Fairchild Oral History Panel: "The Legacy of Fairchild"

Fairchild@50 Evening Panel Session

Participants:
Wilf Corrigan
Gordon Moore
Jerry Sanders

Moderated by:
Floyd Kvamme

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The following transcript is from a panel session on the "Legacy of Fairchild" at the "Fairchild@50" celebration of the 50th anniversary of the founding of Fairchild Semiconductor held at the museum on the evening of Friday October 5, 2007.

Participants were:

Wilfred (Wilf) Corrigan - Former president and chief executive officer of Fairchild Camera and Instrument Corporation, co-founder and chairman emeritus of LSI Logic Corporation.

Gordon E. Moore – Co-founder and former Director of Research and Development at the Fairchild Semiconductor Division of Fairchild Camera and Instrument Corporation, co-founder and chairman emeritus of Intel Corporation

W. J. (Jerry) Sanders III - Former Worldwide director of marketing at the Fairchild Semiconductor Division of Fairchild Camera and Instrument Corporation, co-founder and chairman emeritus of Advanced Micro Devices, Inc.

E. Floyd Kvamme (Moderator) - Former product marketing manager at the Fairchild Semiconductor Division of Fairchild Camera and Instrument Corporation, general manager of Semiconductor Operations at National Semiconductor, executive vice president of sales and marketing for Apple Computer. He is a partner emeritus at Kleiner Perkins Caulfield and Byers and is co-chair of the president's Council of Advisors on Science and Technology.

David Laws: Good evening, ladies and gentlemen. For tonight's presentation, we wanted to ask a group of alumni who went on to leading roles in the industry to tell us about their tenure at the company and how they felt that Fairchild technology contributed to Silicon Valley and the worldwide semiconductor industry. Fairchild produced such an extraordinary crop of engineers, scientists, educators, business leaders, that narrowing the list to a manageable number of participants wasn't easy. There are many we would have loved to have heard from tonight. Unfortunately, some of the most eminent have moved on to higher office. Others were not able to join us tonight for health or for personal reasons. This slide shows just a few of the personalities that came to mind. Sherman Fairchild, inventor, playboy, chairman of Fairchild Camera and Instrument would surely have had some wonderful tales to tell us. Bob Noyce scientist, visionary, mentor, nominated as a Nobel Prize Winner before his untimely death shortly before its announcement, charmed everybody with his engaging personality and brilliant mind. We made contact with the hard driving, first marketing executing of the company, Tom Bay and asked him to participate before he unfortunately left us early this year. Tough as nails, no nonsense manufacturing legend Charlie Sporck couldn't join us tonight but will be at the reunion gala tomorrow. And finally, Les Hogan a Harvard professor, Bell Labs researcher, he invented a number of important microwave devices, gyrators and other important elements that remain in use today. Architect of Motorola's rise to prominence in the semiconductor business, before joining Fairchild and widely recognized as a leader, educator and mentor. Les could, unfortunately, not be here tonight but he is represented by his wife Audrey Hogan. In his recent book "Bill and Dave," author Michael Malone compares the corporate cultures of HP and Fairchild. He says, "Fairchild was a company of legend, perhaps the most extraordinary collection of business talent ever assembled in a start-up company. If Fairchild had a

corporate culture, it could only be described as volatility incarnate. Fairchild was a company, as frat house, brilliant young engineers and marketers working long days and partying long nights. The Fairchildren, as they would one day be called, stole each other's women, crashed cars, and started lifelong feuds and friendships. And somehow in the middle of it all they managed to invent the integrated circuit, the defining product of the late 20th century and the process helped to create the modern world." That's one view of the company. I now invite Floyd Kvamme to lead a panel discussion that may either confirm Michael's view or refute it. He will introduce the other members of one of the most illustrious frat houses of all time. Floyd.

Floyd Kvamme: Thank you very much. It's hard to imagine how you would introduce this group of folks. They're all so well-known. So I'm going to be very, very brief in the introductory remarks. We've been asked to talk about legacy. And legacy, of course, talks about how things are handed down. What came out of Fairchild that is handed down. Of course, we all know of many, many things and, I thought, to kick off the discussion tonight, I'd turn to Gordon Moore, one of the founders, because one of the legacies of Fairchild, of course, is silicon. At the time, I got into the semiconductor business in 1959 at GE Semiconductor we were fooling around with germanium. Yes, we had some silicon. We had some gallium arsenide. We had some copper stuff and et cetera, et cetera. How did you decide on silicon? And how did that all happen?

Gordon Moore: Well, I guess I have to blame Shockley for that. He decided that he would set up a company devoted to doing silicon. We spent enough time there to think "Gee that was a pretty good idea." When we set up Fairchild, it was naturally the material that considered. Bob Noyce told us we didn't know how lucky we were not seeing how easy germanium was by comparison. Silicon had a lot of potential advantages and fortunately we've been able to exploit them over the years.

Kvamme: And how did you decide to come together to do your silicon thing, I mean you must have been very happy at Shockley, I mean it was a wonderful, place.

Moore: Well, that's an oft told story, I think. Shockley was an unusual personality.

Kvamme: Really?

Moore: Very bright. My colleague Jay Last once commented, he thought Shockley could see electrons. You know, he had a physical intuition of what was going on with in these materials, but he had no idea what went on inside people. And the net result was he made an untenable atmosphere in which to work. So the group of us tried to go around him to Arnold Beckman and see if we could get Shockley a professorship at Stanford or something and contribute as a consultant and have somebody else come in and run the company. After a few meetings, Beckman decided that he would stick with Shockley, and we learned that a bunch of young Ph.D.'s had a tough time pushing aside a new Nobel Laureate. But we felt we had burned our bridges so badly that we were going to have to go look for other jobs. Fortunately, we caught up with Arthur Rock and a colleague at Hayden Stone who convinced us we ought to set up our own company instead of just finding somebody to hire us which was our original intention. And we said, "Okay, then we don't have to sell our houses, it sounds like a pretty good deal." That's how Fairchild began.

Kvamme: Thanks, Gordon. Jerry let me turn to you. Obviously everybody thinks of Jerry as a sales guru, which he certainly is, but how many are aware of the fact that he was recently elected to the National Academy of Engineering. Congratulations Jerry. Not everyone gets into the NAE, let me tell you. Jerry as you reflect now on what Fairchild was like back in those times, '60, '61, when you joined, what stands out in your mind.

Jerry Sanders: Well, I guess what I remember the most is how young everybody was. When I joined Fairchild in '61 I was 24 years old, Gordon was 32. I think Bob Noyce and Charlie Sporck were 34. Tom Bay was around 34. This was a really, really young, young group. And the belief of everybody was there was nothing we couldn't do. This was probably truer in the marketing organization than in R&D, but we tried to force R&D to do everything we wanted them to do, which caused some grief from time-to-time, but the realities were it was a really young company. Everybody was just full of energy. It was a 24/7 kind of environment and was growing so fast. I remember how I came to join Fairchild, and I just want to tell that because I ran into someone that I haven't seen in decades. Bob Major, who is here tonight, was the area manager in Chicago. And I was selling semiconductors for Motorola and, I guess, I was giving Fairchild a pretty bad time because Motorola had this wonderful product called the 2N834 silicon epitaxial transistor that they couldn't deliver, but the specs were better than the stuff that Fairchild could deliver. But as many of you know, that never stopped me. So I was invited by Bob Major to go out to Mountain View, California, to an interview. He wanted to hire me and I said I wasn't really interested. He said, "Well, we'll send you out there, you'll meet these people, you're going to love these people. And the reason I accepted the offer to go was because I was going to spend the weekend in Las Vegas and spend one night at Fairchild and then go back through Las Vegas and have some fun and go back to real work, you know. Because I was working for Motorola at the time. Motorola was a legend in Chicago. I mean they made car radios and I grew up in Chicago and I had a Motorola car radio, right. What was Fairchild? I didn't know what that was. Anyway, I got out here and I just couldn't believe the quality of the people. I met Charlie Sporck. I met Tom Bay. I met Bob Noyce. And I got terribly drunk with Don Rogers. Don Rogers was the sales manager and very late at night at Tiburon Tommy's he tried to close on me. "Would I accept the job offer?" And to his amazement and chagrin, I said yes, as district sales manager in Los Angeles. Well, that was a problem because they were trying to hire me for Chicago. But anyway, I woke up the next morning in Don's guest room and I was hired as the district sales manager in Los Angeles, much to the chagrin of the area sales manager in Los Angeles, but that's another story. But it was a young place. People would move on a [dime] - it was dynamic. And decisions were made really quickly and I didn't appreciate at the time how young everybody was. But if you think about, you know, here's Gordon Moore this visionary of Moore's Law and he was 32-years-old. Come on! And here Fairchild was on its way to being the most important company in Silicon Valley history.

