Scientific Data Systems Alumni Oral History Panel

Participants:
Robert P. Adams
Robert Beck
Emil Borgers
Donald F. Cooper
Pete England
Jack Mitchell
Max Palevsky
Arthur Rock

Moderator:
Gardner Hendrie

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Gardner Hendrie: Maybe a good way to get started with the video is to just go down the line and have each person introduce themselves and just say a few words about what their role was in Scientific Data Systems. Why don't we start with you.

Pete England: My name is Pete England. I was the second programmer at SDS hired by Emil. I wound up doing, in the very early days, a lot of programming related to making the hardware work. I also had strong opinions about how it ought to be developed to make it easier for me as a programmer, because I had been at Packard Bell and had problems with what the engineers had developed. So I always characterized my time in the early days as trying to move upstream and influence what was being built so it would make it easier for me to do my job.

Hendrie: Were you doing diagnostic programs?

England: I did diagnostics, I did utilities, I did basic octal loaders -- the things that allowed us to get going on the machine. But I had strong opinions about other things that the machine should do that would make it easier for me and other programmers to actually do something useful with it. I think to a great extent, [in] my opinion, the engineers were trying to make sure they could make the product work. I had no doubt they could make it work, I just wanted them to make it work easier for me. Eventually that led me into what has come to be called architecture of computers, which occurred later with the Sigma series.

Hendrie: All right, good! Don?

Donald Cooper: I'm Don Cooper. And I was hired by Max to do...

Hendrie: Could you just tell us where you came from? Or where Max found you?

Cooper: I was found at Packard Bell. Max found me at the IEEE show in New York City in, I think it was about January 1959. I was currently looking for another position. I went to the IEEE show figuring I might find something there. I was wandering around and I came to this little booth that was sitting on the corner, and there was nobody there manning it, and there was some interesting looking equipment there with analog/digital converters and stuff. So I started opening up the racks and looking in behind, and felt this tap on the shoulder, and looked around and it was Max. I didn't know who he was at the time. He said, "Can I help you?" We got talking and he said, "Well, what are you doing? Who are you working for?" I said, "Well, I'm looking for another position." And he said, "Well, we're looking for engineers." So to cut a long story short, that's how I came from Toronto, Canada to Santa Monica, California.

Hendrie: And you were an employee which?

Cooper: Sorry?

Borgers: You were employee number?

Cooper: I think #70 at Packard Bell. The question was where did I come from before?

Mitchell: Yeah, from Packard Bell.

Cooper: Then later on, when SDS was formed, I went there, and I think I was #5.

Borgers: Well, we were parallel. We were parallel #1.

Cooper: Yeah, one, two.

Hendrie: And what was your role?

Cooper: My role was to work with the logic designers[1], to take what they had come up with, partition it into modules, you see the circuit cards that are in the machines out there [on display on the museum floor]. And so we had circuit cards with different functions. We had AND gates, NAND gates, OR gates, flip-flops, and so forth, to create the digital circuitry that could then be configured and wired on the back panels to create the computer. Then, later on I moved into some of the peripherals. Like, we had kind of an ongoing experience with paper tape photo readers, because prior to that time, most paper tape readers were mechanical, like they had on the teletype machines. The early photo-optical paper tape readers had a lot of different problems. We spent a lot of hours trying to find better ways to make them work.

England: And I tried to program them.

Emil Borgers: Yeah, my name is Emil Borgers, and I was one of the five us that started the first day, I think. Isn't that probably correct?

Mitchell: Pretty close.

Borgers: Yeah.

Mitchell: Close enough.

Borgers: We would have numbers by alphabetical order, or something like that.

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[1] Don Cooper, "A clearer statement would have been, 'My role was to design the digital circuits and to create standardized circuit card modules that could be used to implement the logic the computer designers created.'"

Mitchell: Yeah, I started a week late, because I took a vacation from Packard Bell.

Borgers: Yes, you did.

<overlapping conversation>

Hendrie: You were also at Packard Bell?

Borgers: Packard Bell, Packard Bell, Packard Bell.

England: We were all from Packard Bell.

Mitchell: We were all from Packard Bell, right?

<overlapping conversation>

Borgers: So six of the seven here were Packard Bell. I can remember Dean Wallace asking you [referring to Jack] if you were going to leave.

Mitchell: Right.

Cooper: Dean Wallace, yeah.

Borgers: Do you remember that? And he didn't answer.

Mitchell: No, I did. I did.

Borgers: Did you? Did you say, "No?"

Mitchell: This is from Packard Bell. After I had committed to start with Scientific Data Systems, and I took a two-week vacation. My name is Jack Mitchell, by the way.

Cooper: They've got a sign there.

Mitchell: Oh, do they? So the new guy who was running Packard Bell called me at home, because there was panic at Packard Bell because all the best people were leaving to go to work for Scientific Data Systems. And he said to me...

Cooper: ”Some unnamed place”.

Mitchell: Right.

Cooper: Because it wasn’t that we didn’t...

<overlapping conversation>

Mitchell: He said, “I want to make an announcement that you’re not leaving Packard Bell.” And I said, “Well, I wouldn’t do that if I were you, because I’m planning to leave as soon as my vacation’s over.” He said, “Well, can I make an announcement that you haven’t yet left?” I said, “Well, of course! Go ahead.”

Cooper: That’s what he did.

Mitchell: So, continue [Emil].

Borgers: All right. Okay, well, Pete left out something. He and I were working on what machine we would build at Packard Bell if we could have our choice. So we had some thinking going on as to what we really wanted to do. And in the business plan for Scientific Data Systems, we created an idea of what we wanted to do. At that time we wanted to build three computers. The idea being that when a salesman walked into the customer, he didn’t know how much money they had, so it’s better to have more than one offering. Remember that, Max? More than one offering, so that you could close a deal with them. So you have something that they can afford. So we created the concept of the 910, 920 and 930. Turns out...

Mitchell: A different 930.

