind of getting going and things like that, and so I thought that was really interesting. And I worked on some stuff for him and I forget. I think we were trying to modulate light using some sort of crystal. Shine a laser through it and modulate the light and prove that you could modulate light.

<laughter>

Parker: Whatever. But I was lucky enough to get a summer job with one of the professors in mechanical engineering between junior and senior year, I think. He had me taking data on-- he was doing earthquake studies, where you shake a building and you measure the resonance of things and so forth. So that was really interesting. And I was basically a lab technician doing lab work. I liked the lab and I liked the experimental stuff a lot.

Brock: Uh-huh. In the summers did you have any work with local technology firms or did you work in the summers, or how’d that work out for you?

Parker: Yeah. No, I started working in the summer. After my-- okay, junior year--I’m trying to get it all straight--I actually worked at Edwards Air Force Base, and I think that was after the junior year, summer, worked for the U.S. Air Force. And I was calibrating altimeters for their test aircraft. And so, actually, that’s where I learned how to program because I wrote a Fortran program that would take the data and analyze to see if the altimeters were working properly and produce the data. I don't remember much about it, but it was--

Brock: They were digital altimeters or they were recording somehow?

Parker: They were mostly recordings. I forget-- you’re really stretching my memory.

<laughter>

Brock: Sorry.

Parker: But so I worked for them. Then I went to Texas and worked for Mobile Oil and wound up repairing their analog recorders. They had these big TI racks and we’d go out to west Texas and they’d drop the thumper truck, you know, smashing sagebrush and record it. And all that stuff was TO-5 transistors. And the boards would go bad and so they’d send them in, and I’d take the boards, figure out what’s wrong with them, replace a couple transistors, ship them back out. It was fun. <laughs>

So I did that. Then one summer I worked for Hewlett-Packard, HP Associates, and that was building diodes, some space charge limited diodes. I worked for a Varian one summer where we were making night vision stuff where you’d get-- well, basically, you’d put cesium onto a gallium arsenide substrate so that you’d have night vision. And then I worked at Fairchild one summer, and that was the first time I met Grove. <laughs>

So then after that, I got out of school. I was graduating. And I actually came up to-- and I met Gordon Moore a couple times, and I actually came up to interview at Fairchild and Intel. I had just started across the street, <laughs> and Don Palmer, who was their HR guy, he interviewed me and he said, “Where are you going next?” “I’m going over to Intel,” he says, “Oh, okay, come back when you’re finished.” And so I went back over after I’d talked to Noyce and Moore, and he said, “Did they offer you a job?” and I said, “Yeah,” and he said, “Take it!” <laughs>

Brock: Really?

Parker: Yeah. <laughs>

Brock: And no compunction about that? Wow, huh.

<laughter>

Brock: He was wishing for an offer himself. Well, if we could go back a little bit to talk about just your work with Carver Mead. He must’ve been a pretty young professor at that point.

Parker: Carver is about, well, 10 years older than I am. So basically, I was starting to work for him when I was, what, 21, 22. So he was 30 and he had just been a professor, just gotten to be a professor. But Carver is just great. I mean I can't say enough positive about him. He makes things simple, doesn’t flaunt how smart he is or hide behind any robes, quite frankly. I mean he’s very down to earth. And Carver-- you got two types of grad students. One type was brilliant physicists like Tom McGill or Cardel Thornburg, and then you’ve got experimentalists, because Carver always wanted to have a lab and prove things worked, and so he knew I knew how to do lab work. I wasn’t so good at the math and the theory, <laughs> but he wanted-- so he had a couple of us grad students that were very much in the lab, keeping the lab running and doing the experiments, and he had the really great physics-minded guys, math-minded guys, so he had the best of both worlds going in. That’s Carver, and he was good at both.

Brock: How big was his lab that you were in, number of people?

Parker: Oh, he would have typically about six or seven grad students, but he’d try to get them out. I mean Carver was get the thesis done and get out and move on, not one of these professors that wanted to have free labor for five years.

<laughter>

Parker: I mean Carver was very much, “Let’s get this experiment done. Let’s get you out of here,” and he did.

Brock: He seems to also have been, just from speaking with other people, very involved in placing his students, like helping them to find a position and maintaining that kind of network of his students--

Parker: Oh, absolutely, absolutely.

Brock: --you know far after, far afield from the Caltech campus and way through time. Is that accurate?

Parker: Yeah. Well, I was out at Caltech and I had to make a short speech or something, and I said, “Caltech is great. I got a degree. Carver Mead got me my degree, he introduced me to my wife, and he got me my job. Now that’s full service.”

<laughter>

Parker: Yeah, Carver maintained a lot of relationships outside, and quite frankly, companies would call him for students. You know, when I was at Intel later trying to recruit people, “Carver, who you got that’s good at this or that?” And so he had quite a reputation for producing good students, and so we sought him out. But he got you out but he didn’t get you out and dump you. He got you out and into something, so it was great.

Brock: Yeah, and it seems, then, that he had connections into all these different organizations, too, and I guess by this time he was also consulting pretty widely. I think he was consulting for certainly Intel when you finished--

Parker: Yeah, he was--

Brock: --and Fairchild before?

Parker: He didn’t consult that much for Intel. I mean he talked to Gordon a lot, but after a while, Intel wasn’t Carver’s favorite place in the sense that Carver is full of great ideas. “Let’s go do this and go do that,” and Intel got much more hard nose under Grove, which is, “Get this stuff in production,” you know, performance, performance, “I want things done and don’t waste your time on other stuff.” That’s one reason that Andy and Bob Noyce kind of tangled occasionally because Bob had lots of great ideas and lots of things to do and Andy just wanted, “Let’s get this done.” And so Carver still would consult with Gordon and I would talk to him once in a while, but he was never a big time consultant for Intel per se

because he viewed Intel as being a little bit too much nose to the grindstone and don’t look this way or that way.

Brock: I get it.

Parker: That’s fine. I mean that’s Carver. But he was involved in a lot of consulting. And I know he consulted for Hughes Aircraft. He consulted for Intel. He always had a lot of ARPA/DARPA support, and so that got him a lot of exposure, and so, yeah.

Brock: Well, if I reflect on some of the names that you just mentioned of places where you worked in the summer, you kind of went to some of the most storied places of tech companies in Silicon Valley to get that exposure before making your choice of what you wanted to do. I just wondered if there was anything-- did you take anything really in particular with you from that exposure to HP and to Barian and maybe to Fairchild R&D? Anything stand out from those places?

Parker: Well, I mean the usual clichés. HP was a great company to work for, but they were a little easy going, shall we say? You know, I would show up to work at eight o’clock in the morning ready to go, and the technicians would show up around eight thirty or nine, and the rest of the staff would show up when they felt like it. <laughs> Okay. I mean that was a little laissez faire but they did good work. They had great labs--I worked at HP Associates--and great people. So a very employee-oriented company but not very confrontive. It was very much family-friendly stuff, and so if somebody wasn’t doing a good job, they really didn’t know how to deal with it, so there’s kind of a lesson there.

Fairchild was kind of interesting in the sense that it was very clear there was R&D and there was manufacturing over there. And the R&D guys, <laughs> it wasn’t clear what they were up to half the time, but it was really interesting. But, again, you had the likes of [Les] Vadasz, Gordon [Moore], Warren, you know, Ed Stone, really good people. And so it was hard not to like working there, but they were also kind of lazy, shall we say? I remember one time I rode my motorcycle up to northern California or whatever. The damn thing broke down and I got stuck, and there wasn’t any way that I could get to work on Monday morning at eight o’clock. I left a message for my boss, “Dez, I’m gonna be late. I’m really, really, really sorry.” And the message was there-- I got to work at ten o’clock and he still hadn’t shown up yet.

<laughter>

Parker: I said, okay. I get it. This is how it’s going to be.

Brock: And at that time it must’ve been that big new laboratory building that Fairchild built, right? It’s down-- <inaudible>

Parker: No, well, it was the one by Veterans Hospital--

Brock: Yes, yeah.

Parker: --which was a separate R&D lab.

Brock: Oh, I guess they built that in ’62 or something.

Parker: That was at Arastradero and Foothill.

Brock: Right, right.

Parker: That’s where I worked. And Varian was just off Page Mill. And the Varian thing was much more-- I worked in one lab really with just one guy and didn’t get much exposure to Varian, but I got really good exposure to high vacuum systems and running experiments. So that was, again, a great learning experience, so I learned a lot in the summers. I was determined to get out every year from school during the graduate years, get out and get some experience and pay for school.

<laughter>

Parker: Minor details, but that’s okay. And then at Caltech I was actually a lab TA for quite a while, too, so I took care of a couple of the labs for the professors, you know, basically a TA.

Brock: I was refreshing myself this morning about the work that you did for your Ph.D. thesis, and tunneling in Schottky barriers on top of III-Vs, right?

Parker: Right.

Brock: And help me, if you could, Carver was making some very fast devices around this time, wasn’t he, out of III-V materials? Was there a connection there?

Parker: No, Carver at that time was very much into current flow, tunneling characteristics of thin films, tunneling characteristics, and actually just diodes per se. So we were trying to make diodes on zinc sulfide, you know, just basically anything to do with electron motion in solids, semiconductors, and so we would try different compounds. Gallium arsenide was an obvious one because it was easy to get. But like I say, I was growing crystals, zinc sulfide, to try to see if we could get-- because theoretically you should be able to get space charge current through them. In other words, it had the right band gap. It just didn’t have the electrons. And so if you could get electrons into it you could presumably have a space charge current flow. And so we were working on that sort of stuff, and we were always fighting surface states because the minute you break something you’ve got a surface state, which interferes with the electron flow.

Brock: Very good preparation for silicon devices, I would think, handling surface states.

Parker: That was the game--

<laughter>

Parker: --and tunneling. EPROMs are tunneling, right?

Brock: And I guess the craze for tunnel diodes had kind of come and-- I mean that was the late fifties, wasn’t it--

Parker: Yeah.

Brock: --wasn’t that first craze for tunneling?

Parker: You know, I don’t think they ever really had much commercial value. The tunneling was actually much more a physical phenomenon, which was really interesting to study, and it led to a lot of understanding about tunneling in general. And nowadays with technology getting so-- we’re down to monolayers of silicon and basically the, whatever we are, 10-nanometer technology, whatever. Those are all getting to be dominated by effects like tunneling or avalanching, and so we worked on that stuff 40 years ago, but it was still rudimentary at that time. It was really the basic understanding of that physics that was important.

Brock: That makes sense, too, because by this time, Carver and his coauthor, they did I think those two papers that I think were looking at how small you could make silicon devices. Weren’t there two papers? You know, so looking at these kind of limit phenomena for the scale makes sense.

Parker: Carver was-- that wasn’t the real goal at the time. It was much more just-- this was in the infancy where you’re just really learning about semiconductors and tunneling and so forth and so on, and so Carver was just exploring. And then once he got kind of tired of that, about the time I left, <laughs> then he started in on computers. Layouts and so forth and got much more involved in the computer science. And so Carver didn’t beat anything to death. I mean he learned what he wanted to learn, get some stuff done, and then move onto something else that was interesting to him.

Brock: Well, as you were bringing that dissertation thesis work to a close and thinking about your next steps, it sounds like you were concentrating on going into the semiconductor industry.

Parker: Yeah, by that time, oh, yeah. Even though it was still EE, but that was the only choice you had. They didn’t have applied physics or all the other fancy subspecies now. It’s EE. But Carver was very much semiconductor, and so that path was pretty clear. And the only thing is-- well, at the time, I didn’t really get into design. In other words, Carver later started to lay out the design work, but back when I was a grad student it was still very much the physics of semiconductors.