Kvamme: The amazing thing about the valley, virtually everything that's started out here is started by people in their 20s. It's part of our legacy, I think, and Fairchild set that. Write that one down a 20s, legacy. Wilf, you were trying to make those 2N834s that was Jerry was selling.

Sanders: No.

Kvamme: What was it like to compete with Fairchild back in those days?

Wilf Corrigan: Well, you know, Jerry raised the subject of the youth. Charlie tried to hire me to run the materials department at Fairchild in ’62. Now, if you figure this out, I was 23 at the time. And he said, “Well, Norm Peterson is going to Hong Kong to run our new deal in Hong Kong. And so I came out and I interviewed with Gordon. Bob Noyce wasn’t around so I couldn’t see him. And of course, Charlie seemed so terribly old to me at the time. I mean he was 32 with a big cigar. And so I was quite enthused about it. So I went back to Phoenix and I talked to Les Hogan and he said, “Well, why would you want to go do this?” And I said, “Well, I’ll have profit and loss responsibility.” I didn’t know what that meant but it sounded pretty good. So Les said, “Well, I’m making a change in the transistor department, and why don’t you stay and you can have profit and loss responsibility and run Silicon Transistors?” So as a 23-year-old that sounded like a pretty good idea. So I almost came to Fairchild at that time. I don’t think Leo Dwork is here tonight, Leo who’s my new boss said, “Can I do anything to help you on this thing?” And I said, “Yes, could you show me how to use a 576 curve tracer?” So I’m supposed to be running this operation and he has to show me how to use the curve tracer. So the next thing that we went into was - well we’re in deep yogurt. We’ve got some great designs and as Jerry said, we’ve got great specifications, and the 834 was only one of them. We had the 2218 we couldn’t make that. The 2219, we couldn't make that. My marketing guy was a guy called Gary Tooker and he said, “Well, I guess you’re another guy who is not going to be able to make this stuff either.” So eventually, we figured out how to make it. But in reality, comparing Fairchild in the ‘60s with Motorola, it was almost like two ships passing in the night. Motorola was very focused on manufacturing, manufacturing excellence. We had 16,000 people in one complex, in two buildings, and we had 1,000 guys in the basement in the machine shop designing and making equipment. Fairchild had 1,000 guys in Palo Alto doing R&D. We were convinced that automation and mechanization was going to win. I don’t think it was until ’66 that George Scalise and I actually went to Asia to contemplate perhaps doing some assembly in Asia. One of the big hidden strengths of Fairchild was the early decision to go the route of eight and 10-cent an hour labor and bypassing all of this effort on automation. I think that was tremendous leverage for the company. I know when I finally got to Fairchild in ’68 I was astounded at the level of sophistication of the Hong Kong operation. I saw that as the two major differences with Fairchild and Motorola. Motorola was very focused on automation mechanization. And of course, we had a big discrete business. And Fairchild, I think, even in perhaps ’64 was all ready losing interest in the discrete business. The main focus was on integrated circuits.

Sanders: Absolutely.

Corrigan: Whereas at Motorola, we just kept focusing on improving and improving and improving the transistors. So you ended up with two entirely different strategies. And so there wasn’t really any kind of a competition as we understand it.

Kvamme: We don’t have anyone on the panel that was directly involved, although Ed Pausa, down here, was very involved with that offshore manufacturing thing. Do you recall anything about the decision to go overseas, Gordon? It was 1959, I think, that you made that first plan.

Moore: It was very early. My recollection is that Bob Noyce and some other people took a tour through Asia. They were looking at India, in particular, and came back through Hong Kong and got excited about the activity level in Hong Kong. And sent a crew over there with the idea of setting up a facility much to John Carter’s chagrin, I believe.

Kvamme: Yes.

Moore: And it was a very successful deal. This was a time when other people were automating. I remember once giving a talk where IBM was demonstrating their fancy fully automated line, and I had just seen Intel's line that had Chinese girls going blump, blump, blump, with epoxy on top of the devices. I think it was faster than IBM's line and certainly a heck of a lot cheaper.

Sanders: Well, I was selling in those days and I remember something that went on. You're as old as I am, so you'll remember there was once a company called Philco and they made something called the MADT.

Corrigan: MADT.

Sanders: The micro alloy diffused transistor.

Moore: Noyce developed it.

Sanders: Well, Philco spent a fortune automating that so that they could make it one at a time but very fast. But the batch process just killed that. Motorola did a mesa transistor in germanium which replaced the MADT and then, eventually, we at Fairchild replaced that with the silicon devices. What was kind of interesting was vis-à-vis Hong Kong, somewhere in the '63, '64 timeframe, I'm not sure exactly when, Newton Minow, who was the FCC chairman, edicted that all television sets had to have UHF channels. Up until then, it was 2 through 13. The solution was you had to have a UHF oscillator and that's got to be in the gigahertz range, and all of a sudden a tremendous market [opportunity emerged] for this device. RCA had something called a "Nuvista" and at Fairchild we had something which was called the 1211 internally, the 2N918 was the device type. It sold for about $150 to the military. We'll come back to the military and thank them for those days. But at that time, this actually would do the job of a UHF oscillator except it was selling to $150 to the military. So I was given the assignment of breaking into the consumer market for Fairchild, which was selling green painted transistors which were rejects from the silver can transistors. And that was my job was to go out and make a market for that. So I went around and said, "Wow, this is a terrific opportunity." Except that RCA sold the "Nuvista" which was sort of a solid state [tube] device (but not really) for $1.05. That was [the price that it was] supposed to be at in order to break into this market. So I went back kind of just dejected to California and at that time Tom Bay was the director of marketing at the time and told him this story. And he said, "A dollar five, how many are they going to buy?" "Tens of millions, hundreds of millions, ultimately." "Wow, a pretty big business. Let's go talk to Bob." We went over to Bob Noyce's house and the first thing I saw was he had a waterfall in the backyard, which I thought that's unusual and that's because somebody had put a freeway up nearby and he to put a waterfall in so he wouldn't hear the freeway noise. Now, most of the people I knew didn't put in waterfalls when somebody built a freeway nearby. They turned the radio up. But in any event, we sat down and so Bob heard this story. The truth was I didn't know anything about how much things cost in those days because I was a marketing guy, but they're these tiny little chips and they were like so many on the wafer, and here we're going to make bigger wafers, and the chips were getting smaller, and then they were going to put them in plastic in Hong Kong. And Bob said, "Well, what do we have to do?" I said, "A dollar five." He said "Let's go do it" and literally the decision was made like that at Fairchild. Bob was the general manager at the time, and that was the decision that was made. And I'm sure a lot of

guys in manufacturing went absolutely nuts, but it turned out to be a fantastically profitable thing and it brought Fairchild a tremendous amount of volume and honed their volume skills. I think [what is] indicative of the legacy of Fairchild was, "Why not? We can do this."

Moore: You know, I remember that device with the little black blob of epoxy. We had a market for the rejects it turns out, in Hong Kong. We sold the rejects for eyes in Teddy Bears. That's probably where the profit came from.

Kvamme: The part I remember Gordon about that package was that this package also had another name among our competitors, it was called a flip top box, if you recall.

Corrigan: Yes, that's right.