Borgers: Well, it turns out that we couldn’t afford to do three. But we could afford to do two, if we designed the higher one, and left out some stuff out of the lower one to cheapen the price, which is really what we did. I think some of the original concepts that we had in there was the idea of creating, as was mentioned in the speech, a way of microprogramming, which wasn’t even defined at that time. So that we could write one software package, and have it work on both machines. A little slower on the cheaper one. And it worked. That worked. Another thing that we had in our computer, and all three of us, Jack and Henry, who’s dead, and myself, came up with was the priority interrupt system, which far exceeded anything that anybody could ever do up to that point. And the primary advantage of it was the reaction time of the computer recognizing the outside event, and being able to quickly satisfy it. That was a big advantage in the real time world. I was mentioning to Max before, one of the things that most of us-- we all had experience in other companies, and we had to keep cleaning up other people’s problems. But what he offered us was a chance to clean the slate, and we had to, you know, not complain about anybody else, we just had to do it. And it worked.

Hendrie: Good. Your general area of responsibility in the first couple of years?

Borgers: At the beginning it was computer design, and then programming. Actually, we wound up, in my time there, with over 100 programmers that were very talented.

Hendrie: Okay. Jack?

Mitchell: I worked at Packard Bell for Max. I was the Director of Computer Engineering at Packard Bell. And then when I went to SDS, basically there were four of us working on the computer to begin with, other than a memory design, which were those core memories. Don was doing the circuit design. Emil, I and the now deceased Henry Herold, did the design, the logic design and the basic concept of the 910 and 920. It was a wonderful period because we each felt that the other was smarter than ourself, the other two. And so it was exciting working with those people, and creating something completely new. Then, once we had the design of the 910 and the 920 done, my job became building. And so we hired a couple of wonderful technicians.

Borgers: Ace Garcia.

Mitchell: Ace Garcia, and Hig Shiriama were their names.

Borgers: That's right.

Mitchell: And then there was a question-- we didn't have enough drafting help to get the drawings made -- the logic diagrams made -- for the computer. I had seen in some ad somewhere these items which were 8 x 10 peel-off sheets, which were very new at that time, that were transparent. And so we had the circuits of the modules, those that Don would permit us to build. (We always wanted new and different ones, but his orders from Max were, "You gotta limit the number of modules," and he was very adamant in that regard.) We printed those things on these sheets. Then we took blank vellum, and we would cut off that portion of each board. We would number the sticky sheet with the location where that module was going. And then we would cut out that portion of the module, those circuits within the module, which we were using, and we would then paste those onto the blank vellums and draw lines in between them to create the drawings without draftsmen. Then from there the problem was getting a wiring list from those sheets, which we did on index cards. And then the problem was once we got going we had a larger number of people who were wiring different machines, and we didn't have enough index cards, so we'd say, "Okay, you do these, you do these." We'd take them out of a single box in which they were. Finally, of course, we got those copied off, so that the people could do the wiring. And then, you know, after that I was basically a computer engineer. I did a lot of the debugging of some of the problems which came up later on, when we started doing bigger systems. Well, I basically -- myself and Henry Harold -- basically debugged the initial two machines, the 910 and 920.

Borgers: And I might add, you did the 930, too.

Mitchell: Well, I did 930...

Borgers: Because we didn't have to do any programming. It was compatible.

Mitchell: I was luckier in doing the 930, because the company had sent me to Paris for a computer show with a French company with whom we were affiliated. And I had a lot of vacation time because I had been working nine/ten hours a day for six or more days a week. I called Bob Beck, who was my boss, and said, "Bob, I'd like to take a week's vacation and stay here in Paris and have some fun." "No," he said, "You get back right now. We've gotta get the 930 out immediately, and so a huge resentment with respect to doing the 930.

Borgers: Was it Intertechnique was the company? Wasn't it?

Mitchell: I don't remember the name of that company.

Robert Beck: CG.

Borgers: What?

Beck: CGE.

Borgers: Who was it?

Beck: CGE.

Mitchell: Oh, Company General...

<overlapping conversation>

Borgers: Oh, that's right.

Mitchell: CGE.

England: CAE, Company Automatique Electronic.

Borgers: Yeah, that's right.

Mitchell: That's confusing, because we had another agreement when we were at Packard Bell with a different French company. And so I'm not sure which company was which, at this point.

Hendrie: They all spoke French, though.

Mitchell: Yes, I was sent because I spoke French gobbledy-gook.

Hendrie: I think I'd like to switch and ask Bob to say a few words. Introduce himself and then we'll get to Max.

Beck: My name is Robert Beck. They told a very good story already. Max and I, as I recall, really met at Packard Bell where my pleasure was just doing the detail design of the G15, which was an interesting computer.

Max Palevsky: That was Bendix, right?

Beck: Well, could be.

Palevsky: Yeah, Bendix. Yeah.

Beck: Yeah, that was at Bendix. That's where Max and I got acquainted. I was always proud of the G15. But when Max really wanted to start SDS I was just delighted to join in. I guess I was the chief engineer, the head engineer, for most of the time. Later I became Executive Vice-President of SDS, 'cause I was managing manufacturing and engineering, which was a very hard goal, I'll tell ya, with this tremendous growth that we had that was really unbelievable. One of the pleasures I had was going to the New York Stock Exchange and seeing our stock traded across the board at the opening.

Hendrie: Art, maybe you could just say...introduce yourself.

Arthur Rock: My name is Arthur Rock. I was, and still am, in the venture capital business. And one of the ventures I came across was Scientific Data Systems. We invested in SDS, and I became Chairman of the Board, and it was my job to arrange the financing, and arrange anything to do with the financing. But more important, my job was to keep the company honest. I guess I was able to accomplish that.

Borgers: I might point out that I think we had about a million dollars, but we felt we needed more than that to begin with. Remember that?

Rock: Uhm hm.

Borgers: And we didn't get-- it was very tough times for venture capital at that time, but we had a million dollars and we really did almost everything that we could on that million dollars.

Mitchell: In a hurry. As a matter of fact, someone mentioned downstairs that we had shipped the first computer in a year after we started, and it was actually nine months we shipped the first 910 out the door.

Rock: You shipped boards before that.

Borgers: Yes.

Rock: You actually shipped boards. What was it, three or four months.

Borgers: That's correct, <inaudible>.

Hendrie: Maybe somebody could tell a little bit about the story about shipping boards. Did you decide to start out in the board business?

Borgers: We needed revenue.