But later some of his students became designers, actually worked more in layout and design, so Carver kind of transitioned. But at the time circuit design wasn’t what Carver was interested in. There were some-- Floyd Humphrey was circuit-design type stuff at Caltech, but I wasn’t working for him. So I kind of stuck with Carver and it was fine. I mean I enjoyed what I was doing.

Brock: I would think that you would’ve had a whole passel of job offers to choose from. Can you talk about that?

Parker: Well, the usual suspects.

<laughter>

Parker: I mean TI, Hewlett-Packard, Fairchild. I’m trying to think of who else. Hughes, Hughes Research got interested in me because I knew Carver was an advisor there and they were doing some interesting stuff.

Brock: That’s in Malibu?

Parker: Malibu. And TI offered me a job, but I just couldn’t bring myself to go to Texas after I’d worked there for one summer, <laughs> out in the oilfields. I said, “I don't know about Texas.” And so then Intel, I mean Intel just popped up. If Intel hadn’t started at that time, I’m not sure where I would’ve gone, probably Fairchild, to be honest. I mean I still respected Fairchild a lot.

Brock: Any interest in going to Bell Labs or any of the RCA operations at that point?

Parker: You know, no. I don’t recall getting very interested in those. I think I might’ve talked to the recruiters when I was first graduating, but I don't know. I think once you live in California for 10 years, <laughs> I don't know if I want to go back east, which is a terrible thing to say because back east is lovely, I’m sure.

Brock: So had you met some of the people at Fairchild who you knew were going to be over at Intel when you decided to join them?

Parker: No, because I think by the time I actually accepted the job at Intel, Vadasz had already joined, Grove had joined, Gordon and Bob obviously. And then they brought in Gene Flath who was in manufacturing. I never knew him. So, no, I don’t think so. Actually, Ted Jenkins was at Fairchild. I knew him. And of course Ted came over, but he and I went to college together, so that doesn’t count.

Brock: Right. Well, maybe you could talk about the time you spent working, I guess it must’ve been in Pasadena for Intel, in this light emitting diode operation.

Parker: Just don’t tell the EPA, the stats on that.

<laughter>

Brock: Scout’s honor. Yeah, right. Probably some not- contemporary practices in the lab at that time.

Parker: In those days, I mean we didn’t know what was bad and people just did things. And now, my god, you get in trouble. But yeah, that was Carver and Jim McCalden’s doing. They convinced Gordon Moore to start a light emitting business. And they actually brought Ted Jenkins down.

Brock: Right.

Parker: And so, Ted and I were roommates while he was working there. And I was just finishing up my degree. And then about the time, they needed to get Ted back up to work on bipolar, Gordon and Carver still wanted to keep that thing going. And so, that was what I was actually hired for. And so, I took over that. And the lab was a drafting office in the second floor of a rickety old building on Walnut Street. And

Carver, he drove me nuts a little bit. He and McCalden in that lab were just-- okay, we needed liquid nitrogen for the evaporator that we had. Have you ever tried to take a liquid nitrogen tank up a set of stairs?

Brock: I have never.

Parker: Carver and I would do that. I think I was pulling and he had a crowbar to lift the thing up one step at a time. We get the thing up. We get it up to-- it took us like an hour every time we had to get that nitrogen tank up there. I said, “You’ve got to be kidding.” Then we needed 220v for the evaporator and of course there’s only 110v plugs. So, Carver, knowing electricity, right, two phase. We took an extension cord, cut it in half, plugged one end at one outlet and plugged the other into the other outlet. Then we had power for the evaporator. Then McCalden started running experiments. He damn near killed Carver because he had a tube furnace. And he was doing high pressure diffusion. And he’d weld an ampule together, and open-ended furnace. And then he’d heat the thing up. Carver and I were sitting there working. And all of a sudden kaboom. This projectile shoots across the room and hits the wall right next to us.

Brock: Because one end blew out?

Parker: Blew up, yeah. And so, then I called Gordon. I said, “Gordon, it’s not safe working here. We’ve got to do something.” So, Gordon ordered a blast hood, this big heavy hood. It must have weighed a thousand pounds. And he had it delivered by Bekins [moving company]. And four guys carried this thing up the stairs. And so, then we-- oh, and the reason actually-- Gordon didn’t believe me when I said McCalden almost killed us. So, when Gordon and Bob were both there one time, McCalden was off in his little chemist suit. And this time, he had an open pot furnace with zinc in it. And next thing you know, kaboom. Zinc splattered on the ceiling and all over the place. Then that’s when Gordon ordered the blast hood.

Brock: To do all those operations under, to put the furnace inside of the blast hood or something, or--?

Parker: Well, no. that’s when we tried to grow our own silicon dioxide, where you had to use silane and--

Brock: A bigger bomb.

Parker: We’ve got a bigger bomb.

Brock: Wow.

Parker: So, anyway but no, one time I was trying to grow some silane in a homemade deal. And all of a sudden, it caught fire. And it was just fire. It was in the blast hood, in the fire. But I was trying to-- okay how do-- you know, so I’m banging on the door. And it was a neighbor who was upset about something, noise. And he said-- I said, “I’m really busy.” He said, “What’s going on here?” “I’ve got to get back to what I’m doing.” I was just looking out of the corner of my eye as fire going. Here’s the neighbor complaining. I said I can’t let him in. He’ll call the cops.

Brock: Oh my gosh.

Parker: But anyway, we had a great time. And then about that time the semiconductor stuff was starting to take off at Intel. And so, Bob decided to sell the light emitting business to Monsanto.

Brock: You must have had some results if he could sell it to Monsanto.

Parker: Well, we were getting blue light emitters. I mean it was nowhere near any kind of production type stuff. But we actually were able to control the color. And in those days, everything was red or infrared. So, we actually could get different colors. And nowadays, people use gallium nitride and other stuff, yeah. So, and Monsanto was interested in getting something that had multi-colored. And so they thought, well maybe they could get it to production. And we were to the point where we were going to have to spend some money. It’s okay, we proved that it works. And we can make a few of them. But how are you going to make millions? And so Bob and Gordon decided to sell it. And they asked me, “Do you want to go with it?” And I said, “Well, not really. I think I’d rather stay at Intel.” And they said, “Okay, you’re fine.” And so, I just decided to stay and then started working on semiconductor stuff.

Brock: One last question about the light emitting diodes, Monsanto, at that time unless I’m mistaken, was producing wafers, and I think even epitaxial wafers too. Was there a connection there? Were you--

Parker: No.

Brock: No? Okay.

Parker: No, I think Monsanto was just a typical big corporation. It had an interest in growing the business and eventually maybe making wafers for those or making the product. So, it wasn’t Monsanto seed company, I mean seed guys. It was a-- they had a local lab.

Brock: St. Louis?

Parker: I think it was in Cupertino, I think. I think that’s where they had it because I had to transfer all the equipment, and transfer stuff to them, and show them what we had done--

Brock: Right.

Parker: And how to do it. And I think they played with it for about a year and then decided it wasn’t worth putting a lot more money into it and gave up on it.

Brock: Well, when you chose to go with Intel, had they built the facility in Santa Clara yet? Or were you-- you went to the original--

Parker: Yeah.

Brock: Yeah, could you talk about the job that you had when you arrived, and who you were working with, and what the scene was like in that building?

Parker: Well, they knew I had arrived because my motorcycle showed up on the loading dock. And Keith Thomson said, “What the hell’s going on here?” I said, “Oh, you got my bike? Thank you.” You know. I just shipped it straight to Intel.

Brock: Was it in a box or just-- no, in the back of a truck or something? Yeah, who knows?

Parker: Moving company took it. That, along with the blast hood. But anyway-- no, so I basically wasn’t sure what I was going to be doing. Officially, I was a member of technical staff. And so Gordon-- I sat down with Gordon. I said, “What do you need done?” And Gordon says, “Well, we’ve got potentially major issues on reliability.” At that time, the Schottky diodes on the bipolar were collapsing. And so, he said, “Why don’t you go look at that and work for Des Fitzgerald,” at the time, because he was running QA. And so, I was just tasked with problem solving quite frankly. So, probably for the first year, I was doing nothing but okay, why is this not working, what’s wrong with this, and so forth, and so on. And so, I think I went through most of the major early crisis of things not working, single bit failures and loose wires in packages and one thing after the other. And so, I wound up heading up reliability engineering because we had to get more people in to solve the problems. And then after Des Fitzgerald went over to Microma, they put me in charge of all of QA, which was fun for a while because it was very much day to day problem solving. And here’s what’s going on, and of course whenever Grove and I would get into what we can ship and what we can’t ship. We only got in trouble a couple of times by me listening to Andy.

Brock: Oh, erring on the ship side.

Parker: Yeah. Well, we had one where the guys were bonding too far out on the lead frame. And so, when you put the plastic around them, a couple of times the bond wires were outside the plastic, which is not good.

Brock: No.

Parker: I said, “Andy, we can’t ship this stuff. These are going to fall apart.” And so, we compromised. If they were just inside the plastic, it’s okay to ship them. Well, of course those came back, too. And so, okay Andy, we’re not going to do this anymore. I’m going to stop talking to you.

Brock: A couple different things, I would think that coming in to solve those-- to address these reliability and quality problems is yes, a high pressure situation, but also a good way to get into all of the details of the manufacturing process, the assembly process. You really have to figure out what’s causing it; you really had to go deep into the steps.

Parker: Yeah, I actually would go into the fab and etch the wafers myself. I go in and say, “Okay, part of the problem we’re having with these things is they’re not getting etched.” And so, I’d go in-- and a couple of lab techs took me under their wing. And we’d go in there, and we’re-- etch them and see what it looked like. And so-- but in general, you had really good guys working there, I mean Tom Rowe, Ted Jenkins, Gene Flath, and so forth. And so, it was very easy to work with them. And okay, here’s the problem. Let’s work on the problem, figure out what’s wrong. And it was fun.

Brock: Because it would seem to me that the problems that somebody like Tom Rowe or Gene Flath would be working on to get the manufacturing process to produce working devices, to get yield are the same sort-- it would be the same sort of approach and questions that you would come in from that reliability point of view. I imagine it was a common language, if you will.

Parker: Oh yeah. I mean the product had to work. You know? And it wasn’t supposed to fail. So, other than that--

Brock: Could you talk about… in that original Intel building, how it worked kind of spatially? Where were you? And where were the-- I don’t’ really have a good sense of how it was laid out. Was everybody all together or--?

Parker: It was a pretty small building.

Brock: Yeah.

Parker: The fab was kind of on one quarter of it. And across the front were offices and engineering offices. And then down the other side, we had the reliability and ovens for burning and so forth. And right in the middle, were actually the assembly line where they were assembling stuff. So, in the early days, everything was just right there. And just people kind of worked together. And so--

Brock: I think you were employee number ninety-nine, is that what I saw, something like that?

Parker: Oh, when was-- oh, I was number ninety-nine, yeah, just below a hundred, just got in under the wire.

Brock: One thing that I have come to learn is that that neighborhood in Mountain View, I guess across the street from Fairchild manufacturing, I guess Union—Jean Hoerni had had that building before and was doing fabrication with Union Carbide. But I think that there was groundwater pollution from the manufacturing plants. How, not just at Intel, but in the neighborhood and in the industry, how aware were people at that time of these environmental concerns?

Parker: At the time it, just-- TCE is viewed as horrible, right? I’d take a beaker of it home and use it to clean my carburetor.

Brock: Okay.