Kvamme: Because if you put your fingernail between the bit of epoxy and that solid steel it would click off. We were trying to break into the Digital Equipment Corporation and I was sent to the field. It was my first sales call, actually, as a salesman, or sales engineer as we were called back in those days, 1964 at Digital Equipment. And we had carefully data logged all of these PNPs because they were committed to PNPs because they were coming off germanium. And we built some PNPs in these things. We had data logged everything all of the specs and all of this kind of stuff, we figured the whole thing out. All of the data was there, sheets of data, we presented it. I was in there with a guy named Pete Schenk. Many of you may remember Pete, he was the guy who I was taking over the account from. And the fellow takes our data-logged transistors. I don't recall whether there were 25 or 50 of them in the package, he pours them out on his desk and literally in a Khrushchev act takes off his shoe and starts beating on these things to see if the tops would come off. All of the tops came off, okay. In which case, all of our datalog is real valuable now. He scoops these things into his hand, those of you who remember the old DEC plant was over a mill pond, and he [threw them out] a window over the mill pond. And I'm saying to myself, I got a degree in semiconductor physics to do this to sell transistors to a guy who's going to beat on them. So the flip top was a great thing for transistors, but it was a tough sell.

Corrigan: We trained our salesman to use their nail so they could the demonstrate the flip top - we called them pop-tops. We were doing it with transfer molded plastic and its very tough to flip the top of that.

Sanders: I remember that at the time it was easier to sell the hermetic packages, but we sold a lot of those pop-tops anyway. One of the thoughts which just popped into my mind, if you excuse the pun, is when I was calling on Hughes Aircraft Company, my first major account in Southern California. They had a program called the "Interceptor Improvement Program," the IIP and they were going to put in these new fire control systems in the aircraft. And they had to have silicon. And it was all Texas Instrument grown-junction [silicon transistors]. Now that's an old technology but we were selling planar transistors, as you'll recall Gordon. And those planar transistors had very little leakage. It was insensitive, relatively insensitive to temperature, whereas, a grown junction when you would heat them up, because there was surface leakage, the leakage would go up. Using one of those curve tracers, which I had learned to use at university, I'm just teasing you know that, I would show these guys, we'd put them in the prototype and I would hold a match to the grown junction devices at which time the system would fail. But the planar transistors you could burn. You could hold a match right against it and no leakage change and all worked

fine. Beautiful. On a curve tracer you just watch that grown junction thing fail. I was thinking about the observation you made Floyd that when the TI guys went back to Texas and said to these guys, "This guy Sanders is setting fire to our transistors," and they thought he was lying to them but anyway. But we did get the IIP contract. And we sold it and Hughes became one of our largest, largest customers. So life was simpler in those days.

Kvamme: It was.

Sanders: A little match here, a fingernail there.

Kvamme: Gordon, one of the things that people today, talk a lot about and certainly we had an illustration of this, if I can go to a slightly more serious subject for just a moment is this whole issue of immigration. And, you know, all of these H1B's and that kind of stuff. But, as I remember, in Fairchild R&D that you ran, if you didn't understand foreign accents, you were in trouble. How did that all happen?

Moore: You can blame our graduate schools on that, I suspect. We hired the best people we could find coming out of school. A lot of them turned out to be immigrants that had come here fairly late in life, and therefore, had strong accents.

Kvamme: And there were a lot of them. So the fact that immigrants built Silicon Valley or had a large role in building Silicon Valley goes back to the early '60s, doesn't it?

Moore: And it still continues.

Kvamme: And it continues, of course.

Moore: I remember once at Intel, Condi Rice came down to visit me when she was at Stanford. She says, "Wow, this is like going to the United Nations."

Kvamme: It was.

Moore: Yes.

Kvamme: Well, Fairchild R&D was like that. I mean recall, many of the guys …

Sanders: I wish she would have gone to the United Nations a little more.

Kvamme: Yes, right. Now, let me ask, why the heck did I bring that up? Wilf, you came to Fairchild in '68. Obviously, a lot of us had fled the scene, what was it like then?

Corrigan: Similar, Jerry was still there. He was the stability at the time. The rock.

Kvamme: The rock.

Corrigan: The problem was then, as with you and Charlie in ’66, he left. And then he ripped out a huge amount of management. And then Gordon you helped - when was it, early ’68 …

Moore: Sixty-eight, yes.

Corrigan: And then Intel, of course, took a whole new chunk of the company and so the company really had very little of the original management left. Ed Pausa was still there and so Asia was doing okay, and so on. But a lot of people had been abruptly ripped out in two waves. And so there was a certain amount of chaos. But there was a tremendous number of products that I remember Jerry [introduced], what was it the product a week …

Sanders: The product-of-the-week program, yes.

Corrigan: And so on, this like huge number of products that couldn’t be made. I remember Gordon’s great comment at that time. He said, “At Intel we’ve been able to demonstrate that you really can transfer products from Palo Alto to Mountain View.”

Moore: Yes.

Corrigan: Because Intel was set up in Mountain View. I’m sure you remember that comment, right. But the issue really was about making things. The amazing thing to me was the difference between Hong Kong and Mountain View. John Sussenberger was running the Hong Kong plant, and I was really getting frustrated because I really couldn’t get good data in Mountain View on what’s our cost. And I went off in a little bit of a tirade in John Sussenberger’s office about, “I don't know what the cost is.” And he said, “Well, what do you want to know? Would you like to know what it costs us to make that transistor on the third shift last night?” And I said, “Yes.” So he reaches in his desk, no computers, everything is beautifully handcrafted and he had the exact data and it was with a latency of hours, literally. And we didn’t have anything like that in Mountain View. So the systems, which in the U.S. should have been somewhat computerized, really were not very good. So we had lots of delinquencies, service issues. When you transition between companies there’s a moment in time when you knew the exact prices for specific deals. Connie Pasqua is here tonight and he was running purchasing at Control Data at the time. And that was one price that I knew exactly. And I asked the sales guy, “Well why did you cut the price this much?” And he said, “Well, our delivery is so lousy that we’ve got to do something. So we’ve got a low price, and so on.” So there was a lot of logistics problems right here in the U.S. which had been largely eliminated in the Hong Kong plant, which was really your humming sort of plant. The surprising thing to me was that we were manufacturing a million transistors a day in Phoenix fully automated, and the actual cost of those pop-top things was about the same as what our cost was in Phoenix which was like radical to me. And, I remember at the time, trying to persuade my automation guys, Bill Ammons group, “We’re doing the right thing, we’ve just to pick it up and put it in Hong Kong.” And they said, “No, no, we’re going

to do it here." And this is the sort of thing where you get a lot of PC people today advocating what you should do and you'd get killed if you did this. Really, that manufacturing machine that we had in Hong Kong and also in Korea, it was something that was a joy to behold if you could have somehow got a lot of the logistics solved in the U.S. Now, I don't know whether that that it happened because of the turnover of management.

Sanders: I'd like to jump in on that. I remember the '66 to '68 timeframe very well because when Charlie Sporck resigned I was stunned. I mean, to me Fairchild was a family. Everybody was together. I had been there for a few years. I was living in Northern California and all of a sudden Charlie Sporck, the general manager, resigned. Bob Noyce had been elevated to a group vice-president role and Charlie Sporck was kind of the guy running the day-to-day activity. And I went in and I was like with the white socks, or the black socks, you know, shoeless Joe Jackson, say it isn't so Joe. I said, "You can't be doing this. This is your home. This is the family. Blah, blah, blah." And Charlie basically went off on the incompetent corporate management back in Syosset, which took me aback because I saw those guys as just a bunch of suits that came down every once a while and everybody took them lunch and then they went away. But Charlie told me it was a lot tougher to handle than that. And it's interesting because there were two of them Dick Hodgson who I thought was a terrific human being, and John Carter who I did not. But I didn't know as much about John Carter and the difficulties that Charlie had. Charlie said, "I just can't work here any more. I've just got to be my own man. I'm going to go. I'm leaving." But as you say, Wilf, he took, basically all of the key manufacturing managers, because those were his people. They were his boys, so to speak, in those days it was mostly boys. So he just took everybody. So National became a manufacturing powerhouse. He got recruited over there by Bob Widlar who was a brilliant linear engineer. Widlar had a design capability but they couldn't make these linear devices very well at National so he persuaded Charlie to come over there with his team, and so all of a sudden, National is a major factor in the business. It wasn't too long after that that you defected and went over there. I tried to keep you. I love Bob Noyce he's mentor and hero to me, but I knew when he called you Cloyd during the try to rerecruit you that we were dead. There was a Cloyd there, Cloyd Marvin, who may be in the audience tonight.

Kvamme: And Cloyd's here.