Hendrie: So you did what? I think DEC also did the same thing, started shipping boards.

Rock: I don't know.

Hendrie: But that's what you did.

Rock: Yeah.

Palevsky: At Packard Bell we had done that also.

Cooper: In those days there were a lot of people building their own special purpose computers, you would call it today, for special purpose applications. So there's quite a big market for just say individual logic boards, and all of the pieces of hardware that goes with it; the (mounting) frames and the wiring and the power supplies and the whole bit.

Borgers: A to D converters.

Cooper: Yeah, A to D converters. So one of SDS' first lines was the circuit cards and the bits and pieces, from which we would also, to some extent, build our own computers, but we'd sell them to other people such as the naval base -- Edwards Air Force Base was one of our customers that did that kind of thing. I remember they had a project for some sort of digital device that would help them with gun positioning on battleships. That was built out of those circuit parts.

Rock: I still have one of those boards encased in plastic in my desk.

Borgers: One of the points was that we went to silicon logic in the boards. Almost all of the computers...

Mitchell: Circuitry.

Borgers: Silicon circuitry. Almost all of the boards before that were done with germanium. And so we were in a unique position.

<overlapping conversation>

Hendrie: You were the first ones to do that?

Borgers: We were the first ones to do it.

Hendrie: Max, maybe you could-- I think everybody knows you, so you don't need to introduce yourself. But could you talk a little bit about your earliest thoughts about doing this. Where did the idea of doing another company, and how much was it formed, what you wanted to do?

Palevsky: Well, the background situation was we were a company that was part of Packard Bell. The man who ran Packard Bell...

Mitchell: This was Packard Bell Electronics, by the way. We were a subsidiary corporation.

Palevsky: Called Packard Bell Computer. And at the man who ran Packard Bell was, I don't want to commit...

<inaudible> He's dead. He's dead, it's all right

<overlapping conversation>

He doesn't want to defame the dead.

You can't be sued if he's dead?

Palevsky: Anyhow, he was a little unstable. And certainly, completely ignorant of computers or computer technology, or computer marketing. He just had no clue at all. And that presented a problem, if we were gonna grow and become a big company, to have the man who essentially had the last word be totally ignorant of the subject matter. And I'm sure -- although, I don't remember the detail at the moment -- I'm sure that doing money, that we didn't feel that we were getting the right share, because...

Mitchell: I remember the details.

Palevsky: Go ahead.

Mitchell: What happened was we had an agreement with Packard Bell Electronics. Many of us had shares in Packard Bell Computer Corporation. And there was an agreement with Packard Bell Electronics that when Packard Bell Computer Corporation did $25 million gross, that we would be able to convert our stock into Packard Bell Electronics stock, which was selling at a fairly decent price on the market. What happened was, when that time came, they stalled and stalled as their price was dropping, dropping, dropping. We were all very upset that we were losing money because of their delays. My recollection is that Max issued an ultimatum, that if they didn't do something, he would leave. And the guy said, "Leave." And that basically was the beginning of Scientific Data Systems.

Borgers: Let me add something to that. Packard Bell was originally a radio company that morphed into military electronics. And they were enamored with that. Totally enamored with the Atlas missile, if you remember, building the electronics for the Atlas missile. They weren't that interested in what we were doing. One thing that Max used to say to us over and over again, is that no computer company was successful that had a parent that wasn't in the computer business.

Mitchell: Well, what happened to Packard Bell Electronics actually was that they bid on a very large contract for support and further building more units, when someone else had done the original-- another company-- I don't remember who...

Cooper: Collins Radio.

Mitchell: Was it Collins?

Borgers: Yeah, Collins.

Mitchell: Collins had done the design, had all the drawings, and so on, and had been outbid by Packard Bell Electronics. So what happened was, they were losing their shirts, because Collins was in no hurry to deliver the drawings, and so Packard Bell couldn't produce the equipment, which is why their stock was going down drastically.

Hendrie: So that created an environment where you were ready. Art, when did you meet Max first? What was your first contact with him?

Rock: My first contact with Max was in early 1961. We were introduced by an acquaintance of both of ours who knew what Max was trying to do, and knew what I was trying to do, and introduced us. And we agreed to agree.

Hendrie: So it was a mutual acquaintance, and you got together and talked about what you were going to go do.

Rock: Exactly, and they did it. They did exactly what they said they were gonna do.

Hendrie: Is that relatively unique?

Rock: It's very unique. It's very unique.

Borgers: I think we probably did more.

Hendrie: Bob, you had mentioned something that you had had some discussions with Max about starting something. You mentioned something that even was a loan to sort of get this thing started. Could you tell us a little bit more about that?

Beck: My recollection is Max was, for some reason, a little short of cash at that time. I remember lending him $5,000, which was just a personal loan, because he was promoting this new SDS company and he was short of cash. I talked to him about it today, and he doesn't remember it, but he did pay it back. <laughter> Right?

Borgers: Max had an office at that time. He was left-- you know, left the company, and almost all of us were still there. I think all of us, yeah.

Mitchell: Uhm hm.

Borgers: And Max had an office-- what was the guy's name?...

England: Benson Lehner.

Borgers: Benson Lehner. And he developed a business plan with asking us questions, and he filled in the rest.

Hendrie: So you all sort of were working with Max on the business plan while you were still...

Borgers: No, not all.

Hendrie: Not really?

Borgers: Not you.

Mitchell: Not I. I was on vacation. <laughter>

Cooper: Last vacation, right?

Borgers: No, it was just sort of questions and answers mostly.

Hendrie: Did the company have other sources of funding, or did all of the million dollars come from you?

Rock: Oh, no, no. Leonard Sperry and his brother put up some money. And another venture capitalist put in some money.

Palevsky: The Sperry's were people that Sears Roebuck…

Hendrie: Oh, so from your Chicago connection.

Mitchell: And didn't Marvin Braude represent some group doing...

Palevsky: Braude? He was related them by marriage.

England: Oh, yeah. I think there's still a plaque to the Sperry's in the A&E building in El Segundo.

Borgers: He had a Bentley, I remember. <laughter> Nobody else had a Bentley around us.

Hendrie: So what happened next? Did any of you had started to work for the company before Art did the deal?

Mitchell: No, he couldn't afford to pay us.