Parker: Because it was a great cleaning agent. And you didn’t think anything of it. Then all of a sudden, oops, you’re not supposed to have that stuff. It’s not supposed to be in the groundwater. And then of course-- and I think a lot of it was tanks that were leaking. I don’t think people dumped it on the ground deliberately. It was just leaking tanks. And if you parked your car downwind of the Fairchild building, it would rust because there was so much hydrochloric acid going up in the smokestack.

Brock: Really?

Parker: Yeah. So, Fortunately, we don’t do that anymore, obviously. But it was-- but then we really had to clean up everything. But then you get into the flip side, which we have now, where the EPA has “zero tolerance” for certain things. So, okay in those days, you could measure a hundred parts per million of TCE in the water.

Brock: Right.

Parker: Okay, and then they would ban that. Well then the technology got better, and you could measure one part per million. Oh, okay let’s outlaw that too. Well, at what point do you stop? There are certain thresholds where that’s just stuff in the air. And then it got into overkill situation. Something that really needed to be cleaned up got to a safe level now becomes a zero tolerance. If you detect one atom, it’s bad. But that building was a real problem for us in the sense. And so, we wound up having to pump groundwater and carbon filter it and so forth and try to clean it up so that it didn’t create problems. But I think what they-- I’m pretty sure I’m right on this. The Navy down in Moffett was washing their planes in TCE.

Brock: Oh my god.

Parker: And they never got in trouble. It’s probably all in the Bay. It’s-- They’re, I mean, terrible, Navy are. But anyway no, it’s-- that was an unfortunate thing to be a Superfund site and have to really deal with stuff that you didn’t know any better.

Brock: Had you, just looking forward-- just keep on the environmental topic for a minute…. When Intel was starting to construct its own fabs and its own buildings in Santa Clara, in Oregon, New Mexico, where have you, was that awareness about certain of these environmental harms or problems, did you already have that when you started to build your own factories?

Parker: Oh yeah. Yeah, I think so. Yeah because by the time we were building our own factories, we just always tried to do the right thing. We would put scrubbers in and neutralization. And I don’t recall ever a situation where well, we can dump this. It’s okay. No, there was never, never any of that. And even when we were building in Europe, Europe doesn’t require scrubbers-- didn’t require scrubbers on your exhaust. You could just-- and I asked the guys over there, actually Philip’s guys, and I said, “Don’t you guys realize there’s stuff going up?” And they said, “We don’t care. The wind blows it all north to Denmark.” I said, “Okay. I guess I understand how that works here.”

Brock: Yikes.

Parker: And so no, we used the same standard for every fab and had the same safety protocols and stuff. So, Intel had, I think, a really good record on that. I don’t-- I would never-- could never find anything. And I was big on safety. I mean I reviewed the safety procedures at every factory, every visit. And so, we’d have some lapses, but I get there one time. And I said, “Why aren’t those guys wearing hard hats?” Oh, okay. Get some hard hats.

Brock: Well, to shift back to maybe we could just talk a little bit about some of those reliability issues and problems that you were tackling early on, if any really stand out as either unusual, or representative, or just--

Parker: Where should we start?

Brock: Yeah, I’m not sure. But I’d love to hear just about some of those stories.

Parker: I could go a little bit of a laundry list for you. We, at one point, we were stress testing the junctions on the bipolar. And then we’d do a quick burn in and it had shifted. And it turned out the stress test itself was avalanching electrons into the oxide, which changed the characteristics. And I remember thinking “what the hell’s going on here.” Then I went to talk to Dov Frohman. And Frohman explained how avalanching puts stuff in the oxide for the EPROMs. I said, “Oh, okay there you go.” Fixed that one. All right, stop stressing them that way. Then we had single bit failures, which I should blame Vadasz on this one because… I think it was Vadasz had had this clever idea of having poly silicon go down directly to the substrate. And so, you’d open up a substrate contact, deposit the polysilicon. And then you put oxide; and then you put metal. Well, it turns out-- it took a while to figure out. Right in that little area, sometimes the silicon would grow a single crystal and shoot a spike straight up. And then later when you put the metal on, it would zap.

Brock: Oh, it shorts.

Parker: And I tried to get Vadasz to move the damn metal lines. And he refused to move the metal lines. And so, I-- one of my altercations, shall we say. And so, we worked really hard to not let the silicon grow. But it was tough because it wants to grow single crystal on single crystal. And finally Vadasz had an electrical problem, which was that there was too much capacitive coupling to that silicon. So, he moved the metal line to solve that, which solved my problem. I still hate him for that, but anyway. But that’s the kind of stuff you run into. And Gordon’s invention of using phosphorus to flow the glass was great, except that it made it moisture sensitive. So, then you’d get-- it would pick up moisture, and we’d have water in the packages or basic-- not water. But it would fail because of moisture.

Brock: Because it would affect the metal lines, correct?

Parker: The phosphorus. Phosphorus in the glass affected the metal.

Brock: And it would basically etch away the metal or something in that kind of--

Parker: I’m trying to remember what the failure mode was. But basically, it was mostly in plastic because in plastic-- it didn’t work-- ceramic packages wasn’t a big deal because moisture couldn’t get in, but plastic, it would get in. And then you’d get moisture in there with the phosphorus. Phosphoric acid would etch the aluminum, and off you go. And so, a good thing leads to bad things.

And so, we went through a lot of really interesting kind of things. There was the soft error problem with cosmic rays. And actually I was trying to prove-- we were trying to figure out if it was cosmic rays. And so, I bought something like ten thousand pounds of lead, lead bricks, fifty cents a pound. And then we built a

cave out of lead. And I bought very low alpha radiation lead. So, it was super-- to stop the cosmic rays. And we put a system in there to see if it still failed. And then it turned out it did because the radiation was coming from the cerdip package.

Brock: Right, from the ceramic, right?

Parker: From the ceramic. And so, then I had to get rid of the lead. So, I sold it for a buck a pound, except Gordon wanted to keep about a hundred pounds of it for sinkers.

Brock: Did he really? Did he use it to make sinkers?

Parker: Yes, I gave him lead bricks.

Brock: That’s hilarious. And you could get those with that particular radiation characteristic because I imagine that sort of stuff--

Parker: Yeah, we had to go to a special mine in Utah or someplace that had low lead processing. And I tried to actually buy up the capacity because I figured we might need it.

Brock: Oh, you had to put a film of it in the package or something?

Parker: Well because the glass had lead in it.

Brock: Oh, mm-hmm.

Parker: That’s the problem. The cerdip packaged glass is lead and glass. And the lead was causing the problem.

Brock: Interesting. Oh my gosh. And I guess the EPROM had been developed by the time you first arrived or yeah, that must be.

Parker: Well, I mean it was--

Brock: In development.

Parker: In development-- I mean nothing was in manufacturing when I arrived. We hadn’t shipped the first product. But yeah, Frohman was doing that in the early ’70s.

Brock: In-- there’s this perennial interest in how that trio of Moore, Noyce, and Grove, how they interacted and how they each helped to lead the firm. I just wondered if you could reflect on that from the earliest days when you were there, if you could characterize that and maybe think about also if it changed or not over time.

Parker: Well, I mean now it’s obviously totally different right.

Brock: Well, yeah sure.

Parker: No, I mean there have been enough articles written about that. But it was-- I used to teach the welcome to Intel kind of class. And I’d always start with exactly that discussion. Here’s a picture of Andy, Gordon, and Bob together. And I said, “I want you to remember this because Bob is the visionary that the sky is the limit. Gordon was absolutely the brains in terms of technology and strategy. And Andy was a ramrod. He’ll make sure you got it done.” And the three of them complemented each other incredibly. And those stories are all true. Remember, I saw it. And like I say, I used that as my introduction, welcome to Intel. Here’s where you are.

Brock: Isn’t that interesting? And then kind of telling people to behave accordingly, make use of that information.

Parker: That’s exactly right.

Brock: This is who these--

Parker: Yeah.

Brock: What about the-- I know over time, the very idea of an Intel culture gets kind of codified and taught and is very explicit. And names are given to practices like constructive confrontation. And could you see the basic elements of the Intel culture in the earliest years? Or, how did that evolve?

Parker: It obviously evolved. But I think that Andy, very early, was very disciplined about everything. It was say what you’re going to do and do it. Meet schedules, no wasted BSing and so forth. But early years were tumultuous. And Andy actually was very big on management training in the sense that we would bring in one consultant after the other and usually spit them out, but basically bring them in. And we’d bring in guys that taught management by objectives. Bring in Drucker, we had Drucker. And so, we would have a series of these almost every year, about every year, maybe every six months. Andy would take the whole management team, bring a consultant in. We’d have a two-day session or whatever. And then we’d pick out what we wanted.

And it was interesting. We never had the same guy twice because a soon as you had those twice, they say the same thing. You already got it the first time. Why are we doing this again? So, that’s why I say spread them out. One, learn what they’ve got. Off you go, next guy. And then that kind of evolved into the whole culture in terms of how to manage. And then some things got carried to extreme. We had one huge management by objectives thing where everybody had objectives and sub objectives and other objectives. And pretty soon, all the managers had to have a person in charge of the book, adding objectives to it, more objectives. And finally, screw it, let’s go back to getting it done.

But so, it evolved. And but I think underlying it all was always just this basic discipline of being able to rely on your co-workers. If it’s done, it’s done. Or you agree you’re going to get something done, it’s done. No political games, no oh, the check’s in the mail, or you just didn’t see any of lying-- I use the word lying as a bit of a negative of people saying they’d done something, they hadn’t done it. And so in general, competence and results were respected. And that was the main culture quite frankly. And then a lot of the other stuff got put on top of it. And then you started getting-- Grove started getting older, and HR started

taking over things. The next thing you know, we had to have a great place to work. And of course I was still in the old school. One time, I got so mad at somebody I said, “If this was such a great place to work, I’d charge you admission. Get back to work.”

Brock: What about the angle that so many of the top management and early employees like yourself had pursued advanced degrees involved with doing empirical research, experiment, real measurement, using instruments, true measurement, if you will? Do you think that-- how do you see that, the importance of that background from so many of the people there?

Parker: Well, I think you answered the question, which is it clearly shaped the culture. And it was the sort of person that gravitated toward Intel and the sort of person that stayed at Intel. We had the hardest time with the marketing/advertising kind of thing because those tend to be fluffier things. And Grove of course would want to put metrics on them immediately. And so, some of those people really struggled and-- in terms of how do you deal in a company. But at the same time, we had some really great marketing. Ed Gelbach, for example, really brought a lot to the company. David Allen, those guys all brought something to it. And Grove respected them. And so, he gave them I guess enough rope to do the job. But he also recognized that you just didn’t build the widget; you had to sell it. And you had to have the marketing and the things-- branding and the things that went with it. So, Andy evolved. Andy learned, but he was always very much on the discipline side. And like I say, Gordon was always behind the scenes approving or setting the direction and so forth. And he was always kind of the guiding hand in terms of which direction we ought to be going in. So, it worked out exceptionally well.

Brock: Maybe we could talk about your move then into process development, not just fixing the process as it is, but making the process as it needs to become and what that was like in this period of, let’s say, the mid ’70s and figuring out -- how to figure out what directions to go to just how you did the process development.

Parker: Well, I guess to be honest, I hadn’t really intended to follow a career in quality and reliability. And so, at mid ’70s, I started getting okay, I’m kind of tired of going to customers and kissing their ass because something failed. And so, maybe I should go upstream and try to prevent it from failing in the first place and go develop it right. And so, I talked to Gordon. “Gordon, what are the chances of me transitioning over to development?” And then it turned out there was an opening for running technology development. And Gordon asked do I want to do it. I said, “You know let’s give it a try.” And I actually went over to work for Ron Whittier who had all of engineering at the time. And then I was responsible for working on the process development. It was a small group, thirty or forty people. And our goal was to really just develop the technologies. And it kind of grew from that into bigger and running all of the development and so forth.