Sanders: Is he? Cloyd, well, great guy. But anyway, so Floyd left. So now we had a little manufacturing issue and we were trying to sell things to people like RCA and we couldn't make this stuff. And we couldn't test it. And then I found out from Tom Bay who succeeded Charlie as the general manager, which was probably not the best choice as it turned out because we needed a manufacturing guy in there, and Tom was a brilliant marketing guy, but we couldn't make this stuff and we didn't have enough money for testers and Syosset wouldn't send money over for testers. Now, Gordon, you may know more about that than I did, but they just were tight as a bull's ass in fly time with money. And so you just weren't getting any money. We weren't even 100 percent testing this stuff. And the answer was, "Well they'll test it at RCA and they'll send it back if it doesn't work." Well, I can understand Gordon's frustration. And after the fact, as I understand it, Gordon you were the guy that actually said, "You just weren't happy with the time it took to get your wonderful new stuff into production and out into the marketplace." And that you were the guy that started the idea of Intel. And Bob said, "You know, you're right, Gordon, let's do something." Is that accurate or close?

Moore: Not quite. No, when Bob was getting passed over to be the next CEO of Fairchild he decided he was going to leave. He had approached me with the possibility earlier, and I said, "No, I've got the best job in the industry." But when I found out he was leaving, and management was coming in from outside, and I didn't think I'd like the change, I said, "OK, I'll go too."

Sanders: Okay. Well, you're never too old to learn something. I just learned something.

Kvamme: Jerry, you mentioned something earlier I'd like to talk abut a little bit. You know, people talk about drivers in the industry. Today, of course, the cell phone is a driver for the industry. PCs were a driver. You mentioned military as a driver, was it a driver?

Sanders: Tremendous. At Autonetics there was the "Minuteman Program" and I think it was probably the largest contributor to Fairchild's early growth making the 2N696 and 697 which was the workhouse transistor in the Minuteman One. Unfortunately, the military is a very tough taskmaster and if you link yourself just to that you would, I think, been relegated to a secondary supplier because the volumes weren't large. The specifications were tough. The …

Kvamme: But my recollection is in like 1966, 40 plus percent of our business was Mil-Aero wasn't it?

Sanders: I'm sure it was. As a matter of fact it included space programs. You know, we were actually supplying some Micrologic, the RTL family, as you recall, to MIT for the Apollo. And that was a very [important] program. I mean it took a lot of engineering excellence to do that.

Moore: The paper outweighed the devices.

Sanders: The paper - exactly. And when it came time to do Minuteman Two, out of insanity, Texas Instruments bid an RCTL solution which has capacitors on there which were very difficult to make and control. Basically, all they did was take a simple discrete solution for the system, clump them into what they thought would be a manageable number of devices to put on a chip and that became the specification. At Fairchild we tried very, very hard to convince those guys this was not a reasonable approach, and the Minuteman Two program was delayed. It was horrendously expensive but it put Fairchild in a trailing position. And then, I think, was it about that time that Jay Last left and [Lionel Kattner] went over to Signetics and did DTL.

Kvamme: It was a little before, I think.

Sanders: It was a little before that?

Kvamme: Yes.

Sanders: But in that whole timeframe, the military was key. But as Gordon says, on those space programs you'd have to provide a little notebook with each device, do read and record, burn it in, burn it in some more, read and record, burn it. It was not a great way to make money and Tom Bay to his eternal credit said, "We've got to get into the consumer market. We've got to get the computer market." In the computer market we were making some forays in with the 2N2369 and 2N914 switching transistors.

Kvamme: And a lot of custom stuff.

Sanders: And there was some customer stuff. And of course, we had the incredible CTL, Bob Seeds, Dr. Seeds a genius, came up with a technology called CTL [Complementary Transistor Logic] and Burroughs adopted it and it was a huge, huge success but unfortunately it was a one customer product.

Kvamme: Yes.

Sanders: And thank God, when I started AMD, after being fired ignominiously from Fairchild, technically I wasn't fired but come on, you know. I was approached by some guys to do CTL, and I said, "I'd never do CTL." But they needed a second source. I said, well second sourcing is cool but there's only one customer. I want to do TTL. I want to do the MSI stuff, because at that point in time, Fairchild had changed management and they were de-emphasizing the proprietary brilliant market segment system we had developed to replace it by being a TTL second source supplier to the TI series 54/74. Wretch and vomit!! Awful! Which is why I got fired because I didn't exactly keep that to myself.

Corrigan: Before you leave the military thing …

Kvamme: Sure, go ahead.

Corrigan: In the early '60s there was so much crap associated with the military that you had to say, "Is this really worth it?" I remember, going to the finance people at Motorola and saying, "Look let's really understand this and let's break out all of the costs associated with doing military things and then we'll really understand if it's worth it." They broke it all out very neatly and once we saw the numbers and we looked at the bottom line, we said, "No, put it all back together again. We don't want to know." Because the profits for the military were very high. It's just that the nuisance level was so high. But if you actually looked at the profits you'd see all of the other stuff we were only just breaking even on. That went on into the mid 1960s, I would guess.

Kvamme: Yes. Well, if you think about it, I was a sales guy at Raytheon for the Apollo computer. A dual three-input NOR-gate for Apollo sold for $9.90 and we were selling it everywhere else for 99 cents. So it was a 10x deal. That was a big delta. Talking about the integrated circuit thing and going back to something we were talking about earlier, Gordon, how confident were you that IC's were going to work? I mean this whole notion of putting the whole thing on the chip. The early chips, let's face it, weren't as good as [transistors]. At CDC, for example, I remember, what's his name, he didn't buy into it, right?

Moore: Seymour Cray

Kvamme: Seymour Cray. He never did buy into integrated circuits forever.

[**Editors note**: After moving from CDC to start Cray Research, Seymour Cray did use Fairchild ECL logic and memory integrated circuits in the 1976 design of the Cray 1 supercomputer.]

Sanders: They use AMD today.

Kvamme: Back then, I remember, he was vehement. He wanted discrete transistors. Gordon what was going through your head? You were running R&D?

Moore: Well, fortunately, he wasn't the only potential customer. But in the early days, integrated circuits didn't get widely accepted. People concerned about reliability argued that they couldn't measure the value of the resistors. They couldn't look at the transistor parameters and all kinds of reasons why they couldn't use them. And as I mentioned last night, Noyce came up with a solution to that, he says, "We'll sell them to you for less than you can buy the components to build them yourself."

Kvamme: Exactly right.

Moore: And they made a real change in the market.

Sanders: That's exactly right.

Moore: Of course, it was a lot less than it cost us to build them, too.

Sanders: Those are start-up costs, Gordon, you know, you've got to do that. No, I remember that because Bob Graham, a brilliant marketing guy rest his soul, was always was making the pitch of how much you were saving by the back plane wiring and all of these things and he put this cost together and then cut 20 percent off and showed them how they were saving money. But until the bill of materials cost went below it, and that you credited to Bob Noyce, I'll second that, until the bill of materials cost [using ICs] went below the other bill of materials cost, they just didn't catch on. There were a million reasons and a million excuses but it was just like selling transistors to the consumer market. There was something called AGC for UHF devices. In terms of the forward characteristics, transistors weren't as good as the forward characteristics of a pentode tube. Once the prices got to where they were cheaper then a

pentode tube nobody gave it a rats anything about that. And suddenly you didn't see too many shirt pocket tube radios, let's face it.

Corrigan: No, but CDC could not the degrade performance of their computer. We kind of split that business - between Motorola and Fairchild. And there were one-and-a-half million transistors which were used in an ECL. circuit. So they're always on. Now, it was only a little 10 milliwatt per transistor, but by the time you do that, you've got a 4,000 amp bus board in the middle of the computer that you've got to pour Freon through it to just absorb all of this heat. But Cray couldn't get the speed any other way at that time. Now, I'm sure five years later you could have done it with integrated circuits, but at the time that he wanted it, no.

Kvamme: From a process point of view, Gordon, the thing I remember when I first arrived, I'll never forget my very first week. I shared an office with Murray Siegel and he was having an allocation meeting for the S-element [a half shift register], which was the most complex part of the RTL family if you recall. And that week's production was, and I still remember this, seven pieces. And we had a backlog, my recollection is it was like 2,000 pieces in the backlog. And they were arguing about whether they should give one to each of seven customers or whether AOL …

Sanders: AIL, AIL on Long Island.