Hendrie: Ok.

Beck: We couldn't afford not to be paid.

Mitchell: Right.

Hendrie: Okay. So you closed the deal, and...

Borgers: October, 1961.

Hendrie: Was when it happened?

Borgers: Yes.

Hendrie: When the money came in. How many people were in the initial crew that showed up?.

Mitchell: I think ultimately there were 11 people, not 11 engineers. But there were a couple of marketing people. Bob Fopiano, Jack Behr.

Borgers: They didn't start the first day.

Mitchell: Didn't they start the first day?

Borgers: We had stuff to-- you couldn't sell anything unless you knew what it was.

Mitchell: That's true.

Rock: I knew some people who could do that!

<overlapping conversation> <laughter>

Borgers: Most people could. We didn't think we could.

Hendrie: Who were the original 11?

Palevsky: Cliff Huxford was one of them.

Mitchell: Right, and then there were Don, Emil, Henry Herold, myself, Max, Bob. We had a secretary, Sally something.

Borgers: Sally Field—Not Sally Field. Sally, that couldn't add right.

Mitchell: Right.

Borgers: That's what I remember.

Mitchell: And I think we had-- didn't we have one draftsman? Coleman Smith [ph?]? And I think also a draftsman who worked for him. I don't know if that's 11, but ultimately, as soon as we got the design done, we had two technicians, which I think that all added up to about 11. Basically, in terms of people doing the design, it was Bob Beck who was involved in the memory design. And there was Don Cooper, who was involved with the circuit and module design for the computer, and then there were three of us who were involved with the design of the actual computer.

Borgers: And then Jim Neil [ph?] started somewhere around there.

Mitchell: Later. He came in as they… Oh no, Smith left.

Borgers: Yeah.

Mitchell: No, he was in manufacturing. And also we had John Cool who was the service guy.

Borgers: I remember John Cool came later.

Mitchell: Yeah. But this was after the original 11, I guess.

Hendrie: I was going to ask about the memory design, because I hadn't heard anybody discuss the memory. Bob, could you tell us a little bit about it?

Beck: It was our first experience with core memories. We had our girls thread the wires through them. And we built very simple fiberglass frames for the panels. It was a very precarious thing, getting a core memory to work for the first time, because the signals aren't very strong. It took a lot of sweat getting that darn thing to work.

Mitchell: Well, the story… Actually we had another engineer who was supposed to design, who had experience, presumably, in core memories. And he started trying to design this thing, and it was a disaster. So finally Bob, who's a really good designer, took over. We were on 15th Street in Santa Monica at the time, in this building. And it was essential we get the memory done...

Borgers: We had the prototype done by then.

Mitchell: Yeah, we were coming out with the computer, we were almost done, and we actually had one built, and no memory to work. And so Bob chained off an area in the center of what was going to be the manufacturing area, and no one, no one, including Max, I think, but only Bob was allowed to go into that area, and he worked night and day to get that memory working, and finally did.

Beck: It was a great story. I liked it.

Borgers: That was the random number generator thing, wasn't it? Of course, we found the problem. There was a problem, and Bob fixed it.

Hendrie: So you were responsible really for the core memory. Did you string your own cores, or did you buy cores....

Beck: No, we bought ready-made cores and strung the little fiber wires through them. It's a strange thing. Nobody would do that anymore, because it's...

Mitchell: We put them in those boxes that you see, aluminum boxes. Emil's people, the programmers, would come to test some software, you know, and we didn't have fast enough input equipment for it. So they would load their programs into this thing, into the memory, say 4K worth of program, and then they'd find a bug, but rather than trying to load it in again, they would take the memory box, unplug it from the computer, and then the next software guy would come up and try to load his software in, and there was no memory in the computer. <laughter>

Borgers: We had a lot of little tricks in those days.

England: This is left over from the Packard Bell days, where the memory problem was the major problem to keep the machine running. We couldn't get the magnetostrictive delay line memories in any quantity. And Emil, who was head of software -- and I worked for him at the time -- finally lobbied, fought, to get the programming department issued four working memory modules.

Borgers: The marketing people couldn't take it away...

England: They couldn't put them in the machines to ship them. Us programmers would get a module or two, and go to a machine to debug software, and we'd plug them in, and we'd run our software, and when we got done, we'd take our software department's modules out, and bring them back.

Mitchell: Well, those delay lines we bought from Ferranti. And they were not building them so they would work. And finally Don was sent to the East Coast. How long were you there?

Cooper: I spent the winter of 1960 in Long Island.

<overlapping conversation> A cold winter.

At the Ferranti factory.

Mitchell: Because Ferranti would ship us stuff that wouldn't work. So Don went there to screen it ahead of time, and reject anything that wouldn't work before we got it. So that turned out to be a small disaster.

England: Yeah.

Mitchell: The computer was sort of an odd computer anyway.

Borgers: The story that goes with that, and I told it once, but we went to NASA. And we went to a motel in Huntsville, and Werner von Braun came to see the machine, the PB-250. There was a little demonstration, and he stood up, and he was talking to his people, and he said, "We have to get a lot of these machines like that, and he zapped it, you know...

Mitchell: Electrostatic charge.

Borgers: Electrostatic charge from the floor, from the carpeting. The machine died right there, but he didn't even know it. Max, do you remember that story?

Palevsky: It's true. It's a good story.

Hendrie: It is a good story.

Borgers: Well, it's true. He walked out. Then we did get a lot business from them.

England: That was Packard Bell. Then what...

Mitchell: That was Packard Bell.

England: Then with SDS, we also went after NASA in Huntsville.

Mitchell: I went, and Max went, and we had built a power-fail-safe system into our computer. And the demonstration… Unfortunately there was a logic bug in it, so that one out of maybe 20 times, (maybe even fewer, maybe one out of ten,) it wouldn't work because of this bug that was in it. So we go there, and they're wheeling this computer around on a forklift to different locations, at Redstone Arsenal. And Max is demoing it, turning it on and off, and I'm just in a state!

<overlapping conversation> When is it going to happen?