Brock: Right.

Parker: But yeah, I guess I kind of felt that okay, I got a great education in solid state physics and so forth and so on. It would be fun to go upstream a little bit and work on that. And I was kind of happy with that. And I actually was thinking, “I’m not sure I ever want to try and run manufacturing or something like that.” But okay, that’s just problem solving of a different kind.

Brock: This would have been the era of so-called HMOS, correct?

Parker: Yeah.

Brock: And this is ion-implanted n-channel?

Parker: Well, a transistor. Basically, Dick Pashley actually was the guy that kind of did the design on those static RAMs. And he was a Caltech Carver student.

Brock: Oh, I didn’t realize that.

Parker: And so, he was in charge of the design group, well a combination design and process group. And so Dick worked for me at the time. And I remember they used to call it HMOS. And I said, “Come on, there is CMOS, and there is NMOS, and there’s PMOS. What the hell is HMOS? What’s high speed? Come on.” And now, we’re going to have all kind of MMOS and ZMOS and so forth. People are going to-- you lose control of the naming here pretty quickly. But we got away with it. We said, “Okay, HMOS.” But no, at that time, ion implantation was just first coming into vogue. And you could adjust the threshold of transistors. And that was the big deal is that we could adjust the transistor. And in fact, he had a zero threshold transistor that could be used to shut the power on and off. But still the whole idea was that you could control the thresholds much better. Performance got a lot better. And it got naturally better because we were shrinking dimensions.

But that whole-- that started the whole train toward shrinking. We’d never really thought of shrinking the die. But in retrospect, it’s obvious. And it was one of those things where okay, we design the technology. We build a bunch of stuff on it. Then we go to design another technology, build a bunch of stuff on it. And then I think it was actually Les Vadasz kind of came up with the idea. He said, “Why don’t you just take this one and shrink it?” Oh, okay. Why don’t we do that? So, we stared down that path. And I mean shrink is a little bit of a misnomer. The first one truly was just shrink it. But after that, it was really--

Brock: Just scale all the dimensions to the same percentage reduction.

Parker: Yeah, just--

Brock: Print it smaller.

Parker: Knob on the camera and change it. But that doesn’t work long term. I mean it worked for a little bit. But then now it was more compaction. Take the same circuit, and you just tighten it is up where you can. And that was kind of still the methodology. I mean methodology, that’s how you go from one generation to the next and get more die.

Brock: Right. And then-- so that is the basic transistor structures are getting smaller. So, then you have a cascade of compactions, and tightenings, and changes in all the other geometry. But is it true that that’s all built off of this fundamental shrink, which is of the kind of transistor size?

Parker: Well, you had probably hundreds of design rules. Design rules in terms of how big you could make a contact, how wide the metal can be, how thick the oxide. And so, when you go from one generation to the next, you say, “Okay, we know we’ve got to get more stuff in here. So, now let’s take a look at where can we get a little tighter geometry. We have a new litho tool. We can print smaller lines. But we can’t get these things too close together because we’ve got capacitor coupling. So, we can’t scale that.” So, it’s just a whole list of stuff that has to be integrated. And that’s actually was one of the strengths of Intel. We had a couple of guys that were really great at figuring out this integration. How do you get the stuff together? And then you have the specialists at each area, a guy that knows oxide etching, or a guy that knows metal, and so forth and so on. And not to besmirch IBM, IBM never had good integration guys. We would go to IBM, and they would have ten guys that were the best metal experts ever. And then you had twenty guys that were oxide experts. They didn’t talk to each other. And there was nobody to pull it together. Whereas, we’d have one metal expert and one oxide expert, but we had a guy that could merge the two and come up with an integrated process that made sense. And I always thought that that was a real strength that we had that we could do that. And it kind of grew out of everybody trusting each other and working together as kind of the whole model that Intel was built on. It was never built on silos where we don’t talk to those guys.

Brock: Would those people, those specialists, have to integrate their expertise, so to speak, in the CAD tool, you know like these electronic design tools to actually to the layout of the chips?

Parker: Well, you come up with the design rules, the design rules, and would feed those into the CAD tool.

Brock: Oh, okay. It’s what-- yeah.

Parker: And then the engineers, designers, would know how close they can put the metal, how-- they would-- and they would know the capacitive characteristics of the oxide and so forth. So, you had all that. And of course the guys would work together because if the designers say, “Hey, we really can’t live with this high capacitance between the metal here,” then the integration guy would have to say, “Okay, I need a little thicker oxide. But then I’ve got to make sure I can get a contact though it,” and get all the stuff figured out so that at the end of the day it all worked. But the integration of all that stuff, the collaboration was phenomenally important.

Brock: And that has to happen before you-- that’s how you define the design rules.

Parker: That’s how you get a working part at the end of the day. That’s usually the objective.

Brock: I guess that’s the ultimate test.

Brock: As your oversee-- well, you know, it's so complicated, or it gets increasingly complicated, to go from one generation of the process technology to another. What is it that I'm curious-- it's how you even find out the road you have to go down. How do you even figure out what the problems are that you have to tackle to get from this process generation to the other? Like how do you even lay out the road, no less actually go down it?

Parker: Well, I think you know what the limiters are on your current technology. All you got to do is talk to the design guy and listen to them bitch about why they can't get more transistors, or why it's not faster. And so in some sense you know, you kind of know what you have to do. That, "Okay, I can only make my contact so big. Or I can only get so many transistors in this area. I can only make it so fast." And so then you say, "Okay, well, what do we have to do to make it faster?" And one of the reasons that people want to start going from aluminum interconnect to copper is because copper is much lower resistance. 'Cause the designers are saying, "Okay, I just can't get a signal across this chip, 'cause of the aluminum resistance."

So it just kind of happens. You know, generally what the limiters are, by just looking at what you have right now, and then you work on those parameters, and always you know that you have about eighteen months to two years to get to the next step. And you know what the limiters are, and you kind of know that you got to double the number of transistors, so you know, then you just whack at it one at a time. But you look at the risk. And some Sung Min Cho actually did a great job of kind of outlining an almost a risk matrix. He would show me, "Well, here's all the stuff that's gotta happen. These are very high risk, and these are low risk." And so we would either say, "This is too high a risk." Or we'd put more people on it to fix it. You know, but basically, you kind of went through that in almost a-- if not a—some did it more formally, but I just kind of did it mentally. "Okay how much risk are we willing to take? And what do we have to do to get there?" And then it all coalesced into here's the new technology.

Brock: Risk of not being able to do it?

Parker: Yeah, not working.

Brock: Yeah.

Parker: You could put something in a technology that all of a sudden just makes it very difficult to manufacture.

Brock: Right.

Parker: And then you've got a problem.

Brock: In this period, I guess it's in '77 that you take responsibility, you become a VP--

Parker: For technology development.

Brock: In technology development. '77 it's not just one process, is it? There's memory has its own manufacturing technology, logic has its own.

Parker: That was one of the bigger challenges.

Brock: I would imagine.

Parker: Well, you know, and I think one of the first things I said is, "We're not going to run…everybody run on their own. Even though I didn't have full control over everything yet, that, you know, you'd say, well, the guys who were doing the DRAM process development want to use Shipley photoresist. And the guys doing Static RAM want to use Dow photoresist. I says, "What the hell for?" And at one time, I got a little unhappy. I got the guys from this group, that group, put them in a room. I said, "You got two hours to pick one photoresist. And if you don't pick it in two hours, I'm coming in with a coin, and that'll decide which photoresist we use." Two hours later, we agreed to use Shipley.

Brock: Because the--

Parker: You know, you had to start getting this thing now consolidated. And the same thing with equipment. We pushed on equipment, "Look, we're going to use the same equipment, because then it gives you flexibility in your manufacturing. If you need more memory or more processors, you have the same basic equipment." And the processors are never exactly the same, but the key sub-elements are always-- you try to make those the same, so that you can shift capacity very quickly, and you've also got a learning curve, then. You've got more stuff going into making Shipley work, as opposed to three teams making their own work. So that was something I started very early. Just pushing that like crazy. And then, of course, we carried that all the way into copy exactly, and lot of the other stuff that came out later as it evolved with-- everybody got behind it. I mean, the guys really worked to make that happen.

Brock: Yeah, and it seems like from the very start of the company, there was this close connection to/reliance upon key vendors, for manufacturing tools, you know, metrology, materials, and I remember the story of, you know, Gene Flath, I think, going on vacation or something to Los Angeles, and going to some display, and you know, Moore and Noyce telling him just to buy the equipment off the shop floor at the convention <inaudible>--

Parker: Well, that was very early.

Brock: And that was really early. But that, you know, "We're not going to develop these things ourselves. We're not going to make our own tools; We're not going to make our own photoresist. We're going to kind of team up with these vendors.' How much of your time was spent on that? Working with people like who were making the-- whoever, Perkin Elmer making the machines?

Parker: Oh, well, that's been a long time ago

Brock: Yeah, could you talk about that?

Parker: Yeah, I mean, there were two rules of thumb on this thing. One is, I didn't want specialty equipment. I remember Nikon once said, "Well, you guys make microprocessors, so why don't we design a stepper just for you?" I said, "No. What are you selling to the DRAM guys, because they're buying half your output, and I know you're going to make sure those work. So I want to buy the same tool, and I'll figure out how to make it work on processors. So the idea was never to be out with a special piece of equipment. You wanted to buy what the bulk of the production was going to be, and where they're putting their R&D, so that you knew that equipment was going to be there, and was going to be working.

And then the other thing, obviously, we would use the same piece of equipment in all the factories. We didn't let each factory go out and buy a different piece of equipment. And then sometimes, I mean, we would wind up buying equipment that the manufacturer wanted to obsolete, because they wanted to sell you a new one. "No. The process runs just fine on this. Build me more of them." So I kept very tight control over the equipment, because that's key. You have to have the right equipment, and you have to have good relations with your suppliers. And I don't want to jerk them through stuff they can't do.

Brock: Right.

Parker: So that was always in there. And we never dreamed of building our own equipment. And we established good relations with suppliers, and you know, worked with them, and tried to stay mainstream, quite frankly. It just wasn't worth it to do anything else.

Brock: I suppose over time, however, when the number of players over the course of your career, the number of other semiconductor manufacturers who were at the very, you know, who were trying to compete with Intel, process technology wise, is winnowing down. So I mean, at some point, it seems like now it's TSMC, Intel, Samsung, and then maybe some other people who define like the whole market for these suppliers.

Parker: Yeah.

Brock: That's an interesting-- there's no other mainstream but what Intel wants to do that's defining the direction.

Parker: Yeah, I mean, I was on the Applied Board for about ten years, and so I saw it from that side, which was, you know, between those three that you mentioned they were 40/50 percent of the sales for the most part. And so you pretty much had to work with them very closely. But we also kind of worked it to our-- we're not going to do anything stupid. Because, you know, and since I was on both sides of this thing, you want to be careful what you ask for. And so we would be pretty judicious in terms of, "Okay, Intel wants to do this, or Samsung wants to do that." Well, I don't think we can do it, or let's negotiate or work with them. What can we do? And the relationships were actually pretty good. I mean, there're always bumps and ups and downs, but in general, I don't recall many, if any, big conflicts over what you're going to do, what you can do, what you can't do. The good news, the collaboration was really pretty good.