Kvamme: AIL should get two because they had the largest amount of the backlog, okay, two pieces versus the other customers. And then, to me, the marvelous thing that happened was epitaxy. Because yields suddenly went from one chip per five wafer starts, because that was the S-yield to …

Moore: That was a major breakthrough in the technology. Before that, we did this isolation diffusion all the way through the wafer from both sides. And you had to make very thin wafers - three mils thick. And they came out of the furnace looking like potato chips, you could hardly work with them. Epitaxy got away from that whole deal. That really was a process step that made integrated circuits practical.

Kvamme: Because that's really what made it possible to go to that 99 cent part.

Moore: Well, if you didn't have the chip, you could sell them for 99 cents.

Kvamme: No, but I mean, I've always thought that epi was the big deal.

Moore: That was a real savior.

Kvamme: The other problem you had Jerry, and maybe you could comment on this, I remember visiting a guy named Carl Something-or-Other who was the chief engineer at Zenith. Bernie Marren would know his name. And we were trying to sell him on our transistors and our stuff but he wasn't buying. And we kept saying, "Well, what does the price have to be?" And he says, "You realize you're competing with free?" And we said, "Could you explain to that for us?" He says, "You understand we make most of our

business on tube replacements. And so the manufacturers of the tubes give them to us. You're competing with free." And of course Sony was eating their lunch at that time because their's were more reliable sets because they were using transistors and all, but that was a big problem. I don't know if you recall that, Bernie, I sure recall it.

Sanders: I remember spending an awful lot of times in screen rooms at Zenith and Admiral and all of those places. I hate screen rooms. All of this bad copper around me. Smells bad. I don't remember that particular deal but the whole concept, you know, hand-wired, which is what Zenith's pitch was, well it only took a while for people to say "What's good about that?" But it is interesting. I think the point you make, and maybe this is part of the legacy of Fairchild, was to make the technology available to a wider and wider base by driving the costs down. Thank the Lord for a phenomenon known as Moore's Law. That, you know, as you push the technology you can make more and more for less and less. So you can do everything for nothing, right Gordon.

Moore: Absolutely.

Sanders: But that's what's driven the industry. Look at the change now, I mean we're putting out ever more devices and ever more functionality and that's the legacy of Fairchild. Fairchild started that. The ring-and-dot transistor, the planar transistor, batch processing killed the automated stuff. When these guys came over from Motorola, yes, they set up an automated line for a while but wasn't very long before they figured that the future was in IC's. And Wilf drove that. And that's what it was all about, getting more and more for less and less.

Kvamme: How long did you think Moore's Law was going to last?

Moore: When?

Kvamme: In 1965 when you first came up with it.

Moore: The first paper I was only asked to predict 10 years. So '75 was all I was looking at.

Kvamme: And it actually- you didn't quite say [that complexity would double every] 18 months. You said what?

Moore: I said every year.

Kvamme: Every year, right.

Moore: … for the first 10 years. That would have been 10 doublings and we [actually] got nine. It was pretty close. And then, I published an article in '75 saying it was going to change to more like every two years because we lost one factor, because there was a lot of wasted space to squeeze out of the early

integrated circuits. So we got density by squeezing out isolation and such. But, in ’75 we had CCD devices where active areas packed right against one another, there was nothing left to squeeze. So that was about half the contribution of the complexity [increase].

Kvamme: We have a question from the audience. What was the minimum feature size of the first Fairchild integrated circuit, do you remember?

Moore: God, I ought to. My recollection it was 25 microns, one mil.

Kvamme: I remember you could see them with the bare eye.

Moore: Yes, I’m pretty sure it was 25 microns.

Kvamme: Twenty-five microns.

Moore: And then one of our early spin-offs, Signetics went off to do the same kind of thing and they were thinking the next generation of technology making a half a mil [minimum feature size], 12-and-a-half microns.

Sanders: We used to deal in mils at that time, thousands per inch.

Moore: Yes. Love the old English days.

Kvamme: Well tenth-mil was a big deal, I remember, when we got to a tenth-mil. So what would that be?

Corrigan: Two-and-a-half microns.

Kvamme: Two-and-a-half microns. Yes, that was a very, very big deal. - and that was later, of course …

Corrigan: Much later.

Kvamme: Jerry, you had to be an engineer to be a salesman at Fairchild why was that?

Sanders: Well, actually, you didn’t have to be and a lot of them weren’t. I changed that when I was in charge. And I didn’t mean that to be harsh, but the realities were when I worked for Motorola first as an applications engineer, and then as a sales engineer, the first thing I figured out was that the sales guys who worked for Motorola at the time were just old tube salesman or waveguide salesman or connector salesman, Amphenol salesman. There’s a great Amphenol salesman in the audience today, Steve

Zelencik, one of my great success stories in sales. And he's an engineer, by the way, and that's why he's eligible. But at the time, they were just sales guys and it was a components business. And that's really the difference as time has passed in our industry, you were selling a component. There was a spec. Did you meet the spec? [If so] you bid price and delivery. They did some testing. But what I figured out early on was you had to show the guy - it's been my mantra for 50 years - how are you different, how are you better? And in order to know how you're different and you're better, you really have to know the ins and outs of the device. So when I was a sales guy at Fairchild and I was quite successful maybe not just because of lighting matches against TI transistors but explaining to guys how this thing worked, why it was superior, why it was better, what the other guy did, why it would last longer. And then I was made sales manager of nationwide, I edicted that everybody had to have an engineering degree. Actually, I was worse than that. I said an electrical engineering degree. But if the guy really hit me right, and had a great personality I'd settle for a mechanical engineering or aeronautical engineering. I never went for a civil engineer, I don't think, though.

Kvamme: Is it true the story that went around about you that if you were interviewing a guy for the sales position and he asked about the retirement program, the interview stopped?

Sanders: I don't think I ever gave them a chance to talk, Floyd. Actually, I don't remember that. But I certainly would not have hired the guy. It turns out in those days I had a pretty damn good memory so I had a pretty good handle on what the guy was all about and where he was from when I met him and actually sat down with him. And I was just interested in the energy and his persuasiveness. I mean, if the guy had an engineering background and he had a track record, but was he persuasive? And if he wasn't persuasive, you know, he wasn't going to be on our team. I didn't want him there.

Kvamme: The other story about you on sales guys and hiring was that you always had the guy take you for a ride.

Sanders: Always.

Kvamme: Had to be a wild driver.

Sanders: Aggressive. I'd use the word aggressive.

Kvamme: Aggressive driver.

Sanders: An accident would have disqualified him but aggressive was good.

Kvamme: Yes, OK, good.

Sanders: But, while we're on the topic, one thing that I learned later that people really were annoyed with me about and I didn't realize it when I started out at Fairchild - I was single, the concept of home life and family meant nothing to me. So I just worked. And I would be up very early in the morning, and I

would go around the sales guy's houses at 7:30 in the morning or 8:00 in the morning, as I was more polite then, I'd knock on the door. If they were home, they were dead meat. They had to be on the street calling on customers. And I'd also always check the trunks of their cars. They had to have an adequate supply of catalogs, data sheets, and application notes for what we were pushing, otherwise again, we didn't want them. But you know, the realities were [that] Fairchild had a great product line. And the numbers were so small in those days, you know, the last year that I was there, I think, the goal for the year was $120 million. I mean these are mice nuts kind of numbers today. Now, I mean you start a new company with a billion right or Facebook or something, if it's social networking probably $2 billion to start. But in those days $100 million was huge. So a $10,000 order was a big deal. And so the sales guy was really, really key. And, I think, that we had a great team of people because Fairchild had such a great product that very smart engineers recognized this is the place they wanted to be.

Kvamme: What was your take on the sales force when you got here compared to what you had at Motorola?