Mitchell: For that whole trip it worked every time without fail! But when we got back, I got a machine, and an oscilloscope. It was very difficult to find, because when you turn the power on is when it would happen. There was a fleeting instant in there, perhaps a half a millisecond, during this multi-second process. I finally found it, you know, after wearing out, I think, three power switches. Fixed it, and, "Whew!" But he had me terrified.

England: Well, I had software that ran the demonstration that the power thing was interrupting.

Mitchell: Right.

England: And I had.. The guy that was working for me doing part of it...

<overlapping conversation as Emil Borgers gets up and departs the room>

Hendrie: Thank you, Emil. Thank you.

England: When we got to Huntsville and we were trying to get it all working, the software didn't work right. So I'm busily trying to fix this code that somebody else had written, and Jack accused me of talking to the machine, because I'm ignoring everybody else and, you know, talking to the machine or myself trying to fix the software.

Mitchell: It was your language that upset me.

England: We finally had to stop pulling the plug out, which was, we thought, a much more dramatic indication of it could really handle a power failure. Because when you yanked the plug out there's this big arc that would occur, and all the engineers were concerned about it would disturb other things. I'm only concerned whether my software will work, whether it will start back up again. I built in a big long delay, because the typewriter, a stretched [IBM] Selectric typewriter...

Cooper: That was the main I/O.

England: That was the main I/O. It would be typing things, and then when the power failed, it would stop typing. But unfortunately, it might, all that mechanical motion might not stop in a very good place. So I would give it a long time after the power came back on to settle back into some known state before it would start typing again.

Mitchell: It would type, "A power failure has occurred."

England: Yeah, something like that. But the long delay meant that we spent a lot of time going, <crosses fingers> “I hope it starts this time.”

Hendrie: That’s very good. I’d like to go back to Art and talk about what sorts of problems in the first year that you saw at your level, thinking about the overall company and its finances, and sort of what was going on?

Rock: Well, the only problem that I had to face was how to finance the company. I don’t remember, but we probably had additional stock issues, or debenture issues. Do you remember, Max? But we just had to...

Hendrie: <inaudible>

Borgers: [Returning] I’ve got another hour. <inaudible>

Hendrie: That’s wonderful! Could somebody comment on where the decision to make this a silicon transistor machine came from?

Beck: I would think Max must have made it, I think.

Palevsky: Yeah, well, we were at a stage in the technology where it wasn’t clear… People understood that we were giving up vacuum tubes. But whether we would go then to germanium or to silicon transistors hadn’t been clarified, or decided upon. So always wanting a marketing edge, we decided that we would go to silicon transistors. Looking back, I don’t think it was a very good decision. It gave us, for a while, a talking point, but it had problems, and eventually we gave it up. We went to germanium. But for a while it was-- isn’t that true?

Mitchell: No.

Palevsky: We never went back?

<overlapping conversation>

Cooper: We solved all the problems and stuck with silicon.

Palevsky: Okay, okay, well.

Beck: The manufacturers started making good enough silicon.

Cooper: Fairchild was involved with that, right?

Beck: Yeah, yeah. It took a lot of work to get good enough silicon transistors. They weren't comparable to...

Mitchell: And the diodes as well.

Beck: Yeah.

Cooper: So this is pre-Intel days in Fairchild.

Borgers: Yeah, this is Fairchild.

Cooper: In those days I made many trips up here to Mountain View to Fairchild to work with them on issues with regard to quality, and getting the right product.

Palevsky: Just this little discussion you can see that it involved effort and difficulties. We were just, you know...

Mitchell: In fact, there was a brilliant decision of yours. It worked out.

Palevsky: It was a handful of guys in a garage in the back street and we...

Borgers: Money was running out, too.

Palevsky: We didn't need further difficulties to have to handle. On the other hand, it always struck me as being a very good marketing ploy, because there are advantages to silicon, temperature particularly.

Hendrie: Certainly the temperature range of the machines was...

Palevsky: Yeah, right.

<overlapping conversation>

Hendrie: …very attractive to people who were in industrial environments.

Palevsky: Right, right. So we made the decision to go to the silicon, but it was dicey. It was not an obvious correct decision.

Borgers: But I might point out that our cycle time on our computers was slower than we could if we were risky. We had a six microsecond cycle time that we had.

Mitchell: I'm trying to remember.

Borgers: But it was conservative. We wanted reliability over speed. And we made up for the lack of the speed by the design.

England: There was a rather key design point that I think the engineers should talk to. They all come from Packard Bell, and that was a serial machine. You know, the rotating memory, and the rotating registers. And we now had core. They came up with a rather clever design, where the registers in the 910 and 920 were solid state rotating memory. And nobody ever knew it that programmed it, except that they would ask -- an add or a load instruction only took two cycles, one for the instruction, one for the execution. But a store took three.

Mitchell: That's true.

Borgers: That's right!

England: And we would say, "Well, it's just the way do the system."

Borgers: That's us stupid guys over there.

England: And I don't think very many customers ever realized that the logic was serial, even though the memory was parallel, because everybody who built parallel memory machines built parallel machines. We kept the cost down by doing serial.

Mitchell: All the adders and so on were serial adders rather than parallel.

Borgers: That saved a lot of components.

England: That's right.

Borgers: Yeah.

Borgers: A dollar here and a dollar there, you got some real money.

Cooper: And a lower failure rate.

Borgers: And a low failure rate, right.

England: That's when the essence of logic design, as I learned taking the course from Monty Phister **[Montgomery Pfister, UCLA]** was the minimization of flip-flops.

Mitchell: Was it he who designed that one flip-flop machine?

England: <laughs>

Hendrie: Well, tell me about some other difficulties that you had to overcome in getting the machine to the point where you could ship it to the customer.

Borgers: Well, that's 1962...

Palevsky: So that's 45 years ago, so uh...

Hendrie: Yeah, okay.

Borgers: Well, Max used to go on trips to see customers. And when he'd come back, that's when you'd ask him for something, you know, if you needed something, because he was way up high. And he would call us in, "We gotta do this, and we gotta do that," whenever he'd come back. He would get a lot of new ideas from the customers. And that's good; there's nothing wrong with that. But when he was away, and things were nice and calm, we'd just work. When he'd come back, "Bah!" <laughter>

Rock: But, you know, we figured out pretty quickly that unless we could perform -- give better performance than IBM by a factor of three to four -- it wasn't worth talking to the customer.