Brock: Well, to go back in time then to the late '70s when you have responsibility for technology development. This is the period where Gordon Moore has officially become the CEO, and you become a Vice President. At one time, I did an exercise of looking at, just tracking over time, the group of people who Gordon Moore worked with through his time as CEO. And some people come into it. And some people come out of it. But by and large, you know, it's a very stable group of people. Fifty people, maybe, you know, that really stay for decades. I've always wondered how important that was that it was a kind of a stable group, you know, working together over time. There's changes in roles, but it really does seem, compared to other places, a remarkably stable group of people working together.

Parker: I think you're right. I mean, the core group that was around Gordon, shall we say--

Brock: Yeah.

Parker: -- was probably fairly stable, or it changed slowly, evolved probably. But yeah, and I don't know, I mean, sometimes you wonder, you say, "Well, people did leave, people came, left." But it never felt like, you know, major upheavals. I mean, part of it is, I think, Gordon has a fairly steady hand, and so you just didn't see the turmoil, you know, ten people quit and all of a sudden, everybody's unhappy. So Gordon, I think kept it fairly stable. But he was still very much behind the scenes kind of. He was not a confrontive person, obviously, and but he clearly had his hands on the key levers of power, shall we say? <laughs>

Brock: I would imagine that his-- your area in those years would have been amongst the most of interest to him. Was that something where he would go to you and ask kind of what's going on? What are the problems? Or was he waiting for you to come to him, and kind of tell him--

Parker: A little bit of both. A little bit of both. I mean, Grove came to my office one day when we were having huge problems trying to get the 386, he says, "We can build this thing?" I said, "I think so!" and he went, "Okay." Left. <laughter> But yeah, no, I tried to keep Gordon-- Gordon was interested obviously, but I worked hard to keep him informed and get his counsel on things and what we should be doing. And Gordon was really great in terms of approving the capital for what we needed to do in both R&D and manufacturing. And he was just fun to work with. And I'd get myself in trouble once in a while, and I think one time finance didn't catch me, and I had signed off like 80 million dollars' worth of new equipment, and didn't have that kind of signature authority, and we were having a big finance powwow, and I sheepishly went to Gordon and I said, "Gordon, I think I'm in trouble. I need you to approve 80 million dollars, so that I'm okay." And he said, "Okay!" And then the finance guys couldn't get me. Otherwise, it probably would have gone to the board. But so Gordon was great that way. And he had a great deal of trust, too. But the toughest meetings I always had were budget and capital meetings. Not so much because of Gordon, but because Andy and Craig would just hammer. Well, you know, that's a lot of money. And so--

Brock: And that was hammer on you to really justify it.

Parker: "Why do you need it?" and, you know, "What are the utilization rates?" and this and that. You know, it's legitimate. But usually I got what I wanted. <laughs>

Brock: Couple different things happening in this period, well, this decade, '77 to '88, a lot happened. The scale of the company is changing, so I mean, you're just dealing with more sites, and more activity. That's an interesting thing to contend with. I'd love to hear about that. And then we also have the rise of Japan in this period. So maybe we could talk about those two.

Parker: Well, I think that, as you know, in the early-- around 1980, plus or minus a little bit-- that Japan started rising, shall we say? And that's when we had the big wakeup call about the quality issues, you know, our quality versus Japanese quality. And we also, you know, in terms of our manufacturing prominence, capacity and so forth-- and that's about the time that Andy put Craig Barrett in charge of wafer fabs. And he and I-- we were both working at the time for, trying to think, Jack-- Ed Gelbach or Jack

Carsten, in that timeframe. And Craig just basically took a baseball bat to manufacturing and said, "Damn it! We are not going to get beaten by the Japanese!" And he drug all the factory managers, including me, I was just development, he drug us over to Japan on a couple trips to go visit the Japanese factories, and, you know, and said, "This is how you're supposed to it. You know, basically. But it wasn't so much that we copied what they were doing, but it was just, "Hey, guys! Wake up!" And so Craig really unfroze the thought process in manufacturing that we had to do better. And that started a big ball rolling in terms of, okay, you know, development guys, my guys, had to do it right the first time. We had to get into the factory. The factory guys had to do it right, and so forth. And by the time we got out of those '80s, you know, Intel had really transformed into a much more disciplined and better manufacturing operation. And that was Craig unfreezing them. I mean, he really unfroze it. This was-- this wouldn't have worked with a gentle nudge. This needed a baseball bat.

Brock: And this period is also, you know, this shift of emphasis for the comp-- well, getting out DRAM, really putting a lot of the company's future on the microprocessors. Although, you know, I think it is true that Intel has always manufactured memories, the whole-- throughout its entire existence. So often, I see people saying, "Well, that's when Intel stopped being a memory company." Well, not exactly.

Parker: We just put a lot of memory on the processor chip. <laughter>

Brock: That's true, too.

Parker: That way, we're still in the business. You know, we always had Flash memory and unfortunately, the company missed a big bet on that, because, you know, because iPads and phones and all have Flash, and Intel kind of poo-pooed that. And when I running manufacturing, quite frankly, I used Flash as kind of a buffer, because we needed it. Because it's all the same equipment, right? So if the microprocessor guys needed more capacity, I'd just take it away from Flash. Which Bob Reid just-- he would go crazy. He'd think he'd have capacity, and then, "Bob, sorry. I need to run this factory different." And so, he would be up and down in terms of his Flash, EPROM Flash, capacity. But they're still the right strategy. Processors are obviously what we had to supply. And The Flash memory you could run up and down, 'cause there were plenty of other suppliers. But Intel probably should have invested more in that area, even though the margins aren't as good, but okay. You know, that's the way it is.

Brock: There seemed to be two kind of stories about Intel's pivot, I guess, in '84, was it, from DRAM to the microprocessor. And one school of thought is that, you know, that Grove and Moore's explicit decision to make that shift was sort of just certifying a move that had already happened. That everybody else in the organization kind of below them had already made the switch, and it was them just kind of certifying after the fact that that's what was gonna happen. There's another story that one hears, where, you know, Andy Grove and Gordon Moore have to go around and tell people like, "No, we are really-- yes, we really mean it. You know, we are really actually making the shift." So those two don't seem to be fully commensurable. I wondered how you think about it?

Parker: I don't know. Okay, how did we-- how did Intel make the decision to get out of DRAMs? I know from where I was looking at it, and I had some of the R&D stuff that was associated with some of that. It became pretty obvious that the DRAM cycle was-- if you make a bunch of money, the you lose a bunch of

money, and you make a bunch of money, and you lose money. And it's almost a predictable up and down cycle. And you have to get there early, produce a bunch of parts, and as soon as the other guys come in, you lose money. And so I think I actually showed Grove a graph. "Okay, and here's what's going to happen. The way I look at it, we might make a couple hundred million dollars here, and then we're going to lose about three hundred million. Then we might make a couple hundred million, then we're going to lose." And I'm not saying that was the decision basis, but it was pretty clear to me that the DRAM thing had so much competition. And it was a few months here or there in terms of getting the new product out, that before you got into a death spiral over costs, or you know, selling price. And so the only way you were going to make any money in DRAMs is to get there first with the next generation, pump as much as you could out, and then almost go right to the next generation, because the other guys are six months to a year behind you. And that's when the prices collapse. So it was just the Wild West in terms of the revenue stream.

And I think by that time, we could see that the microprocessor was really taking off. We needed the capacity for it. We needed to build that product, and that was going to be at least a more predictable revenue stream for us. And so but I think when they finally announced it, I mean, a lot of people didn't like it. I mean, Jack Carsten, Woody were all really very disappointed. "How could we do this?" and so forth. Because they were still behind. You know, "We can do this! We can do this!" But I think when you took an honest look at it from a return on the investment for the effort, that effort put into processors was gonna be a much better return. I mean, like in hindsight on these things, you never quite know. But I don't-- like you say there are all kinds of stories about who and how and why. But basically Andy and Gordon made the decision, period. And I don't think the other than saying, "This is what we're going to do," I don't think there was much beyond that. People were disappointed. And you know, I had a whole team that all of a sudden didn't have a job. And the factory didn't have a job. And so, you know, we had to struggle with that. But the good news on that is that we flipped that team and that factory into a processor development in a couple months.

Brock: Oregon.

Parker: Oregon. Because we had all the same equipment, running the same Photoresist, the same stuff, so it was a very straightforward, "Just go do it." So that helped.

Brock: Did Oregon do the 386?

Parker: Well, the first 386 was actually built in Livermore.

Brock: Oh, really?

Parker: Yeah, that was where we had the Static RAM technology. And the yield was pretty bad. It was one die per two wafers.

Brock: Really?

Parker: So, every other wafer that came up, would go down. So that's when Grove came in, "Can we build this thing?" I said, "Well--"

Brock: Was there something particular to that part? Was it particularly complex?

Parker: It was a large die.

Brock: Okay.

Parker: A large die. And our defect densities were still running pretty high. And you have a large die, and the defect density, and guess what? And it doesn't work. So that really brought home that we have got to get the defects down. We got to run the-- we're gonna have to run big die in the future.

Brock: What was your perspective on the sole sourcing the 386? And the, you know, semi-bet of the company, you know, or the microprocessor business, let's say, on that? Put a lot of pressure on you to make the part, obviously.

Parker: Well, once we got to where we're going to be sole sourced, then you had a huge problem in the sense that-- and so I made sure that we had the product running in three factories at all times. That we had, you know, backup mask sets and tapes in secure locations. Because we had to convince customers that, you know, they can count on us being able to make this damn thing. And so you don't need a second source. I mean, that was the argument. As far as the politics of it, you know, that was clearly Grove's decision that, "Okay, we're not going to just give this intellectual property to AMD or anybody else. We're going to keep it to ourselves." And I don't think that's unreasonable. You know?

Brock: What did you think personally? I mean, at the time? Do you remember your reaction?

Parker: Well, it was fine. <laughter> It sounded good to me! No, it was a good, Well, I mean, we obviously were a little bit concerned because at the time IBM said, "Fine, we're not going to design the 386." But then Compaq picked it up, and guess what? You know, we're off to the races! So it was a gutsy move. It was a gutsy move. There was no doubt about it. But you know, in retrospect, it seems like, "Oh, that was the right thing to do." At the time, it probably didn't feel so good.

Brock: <laughs> And this is also at the end of this decade, you know, that '88 time period. Well, I'm just looking back over my notes and trying to figure out the point at which-- was it in '88 that they-- that you had responsibility also for manufacturing? Was that--

Parker: I think so. I think about that time, yeah. Memory fades.

Brock: Yeah, I went back into-- around that.

Parker: No, I think, I had the technology development from '77. And then Craig consolidated things into what's called a Components Technology Manufacturing Group in like early '80s, '84. And then they split that up into the different business units for a while. And then right around '88-ish, they had me take over pretty much the whole thing.

Brock: Of all of manufacturing and the technology development, yeah.

Brock: And the technology development, yeah.

Parker: And it stayed together since that time, hasn't it?

Parker: Yeah, yeah, it did. We had a little few aberrations where when that Dave House decided he needed to be President of Microprocessors, and Frank Gill President of Systems. And then Dave decided he had to have his own manufacturing. And so Craig told me, "Well, you have to let Splinter work for House now." I said, "What am I supposed to do?" "Oh, you're in charge of strategy." I said, "What?!" He said, "But you can still tell them what to do." Said, "Okay!"

Brock: So Mike Splinter had two bosses?