Corrigan: Well, I was pretty brain washed, actually, because within Motorola, we referred to the Fairchild sales force as the "suede shoe boys." I never quite understood what it meant but certainly with some of them, like your old friend Ray Kimball, that said it all. The "suede shoe boys." And I said, well I've got a pair of suede shoes. But I really was surprised. It took about 30 days. I remember George Scalise and I were both going through the same thing at the same time. After about 30 days we said, "Hey, this sales force is great. These guys, on average, are 10 years younger than the Motorola sales force. They know their stuff. They think strategically. And so on." And I think that actually drove the product development. At Motorola because we had a big parent a lot of the consumer products were really dictated by one division or another division of Motorola. So a lot of our product lines were more or less evolving with our big customer and the people they competed with. So it was somewhat different to have people that were shooting ahead of the target. And the marketing guys lived in a totally different world than they did at Motorola because they would actually have ideas and say, "This is what the guy is going to need next, and we're going to sell it to them." And that was very impressive to me, at the time.

Sanders: I'd like to interject. At the time, when I first met Wilf I felt I had met a kindred spirit, although, that might surprise many of you. But Wilf and I hit it off right away. He tried to keep me from getting fired. He told me to keep my mouth shut. I didn't and I was. But but that was probably the best thing that ever happened to me as it worked out because otherwise, I wouldn't have started AMD. But maybe one of the nicest things I remember was a few years later when Les [Hogan] asked me to participate in dedicating the engineering building at Berkley and he introduced by saying, "This is Jerry Sanders. I fired him. It was the biggest mistake I ever made." And that made me feel real good.

Kvamme: The sales meetings, Jerry, obviously, they were a big part of being part of Fairchild Semiconductor back in those days. I don't know that other companies had the extravaganzas that we had. I think that might also be a legacy of Fairchild Semiconductor.

Sanders: Well, I think, it is, but I like to give credit for that to Don Valentine. If you remember, Don, as you probably know is a fabulously successful venture capitalist and probably too wealthy to be here tonight. But Don …

Kvamme: What are you doing here, Gordon? I'm sorry Jerry, go ahead.

Sanders: As I recall, the first year I was at Fairchild which was 1961. I can't remember whether it was at the end of '61 or the beginning of '62 but the first sales meeting - at the time Don Valentine was not the sales manager - was at the Alta Mira in Sausalito. And it was pretty good. We shared rooms which was not so great and not with girls, actually, with ourselves. When Don Rogers went over to run marketing and sales for SGS after Fairchild had made an arrangement with SGS the Italian company.

Kvamme: No, Essa-G-Ess

Sanders: Essa-G-Ess, right. Don Valentine was promoted to sales manager. And he actually started the sales meetings in beautiful places like Puerto Rico, Bermuda, Acapulco and then Hawaii. And then I jumped on Hawaii and Hawaii was kind of - I made my own for about 15 or 20 years - until I didn't make it my own. But it was a special thing and it was all about motivating the sales force. And I used to say a successful salesman has product knowledge on fire. Product knowledge that's why you had to be an engineer, you had to know your stuff. Like you did, Floyd, you know, were a guru in the IC stuff before I even could quite figure out why it all worked and did I care. And then I figured out yes, I do big time. But the other thing was the sales force used to have camaraderie, bonding. Because what I found and many of you probably have worked in sales organizations or with them, everybody is fighting for their commission. You know, everybody got [the product] designed in here, but it got shipped there, and it got produced there, and they're all fighting over the commissions. Well, I wanted guys who used to fight to get the business. And when you're all playing on a volleyball team on the sands of Hawaii or you're in a marathon or some sort you build such camaraderie and togetherness that you just care about winning the business, winning the design. And I thought this is what the sales conference was about. The fact that we had the largest bar bill at the Hilton Hawaiian Village of any company was testimony to the ability of these young guys to drink. But as Wilf said, they really worked hard. They got a lot of business.

Kvamme: I was showing Jerry and some of the guys, I found this a year ago. Here is the notebook from the Hawaii 1964 national sales conference Fairchild Semiconductor. That was quite a conference. Gordon, a question for you from the audience. And I'm going to slightly rephrase the question a little bit because the question as it reads is, "How much was luck and how much was skill?" Can you talk about what areas you look back on now and say, "Man that was a lucky choice?"

Moore: Some of things that came along - the planar transistor, obviously, it was very nice that it came along when it did. It was a step in the direction of the technology that the industry has grown on ever since. I think the fact that Fairchild started in the technology areas that turned out to be the ones that were continued [was lucky]. You know, we developed the first manufacturing use of diffusion and photolithography. A variety of these things that …

Kvamme: And you had to make the equipment yourself, right.

Moore: Yes, we had to make the equipment. But the direction we wanted to go, batch producing transistors initially, required these things to work. So our direction was relatively clear, so we solved the problems of …

Kvamme: I've heard you talk though, about the choice of the NPN versus the PNP initially. Was that a lucky choice?

Moore: No, that was an obvious choice. The NPN was a better transistor and easier to make than the PNP. It's just that the PNP had a very strong advocate in Jean Hoerni who never liked to lose any contest. His PNP got placed on the back burner for a while when the NPN went into production.

Kvamme: So, it was because of what, surface physics?

Moore: No, just the electrons move faster through the base in the NPN. Aluminum works on both emitter and base without having [to do] anything special. It just was a much more straightforward process.

Kvamme: [Jerry] as you look at your history, luck versus skill?

Sanders: Modesty forbids a reply.

Moore: You know, if you had asked me about Intel, I would have said luck was an extremely important part of it. We started out pursuing three technologies for semiconductor memory. I call that our Goldilocks strategy. One of them was going to be a multi-chip assembly of MOS memory chips with bipolar drivers. And we couldn't do the multi-chip assembly. That was too hard. The other one was a twist on bipolar, the aluminum Schottky diode, and that worked so well everybody making TTL picked it up right away and we didn't have any advantage. The silicon gate MOS turned out to be just right. While we were focused on solving the problems we got by two or three pretty tough steps relatively straightforwardly. With the big guys, it didn't get turned around. We, essentially, had a monopoly on silicon gate for seven years.

Kvamme: Yes.

Moore: And that was extremely important. If silicon gate had been somewhat harder, we might have run out of money and not had something [that] made sense. If it was much easier, we would have had competition sooner. That was luck that got us off to that great start.

Kvamme: What's the luckiest thing, then that happened to you, Jerry.

Sanders: Well, actually, it turns out my grandfather always said it would be better to be lucky than smart. I think the luckiest thing was that somewhere early on I recognized that the way the technology was going that you'd be able to do more and more on the chip. And so when I started AMD based on the knowledge I had had from Fairchild about the MSI devices that you're going to build more complex LSI devices, and of course, at the time, Intel was building memories and that was an obvious LSI device. What wasn't so obvious, other than custom circuits which everybody tried but that didn't seem to be the best solution, was what is going to be the functionality [of the LSI devices]? So when I started AMD I

came up with this expression “building blocks of ever increasing complexity to increase the performance, reduce the cost, and speed the time to market for OEMs of computation and communications equipment.”

Kvamme: Man, is that punchy.

Sanders: It was long I knew, but I couldn’t shorten it to a sound byte. I mean that was it. I said, OK, just building more and more complex devices. The lucky thing was that since I started out as an alternate source and I was alternate sourcing Motorola’s best stuff, TI’s best stuff, National’s best stuff, Intel’s best stuff, I figured out early on that it had to be MOS because you’re going to be able to put more functionality on it without bipolar power dissipation, etcetera, so that was, I think, kind of smart. And then these guys [Intel] came out with a two-bit wide bit-slice microprocessor. Two-bits wide but you could string them together and you made your own microcode, so you could do whatever you wanted. So I thought, okay, we’ll do that with four-bits. And we did a four-bit wide and we kicked their butt, probably the only time for a long time until very recently. But I think, again, that what makes Silicon Valley great is competition So I think the luckiest thing I ever did was to sign a cross licensing technology agreement with Intel because they were bigger and spending more on microprocessors and I knew and I saw that the microprocessor was the end-all building block of ever increasing complexity. And from that day forward, we have been building ever increasing complexity. Now, we have the native quad core with hundreds of millions of transistors and there’s more. Throw the graphics on there. Throw the building block of ever complexity thing, as long as that statement was, it’s still applicable.

Kvamme: Wilf, luck what role?