Palevsky: And that's logical. That makes sense.

Hendrie: That's because the customer...

Rock: Well, IBM was...

Hendrie: They don't want to take a risk with a new company.

Borgers: We had very little money for software. We needed a Fortran compiler, for example. And we didn't. We got bids. I can remember-- Computer Usage, what was the name of the guy that died, the famous founder-- wasn't Computer Usage, it was, I don't know, maybe it was-- Max had a friend-- was it Computer Usage? Max, did you have a friend at Computer Usage? Back east? They bid on it, and it wasn't-- it was Computer Sciences, the founder of Computer Sciences -- and they bid on it. I don't know if you remember this, but he came up in a Rolls Royce.

Palevsky: No.

Borgers: At 15th Street, to deliver the bid.

Mitchell: By the way, he came up in Rolls Royce, and our location on 15th Street was immediately adjacent to an automobile junk yard.

Borgers: But don't you remember the Rolls Royce?

Mitchell: Vaguely, yeah.

Borgers: And he delivered the presentation. It was $95,000 he wanted for it, and I think the Computer Usage one was $105,000. Because we didn't have anything like that, Digitek, huh? $25,000 with a very unique way of doing a Fortran compiler. Turned out to be the best one in the business for $25,000. But we barely had enough money to pay that.

Hendrie: The cash was very tight in the early days.

Borgers: Yes. And that worked, that worked. The software, we got very good kudos on the software in the early days. We started a Users Group. We listened to them, and we responded. We had everything that we needed at a very low price.

Palevsky: You could see that the company was very professional, very. The people were very smart, and very smart in the way that you run this complex organization as a computer company. It was very-- it wasn't just intelligence, but it was also a great deal of deep experience.

Mitchell: That's what made it all so much fun!

Borgers: And the lack of politics. There were no agendas. There were no agendas. We just had to survive.

Palevsky: Yep.

Mitchell: Yeah.

Hendrie: So everybody pitched in and did their best. Helped everybody else.

Mitchell: Yeah.

Borgers: Yeah.

Palevsky: Oh, yeah.

Hendrie: Well, I think we've just been joined by one more guest.

Robert P. (Bob) Adams: Just keep going, and I'll listen and contribute when I can.

Hendrie: Would you be willing to just introduce yourself to the camera? Just say a few words about how you became associated with SDS and what you did initially.

Adams: My name is Bob Adams. There were two Bob Adams'. I'm Robert P. Adams. I first met Max, I think, on Arbor Street, is that right?

Palevsky: Arbor Vitae.

Adams: Arbor Vitae Street, when we were working on hooking an 1103A computer to an Electronic Associates Computer, an analog computer to a digital computer. And we talked, and nothing really came about, then parted. But impressed? Yes! I was impressed. And when Max and Bob were at Packard Bell, and then moved on to start a new company, I couldn't have been-- I was itching to join that company, and was invited, and started there. My job initially was in what we called the Systems Division. And the Systems Division was basically those who took the computers made by SDS and added content, software or hardware, to do a specific job. An example of that is one of our customers was JPL, and JPL was doing work with what is known as the Deep Space Network.

Borgers: Goldstone.

Adams: Goldstone. The first machine went into Goldstone. It was a computer with lots of embellishments. JPL and NASA liked that machine so much that they put our system into all the sites of the Deep Space Network-- help me, I believe there were seven-- is that correct? There were seven sites in the Deep Space Network?

Borgers: Yes.

Adams: Deep Space Network for years were spaced around the earth to...

Borgers: Ascension Island, Australia-- I think there was one in Australia. All around the world. To handle satellites.

Adams: The idea was around the world, so that any time of day or night, you could see an object in space. And we did many other systems.

Borgers: I'd like to point out something. The Ascension Island machine died a natural death somewhere, because the diodes fell off the cards. You remember that, Bob? The weather was awful for computers. Do you remember that? They fell off the cards, so they had to replace the whole thing.

Hendrie: What a story. That's really unusual.

Adams: I would also mention, in the hardware area, when integrated circuits came along, no one had built integrated circuits for use in digital computers. SDS designed a flip-flop package. Two flip-flops, I might add, where today machines have hundreds of thousands of flip-flops. And this machine, this design from our company, was mechanized by Signetics here in Silicon Valley in one month, and it worked, and it went into a TO-5 can, and was used thereafter. To my knowledge, this is the first use of integrated digital memory circuits in the world. Now you should check that statement.

Cooper: I can confirm that, because I wrote an article about that development, because I was the circuit designer working with Signetics. I think also Fairchild, but I think Signetics got the production contract. And it's in – I've got a copy at home -- it's in *Solid State Design* magazine [October 1965 issue].

Borgers: That was the 925, right?

Hendrie: Yeah, what machine was that used in?

Cooper: I can't remember. [First used in the SDS 92 computer. See *Solid State Design,* October 1965, page 21 – "An Integrated Circuit Design for a High Speed Commercial Computer", Donald F. Cooper]

<overlapping conversation>

Borgers: Because we couldn't fit everything we had, in conventional circuitry, in the box. It was a last minute necessity...

Hendrie: To compress.

Cooper: I have a copy of that magazine, so I can send...

Hendrie: Oh, we would love to have that!

Cooper: Yeah.

Hendrie: For our SDS collection, that would be wonderful, thank you.

Adams: Okay, now I'll end up quickly. At that point, I was appointed Vice President in charge of Engineering, Development Engineering. I think it was really simply that I was the only one that was a spare. Such people as Jack, and Emil and Don Cooper were at the heart of the company building it together. And there's this guy who maybe knew a little bit more business than the others, but became in charge of that department.

Hendrie: Okay, good. I'd like to go back and hear whether anybody remembers who the first customers were?

Borgers: Motorola.

Mitchell: For a transistor production line.

Borgers: It was a computer to put in their transistor production line. So the transistors are coming down the line, and the computer had to test the transistor. If it was really good then it went to the government, so they'd open a little chute and it'd fall down into the government box. And if it was really bad, it would go somewhere else. And there were other places. Anyway, they needed that computer in their line to test them and sort them.

Cooper: Real time.

Borgers: Real time.