Parker: Oh, yeah, he worked for me. <laughs> Just on paper he worked for House. Nah, I mean, I'm being facetious, but I think that, you know, so we had our little meanderings in there, but basically it was always a consolidated thing. And in fairness, people like George Schnear, who had memories at the time, argued very vocally that he should have his own control of manufacturing, have his own development and so forth. Which, from a business point of view, from his perspective it was the right thing, because he could go with cheaper equipment, and he could go with more focused approach. Whereas, if he stuck with the general manufacturing, "No, you're going to use the same equipment here and you're going to do the same thing." which it wasn't always the best, but it was necessary to have that ability to shift capacity and to really stay on top of the processor business. So, you know, we went back and forth on stuff like that.

Brock: That is an interesting point, isn't it?

Parker: Yeah, so I mean, I didn't dispute their rationale for wanting to break it up and run their own, but in the long run, it was the wrong thing to do. And Grove and Moore kind of sided with that, and so we kind of kept it together, even though occasionally we'd have little org chart forays.

Brock: <laughs> So in this period, '88 to '98, that decade, you must have been responsible for spending most of the money that Intel spent.

Parker: Yeah, yeah.

Brock: And this is the timeframe, too, where, you know, a new factory is going to cost a billion dollars. It's just fascinating to me dealing with-- how you contend with things that have that kind of a scale you're talking about so much money, and so much investment, and so many devices being produced.

Parker: I mean, look at it, it's just the first four digits that are significant. Don't worry about all the zeroes after that. <laughs> It'll confuse you with the details.

Brock: There's some truth to that.

Parker: Yeah.

Brock: Because you're just looking basically at the same fundamental dynamics that were going when it was smaller orders of magnitude. You know, I mean, I tried-- I spent a lot of time worrying about capacity, because you can never trust the marketing forecast. The guys either said they didn't need any, or they needed the moon. So my job was always to make sure we had enough capacity, but not too much, and make sure that we had the equipment. And so I spent a lot of time just really trying to figure out, do we have enough capacity? Where do we build stuff? You know, can we get the equipment? And then I'd keep an eye on the development guys, and say, "Look, you have to reuse 80 percent, 70 percent of the capital equipment. I'm not gonna let you buy all new equipment for every generation."

And we got good at that. Said, "Nope, okay, we're only going to change what we absolutely have to." And so then we're gonna, you know, copy the process, and I'd make sure that we had the capacity, and you know, so I spent a lot of time on that, and I'd have metrics in the back of my mind, "Okay, it should only cost so many thousand dollars of capital per wafer. So if it gets more than that, guys, you're not watching this. It's gonna add too much cost." And so you keep a few metrics in the back of your head. And then you hit-- you know, you set the clear direction for everybody, and you know, the guys were pretty good about getting it done, and we had good results.

Brock: Hm. That's the decade of, you know, the real-- the prime decade of Andy Grove as CEO, I guess.

Parker: Yep.

Brock: And was there much of a change from your point of view, from Gordon Moore as CEO to Andy Grove as CEO?

Parker: No, surprisingly little. I mean, I was dreading it actually. <laughs> I said, "Oh, no. Oh, my god!" You know? But Gordon was, you know, so smooth and charismatic, strategic. And here comes Andy. I said, "Oh, my god! He's gonna be CEO? Now what are we gonna look forward to?" But no, it was a seamless tran-- because for me, it always seems seamless, because I always used to go in and get my budget approved by Gordon and Andy. They were always sitting there side-by-side. And Gordon was still sitting there, even though, officially now Andy was CEO. It didn't feel any different.

Brock: That's fascinating.

Parker: It was just fine. And maybe the rest of the company saw it differently, but I certainly didn't.

Brock: I think it was around '90/'91/'92 in there is when you start to get the technology roadmap for semiconductors that I believe was modeled in part-- well, from technology road-mapping at Intel and other places. I think maybe IBM was doing some technology road-mapping also. I thought-- well, could you speak to that process of technology road-mapping within Intel and in your area? And what that practice was like, or just thoughts about that?

Parker: Good question. Well, we always had roadmaps. Okay, and you typically have road maps even down to the sub-process level. Okay, what do we think the roadmap is for gate oxide thickness, or for metallization, or for usually line width, but basically what do we think the roadmap is? And we always had

a roadmap. And I would have subgroups of people that were specialists that would work on their particular roadmap.

I have mixed feelings about the whole Sematech and all the grandiose roadmaps that they started developing, because then we said, "Well, we have to have an industry roadmap." "Okay, what does that mean?" And so then they started coming up with roadmaps. And I think that on the one hand, it was good to have a public roadmap. And part of the reason is because then especially R&D labs and university professors and people would kind of say, "Well, you know, the world is moving toward--," whatever, "And we should be training our students to do that." And so it was kind of fine to have that. But then sometimes you also get this group-think that well, this is where we have to go. And everybody has to line up with that. Well, it almost stifles doing something else, because now the roadmap is this. And then they'd get a little bit carried away. I remember Sematech, I forget the number, Symantec had a budget of 150 million dollars. And their roadmap said they were going to leapfrog us all. And I said, "Guys, my budget is 250 million dollars. How the hell do you think you're going to get ahead of me?" I mean, you know, get real. And so there was a lot of that sort of stuff that didn't make any sense. But still it allowed at least some degree of focus. It kept some people from going too far afield. So to me, it's kind of a mixed bag. I don't know. I certainly wouldn't say, "Don't do it. It's useless." On the other hand, I would say, "Well, I wouldn't want to tell my guys to go follow the roadmap exactly."

Brock: Mm hm.

Parker: Just doesn't make any sense. But it was-- and it was good. It kind of coalesced people around a little more cooperation on things.

Brock: In all those years of responsibility for technology development, manufacturing process, was most of what you needed to note, involve that technology through all those process generations, was that evolved from within the company, and you know, in collaboration with these key suppliers. Or did you bring in-- were you importing stuff from kind of the academics? I guess the inside/outside question for pushing that technology?

Parker: No, I don't think we had all that much NIH in terms of-- it all had to be done by us, and everything outside is bad. In fact, we got a lot of help from IBM.

Brock: Huh!

Parker: Even though I earlier said IBM couldn't integrate worth a darn, they had great technology. And the whole planarization polishing thing came from IBM. And I remember the first time I saw that, IBM showed it to me, and I told my guys, "Whoever brings that in I'm gonna shoot. This is the dumbest idea I ever heard of!" <laughs> And it turned out that was absolutely the right thing to do.

Brock: And this is so you can have all those metal layers.

Parker: Polishing the front of it. Polishing the front of the wafer. I mean, who would have thunk it? You know, the whole-- the way all this stuff finally-- you know, lithography was always going to stop at one micron.

Brock: Yeah.

Parker: And one of the big reasons for that is because you had this up and down. You didn't have the depth of field. And so you couldn't focus. The bottom and top of a layer of metal. IBM pioneered putting glass on the wafer, all those bumps, and polishing the front of it. And like I said, I said, "This is awful! How can you do this?!" You know? And they polished the front of it, and then you'd punch holes in, and put another layer, polish it again. And that was absolutely the key to where lithography is going now. Because it takes away all the depth of focus issue, because now you've got a planar surface to focus on. Whereas, if you have something that's up and down like this, you can't do it.

Brock: So for example, in an Intel microprocessor today, there's kind of this, kind of base layer where the transistors are. And then there are, I don't know, how many 15 layers or something like this?

<overlapping conversation>

Parker: <inaudible>

Brock: Some great number of layers of metallization. So is one of these polish steps between each of those metallization?

Parker: Pretty much, yeah.

Brock: Wow!

Parker: Yeah, I think they polish every layer now. Because you have to get it planar again. And it has to be planer. And then later, then you drill holes and you fill them with tungsten or some metal.

Brock: Hm!

Parker: But no, it's-- but that was an incredible breakthrough that IBM was using it on their bipolar. And so, you know the point is that we had some cooperative stuff with IBM in technology exchange meetings. And I just thought they were great. I mean, from a technology point of view, they really helped us. Really helped us. But I say we could always do a better job of putting it all together, which hopefully they appreciated from us, because we transferred stuff to them.

Brock: Was that after that big investment that IBM made in Intel?

Parker: Yeah, pretty much. Yeah, I'm trying to think, because that would have been in--

Brock: '83 or something like that?

Parker: Yeah, the early '80s. Early '80s/mid-'80s when we had a lot of IBM interaction. And I enjoyed working with them. I really thought IBM was top-notch.

Brock: I wanted to ask you a question about Moore's Law. And when I was read-- as I have read Gordon Moore's kind of earliest work on it, it seemed to be Moore's Law was a kind of, a pace of change that was

empirically determined. That is to say, "This is how fast you go in order to get cheaper transistors on the integrated circuits that you're making." And then it seems that, okay, that there was an effort to kind of maintain that pace for a long time. Everything became geared, if you will, to that sort of a pace. And more recently, there's been a lot of talk in the press about some recent statements by Intel that they have found that it's gone from whatever it is, two years, to two and a half. And it seemed like that was something that Intel was discovering. Like, at this level, at this-- with this process technology, it actually-- that point of-- that pace of change is now a little different than we'd seen-- what it was in the past. I would just love to hear you, since you lived with that for so long, talk about-- if you could react to that comment, if that seems right or wrong, or just talk about living with that phenomenon.

Parker: Well, as you say, Moore's law started off as an empirical observation. Gordon was great at observation. I mean, data taking and observation. So that was pretty clear. And we would try to analyze a little bit because we knew we had to kind of keep going on this thing, and it tended to fluctuate a little bit between design innovation and manufacturing capability and shrinking. So-- but the cadence was sort of there and-- whether it's every year, year and a half, and so forth, didn't matter. But-- so there was kind of that cadence that was established that you knew you had to kind of do it. And it also-- I don't know which, chicken or egg, came first. But once you kind of had that cadence and you said, okay. We have about two years to develop this new technology and it's got to be twice as fast and half the density or twice the density and some of it's going to come from design innovation.

And what they're doing now, of course, is stacking transistors. Right? More layers. So there's always been that little metronome of doing that, and you use that as kind of a guideline. We don't want to do something-- change the technology in six months, every six months come out with something. And you can't wait five years. And I don't know whether that's-- if we take five years, somebody else will take four years, or if you take six months, you won't get what you-- enough of a bang for the buck to justify it.

So somehow, it was almost kind of a natural evolution of life cycle that said, yeah. About every two years, you should be putting a new technology in and that gives you time to ramp the old one, time to design the new one, and move on. And it happens to be on that kind of a cadence. And quite frankly, if, after two years, you didn't get any shrink, then why bother? Or any cost advantage. So it kind of all has to work together. Yes, we have this cadence and we know we have to get the cost down. We have kind of a two-year window to do it, so let's get cracking. And I'm not sure there's much more thought that goes into it than that, quite frankly.

Brock: A lot of people, especially now, as we're talking, are concerned about, and I think justifiably, for how long that cadence can continue. Because if you think about it, many people working in technology today have never lived in a period without this cadence going on and getting a lot of free compute in the next microprocessor that they buy. And Gordon Moore's position seems to be, if you boil it down, that's silicon special. So the concern about how far it can be pushed is a real one. I wonder what you thought.

Parker: I learned a long time ago not to predict the demise of Moore's law or so-- but these things, even Gordon says an exponential doesn't go on forever. And so, I think that we're starting to see some pressure points and it's getting a little harder and it's getting a little more expensive. And, okay, Bob Noyce always used to say I don't see why do 3D; it's only-- that's only one more dimension. Keep

shrinking. So you can't do 4D. All right. So we've kind of exhausted some of that. I think we'll continue to see innovation and we'll continue to see things happening, but maybe it'll slow down. I used to always worry about it just getting too expensive for the marginal gain. And you see a lot of successful semiconductor companies using old technology because there's plenty of things that can be done with the older technology that you don't have to have a trillion transistors on a chip. So I think economics may well collide with reality at some point too, but who knows when.