Corrigan: Well, when I was running the epitaxy group at Motorola I was invited to TI. I go to TI and I thought it would be really interesting to see what they do in an epitaxy. And they said, we can’t really do that. But we’ll show you how we make our polysilicon. So I said, sure, I’m a chemical engineer, I’d be interested that. So they had a distillation column there. And I said, “Gee, you’ve got this 50-foot column, how do you line that inside with pure quartz?” [Because all of us in the industry believed the only way to get ultra high purity silicon was to keep silicon tetrachloride in a quartz environment] And they said, “Well, we don’t.” “What do you mean?” They said, “We just pickle it. We just have a plain stainless steel column, fill it with a first batch of silicon tetrachloride, run it for 24 hours, then flush that batch out of the column. We then refill it with a fresh batch, distill it in this now conditioned steel column and now this silicon tetrachloride will produce 100 ohm centimeter silicon - essentially zero impurities. [They were making raw silicon which would go into crystal pullers, but the principal would be the same if you were depositing the single crystal from the gas phase directly onto a single crystal wafer – EPITAXY] And I remember saying, "I have to get an earlier plane." And I went back to Phoenix and said to my guys, "Go build a system to run epitaxy with stainless steel and the only piece of quartz is going to be the tube." And they said, "We think you're crazy, because of the contamination" and I said, "Look we've got more contamination from the grease and trying to seal up these quartz tubes." [We ran silicon tetrachloride and hydrogen thru the system for a few hours, and then used it to make real epitaxial wafers. It worked perfectly the first time.] Up to then, we were committed to doing everything with bits of quartz, which was a mess to make into a manufacturing system. Now we could build gas control panels that looked very much like a modern piece of semiconductor process equipment. And that's probably the luckiest thing I ever got into.

Kvamme: As you think about today and think about lessons learned back in those very early days, what applies today? As you look at it? I mean we're talking about legacy. We're talking about things that we launched from the Fairchild days. I'll start with Wilf. As you think about today's business what's applicable in your mind?

Corrigan: I think you've got to see the trends and you've got to move fast. I mentioned that Fairchild saw the idea of using Asia and the big differential in labor rates with the U.S. very, very early and they executed on it. And it wasn't just Motorola that was slow. Everybody else was slow. The Japanese were slow. Because of that decision, the disk drive guys who all one way or another had their seeds in the semiconductor business in the valley here, they very quickly went to Asia. The Japanese had the same idea of automation and so by the time the Japanese figured out how to get the automatic line, suddenly you're now doing three-and-a-half inch disks. And then they go away and they spend a couple of years automating that. And by the time they got to that, the disk drive guys went to two-and-a-half. Seeing things like that and then moving on them quickly, early, I think that's the lesson. You notice how quickly people jumped on the fabless model. Many people starting companies didn't do that. And if they had, they would have been much more successful.

Kvamme: You know, we're talking about legacies, and you reminded me of one thing if you wouldn't mind commenting on it, or maybe I'll turn to Jerry on this, I kind of have the feel that the fact that we went to Asia from a manufacturing point of view, helped the valley have a global view from its very earliest days. Do you buy that?

Sanders: Well, it's interesting, I was fortunate enough to know Dave Packard and he asked me to go with him back to Washington to testify before Congress about this transfer of jobs for assembly over to the Far East and how we were destroying all of these U.S. jobs. And of course, we then had to research the impact and it became pretty clear that having this lower cost capability which allowed us to drive larger shares of market and do more business meant more R&D engineers, more marketing and sales people, more wafer fabrication people. So in reality by using a global approach to driving costs down and today we do it with design centers around the world, yes, I think so. But that comes back to, what's that old line, "a good idea doesn't care who had it." I mean going offshore to get low cost assembly and going offshore just so you could get the assembly done because it wasn't easy to hire wire bonding operators. And in those days, I think when we started at Fairchild, we used wedge bonders and we had the purple plague and God, there were nightmares there. So having a lower cost solution and the global approach, I think, that's it. And the legacy of Fairchild, it seems to me, is the idea it didn't care where the idea came from. I seriously doubt that John Carter or Dick Hodgson came up with idea that we should do assembly in Hong Kong. I mean an idea that comes in from any level - what you need is management that has that neural network inside your corporation to respond to it. Because great ideas can come from any place and I think Fairchild would take a great idea wherever it came from and they'd act on it. And I think that's a really key thing because Fairchild especially in the early days when I joined, it was a rag tag bunch of guys. I mean they were all bright but they were very, very different. There were shouting contests. One of my favorite stories is early on when Tom Bay was running marketing and Charlie Sporck was running manufacturing, they got into an argument and Tom Bay broke his hand pounding on a bar in an argument. It was scary. I got into an altercation with Tom about transferring an epitaxial reactor to National, when we were short of exitaxial capability. Charlie had had a commitment from Tom that he would give [him the system] and I said you can't do that, we need the capacity. Tom grabbed me by the shirt, by the tie and strangled me, and said "I made a commitment, my commitment counts." Yes, sir.

Kvamme: You actually, said, “Yes, sir?”

Sanders: I said yes sir because he was two inches taller than I was, and I wasn’t in a good position. I think I was stronger but he was the boss.

Kvamme: Gordon what was the reason for [Fairchild] having a separate R&D center? Nobody else did that after that, right?

Moore: That’s probably true. But at the time there was a lot of stuff that still had to be learned. You know, we had a lot of technology that worked but we had no idea why. We had to understand things better. And also we wanted to develop products away from the manufacturing line. And it worked well for quite a while. But the more technically competent the manufacturing people became, the more difficult it became to transfer stuff to them. With all of the best people in the laboratory it was easy to transfer technology. But as the manufacturing people became competent, they wanted to reengineer everything and start over. So it became very difficult.

Sanders: You know, I remember that. You had a guy there, a really smart guy named Phil Ferguson

Moore: Yes.

Sanders: And Phil Ferguson said that, “Sanders is playing R&D like a piano.” I remember that line. And all I was trying to do was get that great stuff you had over there, which was working fine, into production That was a tough thing to do. You know, it really was a tough thing because, as Wilf mentioned, when they were at Motorola Fairchild had the ring-and-dot and then we had the bigger ring-and-dot. And Motorola came out with the 2N2218, that was the star transistor, it had the shape of a star. But because its perimeter was longer but its capacitance was less it was a faster device. And that competition, you know, caused Fairchild to rethink some of their geometries. And getting that stuff from the competition drove Fairchild to respond to get a better device. Then getting it over to production really took somebody working hard. But yes, I remember Gordon, about the time that you and Bob left it was tough to get that new stuff into production.

Corrigan: That was another big difference.

Moore: Things like that went pretty well. The one that was the pain-in-the-neck was MOS. You know, we had a spin off that had a spin off in MOS before we got any place in Fairchild.

Sanders: But the good news is they didn’t have silicon gate.

Kvamme: Jerry, do you remember Gordon’s presentation at one of the sales meetings, I think, it was maybe in Hawaii or the Acapulco, one when he described how they came up with the shape of the emitter? Gordon, you must remember this?

Moore: That was San Diego.

Kvamme: Okay, tell the story.

Moore: Well, this was when the star transistor was getting all of the publicity and we had other ways of doing it. So I gave a talk where I came up with all of the things I could think of in nature to show different shapes that made sense. I remember I had astronomical pictures that show spiral galaxies, pictures of the bottom of the ocean with all of the coral formations and the like and I was selecting from that what would make decent transistors. And they would have worked.

Kvamme: But then you described how Fairchild R&D was near a cow pasture on one of these. And you talk about Motorola seeing the clear skies looking up at the stars, and you guys looked at utters of cows, as I recall.

Moore: Yes, that was one of them.

Kvamme: That was one of them. I actually remember that one.

Corrigan: The biggest problem there actually was because Motorola was epitaxial. The chip size was a third. And the cost was much less. Because once you got that chip size down a third, most of us didn't think that much about defect density at that time. But automatically a defect density per chip had less impact on the yield, so [it made] a major difference in cost at the time.

Kvamme: Gordon just mentioned the transfer of MOS. If we can talk about what went wrong, I would say that MOS was kind of a death knell at Fairchild. I will posit that for just a moment because number one the military didn't want to buy it. And every spin out went with MOS and Fairchild didn't really ever get on the MOS thing for a long time. What do you think?

Corrigan: That was always the weakest point we had.

Kvamme: Yes, I mean, what do you think, is that accurate?

Corrigan: Oh, yes. Absolutely.

Sanders: Well, it's interesting because Fairchild did incredible work in bipolar. There was no question.