Mitchell: It was funny, because we had, I think, an error in the memories of those machines, which we retrofitted throughout every machine. Motorola would not let us touch that machine, I think, for two years, and it had this error in the machine. But they just ran it night and day, you know, 24 hours/seven. We were terrified, but ultimately we upgraded it.

Borgers: Well, Tom Marshall did the programming on that. It was the first time he'd done anything like that for us. He was so good that they almost wouldn't let him go. We kept saying, "You've done enough. They should pay us some more money for what you're doing." And he wouldn't leave it until he got it super right.

Hendrie: Was this a 910, or a 920?

Borgers: It was a 910.

Hendrie: 910.

Borgers: It was a minimum machine, yeah.

Mitchell: With 4K memory.

Borgers: With 4K memory

Mitchell: That's when we upgraded it. They needed to make it 8K, and so we just switched the memory things and gave them upgraded one.

Borgers: He slipped the upgrade in.

Mitchell: Yeah, right.

Hendrie: Very good.

Adams: I think the JPL machine must've been one of the early ones also, which was a...

Borgers: Westmoreland.

Adams: Westmore, Paul Westmoreland. Which was a 910 and a 920. And the only difference between the two machines was that the 910 had some modules left out. It was pre-wired, and it could be either machine.

Borgers: Oh, close. Close, but no cigar.

Adams: Okay.

<overlapping conversation>

Mitchell: The 910 and 920 were actually different machines with different logic designs. They were not just, you know, plugging modules in. The only time we did something like that was on a computer called the 92.

Borgers: Yeah, that's right.

Mitchell: Which was a little one. And there, that machine, basically, was the first machine to be designed by the marketing people. We all in engineering hated it. What they wanted to do was, they wanted to have two versions of it, one of which had an additional set of commands in the structure. So what we did is we designed it with everything in it, and then we disabled part of it.

Borgers: And sold it cheaper.

Mitchell: The hilarious part of it was that the machine itself was wired with white wire, and the disabling part was wired in black wire. And one of the guys who worked for me had the job of going out and upgrading it. He would go out with a pair of wire cutters.

Borgers: Just cutting black wires.

Mitchell: And he would cut all the black wires out, and say, "That will be $5,000, please." <laughter> He came back and he said, "I can't keep doing this. I can't face these customers." <laughter>

England: We gave the upgrade to Shell Development to compensate for all the problems we had in getting the 920s that we had installed in Houston to work. The guy that was in charge was a very sharp technical person, but his management was off negotiating with us for compensation for all of this effort that we had put in, and had not gotten a machine to work to their satisfaction. And I think McGurck [Daniel McGurk][ph?] was negotiating our side. They had bought some 92s to go on shipboard for seismic surveys, and they were collecting data on shipboard. So McGurck gave them the extra instructions, the multiply/divide instructions, for free.

Mitchell: This little snip.

England: The technical __________ on their end knew what the difference was. He was technical enough to have figured it out, and he went through the roof, but his managers had already agreed that that was their compensation.

Hendrie: Very good. Tell me about some more of the early systems that you shipped. Any more stories? Good stories about early installations? Those are usually the ones that are sometimes a little __________.

Adams: Yeah, in Huntsville-- Huntsville? Maybe it was Houston. Houston, in checking out the missiles at that time, in their vehicles.

Borgers: I think it was Huntsville.

Adams: Was it Huntsville? Okay.

Borgers: Yeah, it was called the __________ system.

Adams: It was called the Digital Events Evaluator. Our machine would sit and listen to events as inputs were changed, and would predict faults in the space vehicles. And if it passed through our test station, it would then move on as an operating missile.

Hendrie: Okay, good.

Adams: And that machine, talking about terror! John Moser designed that machine. John was going to Hawaii, so I inherited it. I went down there to install it, and it had a flaw. And the flaw happened very infrequently, but it definitely was there. If the machine ran at a certain speed, it practically never made an error. We didn't know what the problem was. So we ran it in that mode, in terror, and came home. And the machine, I'm told by my brother, who worked there, my brother went around to ask, as far as I know our Digital Events Evaluator never made a mistake.

Hendrie: And you never...

Adams: And I was still in terror!

Hendrie: Whatever it was.

Adams: Yeah.

Hendrie: Well, you said that somebody had designed the machine. Is this a special system?

Adams: It was a system.

Mitchell: We made a lot of systems in which the computer was the heart, and then there was a bunch of additional logic to interface between the computer itself, and then whatever the external system was.

Hendrie: Okay. And the customer's equipment.

Adams: And Max made the suggestion, the decision, that the costs were so small in upgrading a machine into a systems, systems of this type, why should we charge money for it? And so we-- Max instituted a program where we delivered systems at the price of manufactured hardware. And we made a great deal of money that way.

England: As long as the customer accepted them on our premises.

Hendrie: Ah, so you didn't have to go there.

Borgers: It was about a third of our business at that time, I think, the systems business.

England: In SDS nomenclature, "systems business" meant custom system. We were building computer systems, but when we said "systems", it meant a custom system for the customer. With computer and other things.

Borgers: And that's about a third of the business.

England: Yeah.

Hendrie: All right.

Adams: Another computer that was delivered was -- someone correct me here who knows astronomy, One of our planets goes the wrong way, and this had never been confirmed, proven, by experiment that this was the case. This again was JPL. JPL, and one scientist at JPL, who used our machine to confirm the fact that this one planet went the wrong way.

Borgers: <inaudible>

Adams: Beg your pardon?

Borgers: OGO.

Adams: OGO?

Borgers: OGO.

Adams: Pogo.

Borgers: O-G-O. The Orbital Geophysical Observatory?

<overlapping conversation> Could be.

Borgers: You're testing our memory. You know, that's a long time ago.

Hendrie: You are doing very well

Mitchell: On individual systems, no way.

Borgers: We did some brain research work for UCLA, University of Oregon, I think. You know, in the laboratories, experimenting with primates. They take the cranium of the primate off and wire it up, and do brain research.

Cooper: Oregon Primate Institute.

Borgers: Oregon Primate Institute. That's what it was. That was another step forward, you know? You had to have a very fast machine that could gather that data up rather rapidly to make any sense of it.

Beck: But those were the 930s, I believe.