Brock: Let's see. Well, I guess it was in this decade of '88 to '98 where the sorts of standardization efforts that you were driving from early on get codified as copy exactly.

Parker: Yeah.

Brock: And was there anything-- I just wonder if-- we talked about it a bit. Is there-- was there anything-- any other comment about the copy exactly story?

Parker: Well, I'll give you a little bit of background, in the sense that when I first got involved with technology development, it was a pretty small group. They would basically write out a process flow, make sure it sort of worked, and then we transferred it over to manufacturing engineering, who would go through and kind of tweak it and fiddle with it and do whatever. And then, they would transfer it into a factory, who would usually also twiddle with it a little bit. Okay. And so, you think of it as a learning curve. You look at the yield versus time. It got better, better finally out here, after we processed 100,000 wafers, we got good yields. Okay. It makes sense.

Now, give it to a second factory, guess what? They start off at the bottom, and it took them 100,000 wafers to get to good yields. So I said this is bullshit. We can't run the things that way. So between—Sung Min Cho-- running stuff, Dick Pashley was there. I mean, we really started noodling on, come on, guys. We got to do better than this. And, of course, Barrett was hammering people to get better. And we said, No, we've got to get this thing more streamlined. We've got to get-- do it right the first time; all the jargon that you want to use. And that got-- kind of got involved into, okay, let's do it right the first time and then you copy it and you don't change it. And if you looked at that same graph 10 years later, okay, first of all, yield started off up here because the development guys had to have it right, and it-- 100,000 wafers, great yield. Second factory comes on, first wafers, 100,000 of them. They didn't start over again. Because we had a process that worked, copied it exactly, right equipment; same thing. So the data proves that that works. Whereas before, it was-- everybody would just reengineer it.

Brock: And do you do that by documenting every setting and part?

Parker: Pretty much. Yeah. I mean, it was early-- I mean, you have recipes and the recipes are-- nowadays, you just plug them into the machine and here it goes. Right? Not quite, but close. The same equipment. And when we transfer, I mean, when we brought up Ireland, we had 300 guys from Ireland here in Mountain View working side by side with the fab guys and then they all went back with exactly the recipe, the exact equipment, everything. Then all the bars went out business.

<laughter>

Brock: At Fairchild R&D, there were a couple of interesting cases where when somebody wanted to-- when there was a process technology innovation or development, Gordon Moore would say, well, if we're going to get serious about something, like if we're going to get serious about silicon-gate MOS, develop a product with it. I wondered if you could talk about-- and so, it would be actually developing the process while you're developing the product that you're going to make with that process. And I know that was the case in the early years of Intel, that there was always this vehicle. Did that continue throughout that whole time? How important was that?

Parker: Well, you have to have the product. Right? Otherwise, you're running test chips. Typically, on a new technology, there-- you have a new processor or whatever that's designed by those guys and we have to make sure it synchronizes with the process development and the manufacturing capacity. So you work together on it. You have to do that. But we always had a test vehicle, which usually was-- which was the shrink of the last product. So again, you take a 386, the processor guys are developing the 486. We're developing the technology to run the 486, but I have to have a vehicle. So I said okay. Let's just take that 386, shrink it, and use that. And then, quite frankly, if they're a little late on the 486, I've got a vehicle that I can ramp production with, and the 386 is faster, better, cheaper, and so forth. And we did that, shrunk the 486, shrunk the Pentium, on and on. Because usually, the first chip that the processor guys design is as big as a house and hard to make and slow. And so, it's a natural to go, compact it, shrink it right away, get it on the next technology and ramp manufacturing. So usually, the big ramps are on the second generation of the technology, not the first. I don't think we made more than about 7 million Pentiums on the first technology before we shrunk it, and then we made 200 million on the shrink. So--

Brock: For you personally, you had so many locations that you were responsible for throughout the eighties and nineties. Were you constantly on a plane or were you getting data coming back into-- how did you personally manage that?

Parker: Well, we had locations around the world. I mean, if you think about it, we had the wafer fabs, assembly plants, box plants, system plants, and then, suppliers. I spent quite a bit of time dealing with suppliers and subcontractors. And so, I would just kind of budget my time, would say okay. Usually, once a month or so, I would just do a one-week trip and I hit all of Europe at the same time, one day in each place or whatever. And then, I'd hit Southeast Asia once, then I hit Japan and Korea. And just kind of--

Brock: Stay cool.

Parker: Do the cycle and then hit the US ones and just kind of fly in, do the usual ops reviews, see what's going on first-hand, and then-- and the rest of the time, I don't know, just try to make sure it all didn't fall apart. <laughs> I used to tell the guys if you use a CB radio, say, "Hey, guys, remember. Keep the shiny side up and the greasy side down."

<laughter>

Parker: The truck drivers.

Brock: There's another fascinating period on the-- this kind of the Web and Internet bubble where Intel's valuation is going through the roof and it just seems like a tremendous amount of activity and business, just your impressions of that time. Because I know at kind of the height of it, they gave you-- you transitioned to a different job with the new business group. So just your experience of that time, I'd love to hear about.

Parker: Well, the new business thing was an eye-opener, shall we say. A couple of thoughts come to mind. One is, when I started dealing with some of the companies and trying to figure out what's going on, I just couldn't believe the shell game, for the most part. And it didn't-- basic economics seemed to have gone out the window. And you go talk to somebody. They say, "Oh, no. This is a new world. The old economics don't work anymore." Said, "Oh? <laughs> You mean-- okay." And so, then, Grove asked me to start a new business group, which, okay, there is some issue, and I think that was doomed to failure, to be honest. And the reason is trying to start a new business in a big company is-- let's use the word near impossible. And you can hire consultants and they'll tell you all kinds of things. Well, you have to have a dedicated sales force or you have to have your own building or you have to have some-- you have to do this, you have to-- the problem is the accounting rules.

To give you a simple example, if I have a new business I want to get going inside of a big corporation, I need $50 million, $100 million a year expenses and it'll take a couple years, maybe, to get revenue, to get it going. That money is straight off the profit and loss, straight off the P&L. So he gets scrutinized. Wait a minute. You can't have $100 million. How about $20 million or let's cut this down. Do a flip. I go off and start my own company and get venture capital to give me a couple hundred million, raise a little money. Then, Intel comes along or somebody comes along and buys me for a billion dollars and say what's the difference? You wouldn't spend 100 million, but now you spent a billion. The reason is the billion goes on your asset books, mostly good will, and all the 100 million comes off your earnings per share and your stock gets hammered. So the accounting rules, GAAP, has done the world a great favor in terms of financing the bankers by making it easy for a company to spend a billion dollars acquiring a startup. 10 guys and a dog worth a billion dollars, and then they just put it on as good will. Whereas if you tried to spend a tenth that money out of your P&L, they'd hammer you or your earnings are down two cents because you-- that's the fundamental problem.

Brock: That is a very clear explanation. I mean, well, you can see from my reaction. Is this kind of the idea? Well, I guess it's not the same idea, but this movement of Google to Alphabet, is that-- it's different, but--

Parker: I think-- what-- the best way to do it, actually-- I may be wrong on this, but I think Cisco actually had pretty close to the right idea. Because the way you want to look at-- say you're a company and you want to invest in something-- invest in small company. If you invest-- if you own less than 20 percent of that small company, then it's just an investment. You put it on your books as an investment. You may have to write it off, but even if you write it off, nobody cares. If you invest between 20 and 50 percent ownership in that company, then you consolidate the net. In other words, the company loses money. You just add a loss somewhere, if they make money. If you take 51 percent, you consolidate it line by line; R&D, manufacturing, and so forth. And so, if you want to keep this thing from hitting your P&L, it's-- you do a startup where you own 19 percent. If they're successful, then you go buy them for whatever amount

of money that they need to buy them and it never hits your P&L. It goes on as good will and now you've got a product.

Brock: Is that Intel Capital?

Parker: Well, Intel Capital just invests. They weren't--

Brock: But that's--

Parker: They were-- well, they were doing buying, too, but it-- yeah. I mean, in that sense, but it wasn't like they thought about it.

<laughter>

Brock: And were-- was Les Vadász doing Intel Capital at the same time--

Parker: Yeah.

Brock: --you were doing this?

Parker: Well, that's where this thing kind of-- I was trying to get about $25 million to build laser amplifiers on silicon. And, of course, getting hammered by Barrett and finance guys. Why do you need $25 million or-- and then, a month later, Vadász bought a company, 10 guys and a dog, for $450 million. They were doing the same thing. They hadn't even made a product. That's when I said okay. This is really an interesting scenario, how we're going to do this. But that accounting situation that works against you and, like I say, I'm a-- I kind of noodle. Okay. Now, how could a big company do this without-- because you're not going to change GAAP any time soon. The bankers like it when you buy a billion dollar deal because they get 50 million in fees. So you-- that's what I said. I think you do this. You start on the outside, invest 19 percent, and then you buy them. So it never hits your P&L, except when you finally buy them, and you could argue, okay. Yeah. Now, I got to pay a lot more money than if I had developed it myself. Maybe, maybe not. If you use the venture capital model, one in ten is successful. So maybe I got-- I do have to spend a billion dollars before I get my billion-dollar return. So it wouldn't be a bad idea to do it that way, but-- everybody struggles with that, all the big companies, and they all talk about either setting up incubators or, like, I say, you can hire consultants that'll give you all kinds of great ideas. But--

Brock: Yeah. I sometimes wonder about-- I wonder if what you're just describing can account for just even the struggles of maybe a lower, less profitable business within a corporation--

Parker: Sure.

Brock: --that has a very profitable franchise, like microprocessors or the server microprocessors. The struggle of the folks trying to get processors for telephones or for tablets or things like this, they're-- it would seem to me the accounting would present them with the same struggles, that it's always affecting the ledger, drawing the ledger down.

Parker: Yeah. I mean, once you have a certain business model that says your gross margin is 50 percent, 60 percent, or whatever, the minute you take on a new business that's only a 20 or 30 percent gross margin, the Wall Street analysts hammer you and say, oh, your earnings per share are going down. And so, people are deathly afraid of doing that. And I think that so shortsighted for the most part. If you want to grow the company, you're going to have to grow revenue. And, yeah, you don't want to have a money-losing business, but I think if the business contributes net positive cash flow, you should do it and the hell with the analysts and just tell them no. Our-- we're going to target a lower gross margin because we want to grow revenue and get into these new businesses. And I think you could do that.

Now, that's one side of the coin. The other side is when you're investing a lot of capacity-- remember I told you it was-- it costs $250 million capital per thousand wafers capacity. A lot of these businesses the guys were trying to start don't justify the capital. So they kind of can't have it both ways and say, look. Our capacity costs a certain amount, I have to get a certain amount of revenue out of that-- out of those wafers. Otherwise, it isn't justified. And a lot of times, they would come in with stuff that just didn't justify it on a per wafer basis. And they tried to piggyback on the manufacturing that was already installed and the classic one would be, well, you're building a new factory, I want the old factory. No. You don't understand. I'm reusing 70 percent of that old factory and so I'm not going to give it to you because that-- now, I have to spend 70 percent more on the new one so that you can have this old one. How about paying for that? And-- oh, well, we can't pay for that. Okay. So that's the flip side of the thing. I mean, so you-- the dynamics are more complicated than just that they're-- but-- that they're low margin. I mean, I think you could handle a low margin, but you can't handle the investment sometimes and you can't let them just piggyback on the old factory because the old factories are valuable.