Kvamme: They were geniuses.

Sanders: In fact, I ran into Bill Baker tonight, he did all of that Isoplanar work. I know I tried to hire him many, many, many times. Unfortunately, he never showed me anything like what they showed you at TI so I couldn't go back to my place and make Isoplanar. But maybe that's good because otherwise maybe we wouldn't have been so aggressive into trying to get into MOS. But, I think, at Fairchild you had so many different people and MOS was never their strength and of course, it was the future. But you never know. When T J Rogers left AMD to start Cypress basically what he did, which was brilliant, was implement all of our bipolar devices with CMOS technology. The technology was good enough that they were smaller, and cheaper. But again, competition is good and it just spurred us on. It just wasn't too pleasant at the time.

Kvamme: We have another audience question that we kind of touched on with a number of the legacy things but we're getting close to where we're going to do a wrap here, and the question is, "Please comment on the long-term impact that Fairchild has had on world technology, culture, and style." In the technology area, we've obviously, mentioned, silicon. We've mentioned off shore. We've mentioned the impact of epitaxy, cost drivers. We've mentioned Asia. We've mentioned using the best and brightest immigrants from wherever they were. What would we add in terms of style and culture?

Moore: I'll take that. I think that Fairchild is really where Silicon Valley started and the phenomenon that we've all come to love. The company exploded into literally dozens of spin offs that took these bits and pieces of technology. It developed a bunch of tools that were used broadly. And it really developed the idea of the engineer entrepreneur who had an idea to go off and set something up. We weren't the first electronics companies, there were the HPs and the Varians before, but they operated more like the classical companies that would have been any place in the country. But out at Fairchild you had this tremendous explosion that, I think, has made Silicon Valley unique.

Kvamme: Most people say that makes a great area for start ups, is one big success. If you think about the different areas of the country one success drove most of them. What would you say, Jerry, on the culture and style side.

Sanders: I think it was risk taking, certainly. I mean from the start of these eight guys starting this company up when they- Gordon is way too modest. I understand from a paper he once wrote that they actually had to go down and buy Nikon cameras and try to match up the lenses to build their first photolithographic equipment to get a good match. I mean, when you think of what they had to start with to start a company like this and then to go forward with it, I think, it was a tremendous risk. And frankly, I don't think they were ever rewarded appropriately at Fairchild. I, for example, and my contribution was, miniscule compared to his at Fairchild, but I never made a penny on a Fairchild stock option. I never made a cent. And I pride myself that we made lots of money for our people at AMD with stock options. I think the concept of rewarding people and giving them a chance, the idea started at Fairchild but it never really happened there.

Kvamme: Well, it [the granting of stock options] started later than the start-up phase, right?

Sanders: Yes. Well there was the start up where the eight guys [founded] Fairchild Semiconductor as a wholly owned subsidiary of Fairchild Camera and Instrument. Those guys made a lot of money.

Kvamme: Wilf, style and culture?

Corrigan: A disproportionate amount of money was spent on R&D. I mean if I think back one of the big surprises when we arrived from Motorola was to find that there was a $5 million IBM computer that was totally focused on trying to figure out how to accurately simulate and do design computer aided design. I know when we started LSI Logic, Rob Walker and Jim Koford and Ed Jones did an assessment of what was the state of the art of the industry in 1979 or 1980. And it really hadn't moved in 10 years from what was being done at Fairchild in 1970, it hadn't moved. The simulator that Jim wrote at Fairchild was 10 years old at that time but was more advanced than anything else in the industry when we started LSI Logic. So somebody had a vision, it probably was Bob and Gordon, to spend what would have seemed like an unreasonable amount of money to John Carter. It probably would have seemed unreasonable to me at the time, as a percentage of what you were spending. But somehow that was done. And, I think, in a lot of other companies it would have been difficult to do that.

Kvamme: How did that happen Gordon?

Moore: They left us alone.

Kvamme: There's a lesson there. In wrapping up, Wilf, let's start with you. We're talking about legacy. We all learned a lot there. What do you predict for the next 10 years based on what you learned 50 years ago or 40 years ago?

Corrigan: I don't even know that it's relevant, actually. I mean, they will probably do more of the same, but the whole global nature of things is changing very rapidly. And I do think that Silicon Valley will have a major part to play, but you see what's happening now in the Eastern Block, Russia and so on. You see what's gone wrong with our educational system. And, I think, we're going to have a tough time in competing. And we've probably got to realize that and then come back. But, I think we're in a downtrend that's got to kind of hit the bottom and then it's got to come back. But I think the educational issue is going to hurt us.

Kvamme: Jerry, how do you see the future?

Sanders: Actually, I'd like to just take a look at the past for a minute and project it into the future. If you look at this little badge that says "We Love Fairchild" I think Fairchild, and this happened on my watch, but I'm not trying to take credit for it, I think, Fairchild really was the original brander. Now, everybody talks about what's your brand? How are you identified? And if you think about it, Fairchild, at we had our product-of-the-week campaign which was intended for me to show everybody we were an innovative company introducing all sorts of exciting new things. We had the yellow smock campaign, showing how we were going to provide this high reliability shop with this special team of people and that was a brand. And then maybe the most important brand that ever got recognition acceptance still, is on these badges - is the Fairch campaign. We used to have a flying F, it was a green F in a circle, the flying F. And you'd fly into Hong Kong and you'd see that on the building. And then we had the crazy idea that this antiquated logo didn't really represent the state of the art. We were going to be the computer guys. So we did this Fairchild campaign and we kept shortening the Fairchild. We had the logo, the two red bars and the big

Fairchild, so it got shortened to Fairch. And the advertisement didn't say Fairchild Semiconductor. It just said Fairch, and everybody know Fairch. And what was the brand? This is the innovator the leader. And, I think, branding continues today in our industry. But the future of our industry, as I see it, is a global integrated company. You're not going to just manufacture in one place and have R&D in a different place. And Intel's on the way to that. You know, they've got R&D in Israel the last time I looked as well as manufacturing. But it's not going to be like Fairchild tried with SGS where you had a little factory assembling stuff in Sweden and somebody assembling stuff in France and somebody else assembling stuff. Instead it is going to be a global company with design centers in Russia, maybe R&D centers in Russia, China certainly. It's going to be a global integrated company, that's the future. Because it all comes down to this, it's all about the people. The people in this room, you know, that built Fairchild. The people in the room and outside this room that built LSI Logic and AMD and Intel, that's what it's all about. It's the people. And it doesn't matter where they come from. It doesn't matter whether they're Russian or Chinese or Indian or American or anything.

Kvamme: Like it didn't matter at Fairchild R&D.

Sanders: It didn't. It matters just if you've got great people, highly motivated with a brand. They know what they stand for. You know, building blocks of every increasing complexity. Just know what you're doing. Don't lose that brand. And eventually, like Gordon says, we'll make everything productive.

Kvamme: We were much more practical at National. You know what our brand was? If it uses springs, levers, stepping motors, or gears and it's performing logic, it's better done in silicon. And we went out and did watches and timers and everything, calculators, and everything that used springs, levers, stepping motors and gears. And in the process we caused the Rust Belt. Gordon, the future?

Moore: Well, as Wilf said, more of the same. But the real things that are technologically different are things you have great difficulty predicting. They come out of the blue, like Google. That I'd call the most recent example. Whoever imagined you'd be able to search the entire Web in a half-a-second and get a half-a-million responses back? It's well beyond anything I imagined that we were capable of electronically. And I think there will be more things like that that surprise us. I think the biggest concern is how the real populated countries, China and India in particular, come into this and who controls the facilities that end up making the things. The world is going to change dramatically and we have a real task to make sure it changes in a way that is least neutral and preferably favorable for us.

Kvamme: The thing that impresses me is how the kinds of problems that you folks solved way back then in those R&D days, to understand how the transistor worked, to understand what was really going – how some of the things you commented on tonight are now helping people understand health, the genome. I mean the genome was a computer project. And all of these things are now using technology that really started at Fairchild. I want to thank our panelists, Wilf Corrigan, Jerry Sanders, and Gordon Moore for their help. I want to thank everyone in the audience who had a part in building what become a real phenomenon - Fairch, I won't say Fairchild. And thanks for being here tonight.

END OF INTERVIEW