Brock: Right. How did-- well, you're in this tough position, this job, '98 to 2001, and that bubble bursts. Could you-- I just wondered, did-- what that was like for you and your colleagues at Intel and also just everybody in Silicon Valley. Was that completely unexpected or-- just your recollections.

Parker: You mean the new business? I don't know. I say it's-- I had very mixed feelings about the whole thing. When I was asked to do that, a lot of my guys – I’d get a phone call. Hey, can we join you? Let's go do this. Because everybody had kind of-- this is a great chance to go do something without realizing what the real issues where. And so, we had that dynamic to where it was relatively easy to, quote, recruit people to do that. It was a lot harder to kind of justify each business. I mean, in a startup, you need to be able to change directions overnight. Okay. This isn't working; let's go do something else.

In a big corporation where your plan said that you would have this by September, why don't you have it? Well, because we decided back in January it wasn't worth a damn. Well, let's kill that business. Okay. So there is a little bit too much, and I remember practically yelling at Barrett one time and-- as we were going to slip a month on-- we were doing something that looked like an iPad. We were going to slip a month on it. He said, okay. We're going to kill it. And, Goddammit, if the Pentium slipped a month, would you kill it? Come on. So-- I mean, so we'd get into those kinds of arguments. So that was kind of the one learning.

The other thing is I didn't fully appreciate how hard marketing [was] and just developing a product that's new and how do you get it out? Do you hire-- and these marketing people and advertising people would be-- didn't speak the same language. And so, that was hard for me. I just-- oh, boy. What have I gotten

into? But it just-- it was an interesting experience and you kind of learn a lot in terms of, okay, what does it take to get a business started in a big corporation? What's really going on in the Internet? And most of it was a shell game. Total shell game. I mean, the--

Brock: Consciously?

Parker: Yes. I'll give you a simple example. Internet company A, Internet company B. I'll advertise a million dollars' worth of advertising on your website. Okay. A million dollars' worth of advertising on your website. They each count a million dollars of revenue. And a million dollar expense, but nobody expects them to make money. And, you know, as near as I can tell, the telephone company's been doing that for years. Okay. I'll charge you for bandwidth and then, in Brazil, okay, and we'll charge you here. Oh, it offsets, but we get a lot of revenue. So there was a tremendous-- a lot of that crap going on. People were basically counting-- reselling dollar bills and-- or exchanging dollar bills and counting them as revenue. I was just horrified. I'm-- and-- Grove pounded on me. Goddammit, Parker, get some revenue. I said okay and I'll show you how I'm going to do it. I'm going to show-- I'm just going to exchange this and do that. And he got, don't you dare. I said, you wanted revenue, for Christ's sake. Easy. I could do it for you. Might go to jail.

<laughter>

Parker: I could do it. No. But the point is that there was a lot of that going on. People were basically, use the accounting term, cooking the books in terms of reality of what was real revenue and what was just I'll resell something and so forth. And then, of course, the valuations. People were just rolling the dice on stuff and-- so I learned a lot about--

<laughter>

Parker: --business, shall we say. But Intel didn't have the stomach for it. I mean, I think that, ultimately, we got killed by that same accounting rule, which said it's easier for Vadász to spend $13 billion than for me to have a $500 million budget to do something. When we had to cut, we cut. So--

Brock: Well, talk about your decision to retire from Intel.

Parker: Now, I mean, I had always said I'm going to retire when my kids get out of college-- or out of high school, actually, out of high school. Gordon had retired. So-- and that was kind of a mentor, mentorship, leaving. So maybe I figured, okay. Now, I don't have any air cover <laughs>. I don't know. But-- so that played into it, but also the whole Internet bubble was just crashing, and I knew we were going to have to shut down all the new businesses, most of them, really, because the corporation just wasn't going to fund them. And again, the P&L was going to be there. And so, I mean, Andy was a little bit unhappy. I mean, he actually wouldn't speak to me for three months. He was-- but I said--

Brock: He wanted you to stay?

Parker: Well, yeah. But we'd already turned over the operations and so, what am I going to do? Hang around as an expensive strategist or something? That just didn't feel right to me. I felt, hey, I gave it my

best shot on the new business. It wasn't something that was going to work within the framework of bubble of Internet and corporation, and the kids were out of school. So I felt pretty good about it and-- but like I say, Grove was a little unhappy. He told me I promised him four or five more years and-- but I said come on, Andy, wake up. I mean, it's-- and he got over it, but he was mad.

<laughter>

Brock: Did you-- I know that in that period from your retirement from Intel until very recently, you were serving on a number of corporate boards and other organizations too. But I wondered if you put some of-- well, your Intel experiences, including the new business group experiences, if you did any kind of investing work for yourself based on those experiences? Things that you saw and have you done investing yourself afterward and--

Parker: Nothing that I would brag about.

<laughter>

Brock: Fair enough.

Parker: I put some money in a restaurant in Los Gatos that went belly up. I put some money in an online jewelry and it went belly up <laughs>. Let's see. What else would <laughs>--

Brock: I don't think you're the first person to lose money in a restaurant. Yeah.

Parker: So other than that, no, but not seriously. I mean, I--

Brock: I was curious if you continued.

Parker: Yeah. I put some money into a small venture fund, but, really, it's not-- I just got-- didn't feel like it. I enjoyed being on the boards and that was-- kind of kept my hand in things.

Brock: Well, it seems like for FEI and Applied Materials both, I mean, you must have known both those organizations very well from working with them--

Parker: Right.

Brock: --for all those years at Intel. I got to do an oral history interview with Lynwood Swanson and saw where FEI is kind of in the shadow of the Hillsboro plant itself. Just wondered if there are any-- just what it looked like working with Applied and working with FEI. We talked about some of the dimensions, just from the other side of the table. But there's-- was any big experiences of that that we haven't covered yet?

Parker: No. I mean, I enjoyed being on the boards and I'm always a stickler for discipline, and so, I kind of pushed very hard. And I was chairman of governance committee and helping out and so, I kind of tried to, okay, guys, start the meeting on time. So I was much more into the governance and get things done. And Applied was run like a whole bunch of fiefdoms and having just come from Intel where a-- use a common platform, use common stuff, I kept-- we got to get-- why do we have to use a different gas flow

controller on every piece of equipment? Can't we use the same one? And so, Mike put some guys in charge of doing that, but it was so entrenched in that company. I think it's now 10 years later and they're just kind of getting to those common platforms, quite frankly. Gary Dickerson's now running it and I think he gets it and-- but it takes a long time to change a mindset. And so, that was kind of one of the, okay, guys. And I'd work on that, but I enjoyed working with that board and they'd invite me in to talk to the guys about everything from management to what have you. And I could see it from the equipment side, dealing with Intel from the outside versus from the inside.

FEI was-- is another great story. They came out of the Philips electron beam, merged, and started doing SEMs, and we hired Don Kania about six, seven years ago and he's really made a huge difference in growing the company and getting-- branching out a little bit from just semiconductors into medical and so forth. And it's a well-run, well-run company. And I was on the board of Lattice for a while, too, which is kind of interesting.

Brock: Forgive me, but I'm not familiar with them. I mean, I'm familiar with the name, but not really the details of--

Parker: Well, they're a small third place in a three-horse race <laughs>, as Xilinx has about 40 percent of the market, Altair has about 30 percent plus of the market, and Lattice has 10 percent. And so, Lattice is going after the small chips. This is a case where using older technology is great. I mean, these chips are-- I mean, they get 10,000 die per wafer, when you only need one wafer <laughs>. So-- and they're basically the glue chips that go into phones. I mean, Samsung buys them. I think Apple buys them, but not officially, and we sell them to Huawei. And so, these are just tiny chips, but it's a great little business model and they're-- the big guys don't want to go down there because they don't want to devalue their $10 part. When we're down there, we don't have a $10 part. So <laughter> we’re just happy. So that was fun. And I got off all those boards. Mainly, I feel, at 70, you ought to be getting off things, not getting on. And so-- but all three of those companies, I enjoyed. They're great companies.

Brock: And had you-- so you left those boards and then started a walnut farm. Was there an inkling of an interest in agriculture before that? Had you been an avid gardener or--

Parker: No.

Brock: --anything like that? No? Just it-- an entirely new thing for you?

Parker: Well, my wife was born on-- raised on a ranch in Colorado and so she had always kind of wanted-- why don't we get a farm or get some land, get something? And I'm kind of okay. I mean, I'm not sure I want to do that. And so-- but then, it turned out-- my grandkids live in Davis. And so, we said, well, why don't we live out there, move out there? And then, I was looking around for a property or-- and I saw a walnut orchard. I said, "Hey, wait a minute. This could be interesting." So, long story short, bought the walnut orchard and built a house out there and moved out there. And so-- and then, bought a couple more orchards and then, my wife said "You're nuts. You go buy all this land and orchards right when we go into a drought and water-- what are you thinking?" So-- anyway. So-- and drill-- and so, I've got a new well going in. It's a whole different world.

Brock: But it's manufacture. Right? So it's a--

Parker: It kind of is a manufacturing challenge.

Brock: A familiar-- yeah. With the-- with probably just as many-- probably more variables than your earlier manufacturing. Yeah.

Parker: There are variables.

Brock: It's certainly an open environment.

Parker: But it's really interesting. I mean, farming is becoming much more scientific. I mean, it's-- and actually, it got interesting. The guy I have that really kind of does the work-- gets the work done, he's old time. And I went to Davis for a week to get educated on how to grow walnuts, which if I had gone before I bought the walnut orchard, I wouldn't have bought the orchard. So that's a whole-- another story. But nowadays, I mean, there's a lot of science that's going into this. Everything from testing the water content of the leaves to make sure that you're getting the right amount of irrigation and you do the math on how much nitrogen you're taking out with the walnuts versus how much you're putting in so that you don't pollute the groundwater or use too much or too little.

So it's really kind of fascinating to figure all that out. And then, they're testing all kinds of different rootstocks and, of course, the farmers go chase each other around. They decided about 15, 20 years ago the way to grow walnuts is with a real fast-growing variety in a hedgerow. And now, just last year, they figured out, oops. That's not good because half the tree is shaded and you only get half the nuts <laughs>. And then, they're so fast growing, the wind comes along and knocks all the branches off or something. So now, we're going back to spacing. But it's an-- it really is kind of fun to learn something new.

Brock: Yeah. I would expect so. Well, I think that has brought me to the end of my question list, but I always like to ask the question is there something that I missed that we really should-- that you can think of right now?

Parker: No. I mean, it's interesting. I mean, I-- when I was a kid, we moved every year, every six months. I mean, it seemed like-- I think I went to, like, 13 different schools before I got to high school and then, all of a sudden, I went to Caltech stayed there eight years and go to Intel, stayed there 32 years. I just somehow went from being totally transient to staying in one place. But at the same time, I was incredibly fortunate to get into Intel with those three guys when it started and I never saw a better opportunity. So why-- why would you want to change that? So--

Brock: Yeah. I mean, you chose a very lucky place that was kind of changing the world around it while you could stand--

Parker: So it was a good run and I kind of felt that, back when I retired, it was about the right time. I mean, like I say, the Internet bubble had passed, had already turned over all the manufacturing, and, well,

let's go do something different, and that worked out fine too. So I don't look back with any regrets on anything, quite frankly.

Brock: Now, that's very enviable position to be in. Well, thank you again for the interview.

Parker: Thank you.

END OF INTERVIEW