Borgers: Well, I think that might have been 930s at that time.

England: We put a lot of 920s onto the deep space tracking radio telescopes that NASA put around the world to track the orbital and deep space missions that they were beginning at that time. There were 11 of them, I think, in the initial configuration that NASA had.

Borgers: That's the one I was talking about, at Ascension Island, where the components fell off the cards, because of the weather. Terrible.

England: They had one at Goldstone.

Borgers: When I was depressed, I'd like to go out to Goldstone and see all the SDS machines that were all over the place. If you closed your eyes and walked in a straight line, you'd hit one for sure.

England: Of course, the little handouts they gave you said, "Don't close your eyes and walk in a straight direction, look down for scorpions."

Borgers: Yeah, right.

Adams: Perhaps you've gone through this already-- stop me if you have. In my view, the real success of the SDS machine was based on machines designed earlier, primarily by Bob Beck. And the component that Bob designed was a very fast flip-flop. Bob poured hours and hours into the flip-flop. The reason this was so important-- it would not be today-- the reason that that was so important is the cost of our machine was hardware gear. That is, the components that went into such machines were the key cost element. Other people, such as Digital Equipment, DEC, were true parallel machines. That is, to add a number, you had a parallel adder. In Bob's machine, with this super fast flip-flop, we could do it serially. That is, the bits would pass by the flip-flop, and some logic, not much. You'd add successively, bit by bit, and then you'd come up with a result, which is, if you like, is a parallel word, which could then pass on to do the work of the rest of the computer. So if you're talking 24 bits, it means that we had about $1/20^{th}$ of the hardware that our competitors had. Hence, our ability to sell a machine at a lower price, and make a handsome profit. All based on a super-fast flip-flop. Is that pretty close?

Beck: I think I like that, yeah.

Borgers: And reliability was high.

Hendrie: I heard you talk about that the registers were serial shift registers. Were they also dynamic, so you didn't have to have a flip-flop at each bit?

England: No, we had no dynamic circuitry.

Hendrie: No dynamic circuitry.

England: I don't think dynamic memories were available at that time.

Hendrie: Right.

Adams: Is that what you mean by it?

Hendrie: I could conceive of Bob designing a circuit that is one transistor per bit.

Adams: Oh, no.

Hendrie: Okay, it was just a serial number with these very fast flip-flops. Good, okay.

Adams: Huge difference, I emphasize, a huge difference in cost. It was based on dear costing hardware.

Hendrie: Very interesting. Good. Who were your principal competitors during this period?

Adams: PDP-1.

Hendrie: Who?

Adams: PDP-1 from DEC.

Borgers: And Control Data to some extent, too.

Adams: Yeah, Control Data, again talking hardware.

Borgers: 160 and 160A, if I remember the numbers. But they really, both the PDP-1 and Control Data machines, were not built by anybody that really understood the real time world. They had to add a lot of stuff to make them work in that environment, and that made them non-competitive lots of times.

Adams: Yeah, furthermore the machine had an interrupt structure which didn't work, okay? That's strong words. They had an interrupt structure that didn't work. And we logically -- I guess, Jack, were you involved in this?

Mitchell: Yeah, I did the interrupt thing.

Adams: Built a true interrupt for our machine. Absolutely necessary for a real time machine.

Borgers: That was a massive difference. They were using serial logic. They would say an interrupt occurred, and then the computer itself, they'd say, "What happened?" And look around for something that happened. But ours, whenever the external interrupt occurred, it went to a location.

Mitchell: A memory location.

Borgers: A memory location.

Mitchell: Where the sub-routine was.

<overlapping conversation>

Borgers: And bounced right into what it was supposed to do.

Adams: Furthermore, the early machines, besides ours, in particular, DEC, used ones complement arithmetic, whereas we used twos complement arithmetic. Either one works, but it's much, much easier to use true twos complement. Again, simplifying Rob's serial concepts.

Hendrie: Could somebody offer why that is true?

Adams: Why it was true?

Hendrie: Why one's complement in your machine would've been more difficult.

Adams: I guess I need help there.

Beck: Not something I can answer.

Adams: Sorry.

Hendrie: But you figured it out, and that's what you did.

Borgers: In today's logic, that doesn't make any sense, but because 45 years ago, it did.

England: When we talk about real time systems, and how successful we were, by the time we got to doing the architecture for Sigma-- and that gets recognized a lot for including time-sharing capability, and the memory map for relocating programs. But underlying all of that was a continuing improvement in our capabilities to do real time. I spent lots of time talking to people in the systems group about the problems they were having in building special systems. So when we did the architecture, we made improvements on the interrupt system, which Jack had developed so well.

Mitchell: But you came up with the design, really, for those, because you told me what you needed.

England: Yeah.

England: I merely designed the modules. I was building on the capability that was in the nine series. He had educated me about how a priority interrupt system would work. We just enhanced it. We included the abilities to enable or disable specific interrupts, if they weren't important. The other thing that was always coming up by the system designers was the speed with which you could acquire information. How fast was the interface? So we made an effort to make sure that we had interfaces for as fast as you wanted to go. We had one-bit interfaces, we had one-word interfaces, we had the I/O channels, serial and parallel. And if you needed it, you could get on the memory bus. We gave that interface as a capability. You could build a system that just tapped to the memory bus. And the other thing we did in Sigma was made multiple memory buses, so that the memory modules could be accessed from several different processors.

Borgers: I don't think the competition ever caught up to any of those.

England: No.

Borgers: What happened was that the computer got so fast, it didn't make any difference eventually.

Adams: Now computers-- you mentioned timeshare-- again, computers were dear. Computers cost a lot of money. So it became to the advantage of many business customers to use the computation power of the computer for a while, and then it'd be turned over to another person, and then another person, etcetera. The early machines-- who built timeshare machines, did it by swapping memory. And by swapping memory, I mean if a user was on there, at his environment, in order for it to go to the next user, you would dump what was in the first memory, replace it with the second users environment, and then proceed to compute, and to the third user, etcetera. Our machines, when we built a timeshared machine, was built according to what is known as Project Mac specification, which was the MIT environment, where you did not have to swap out the memory at all. You merely said, "Go to User 2," and it would go to User 2. As long as the memory was big enough, the two could be intermingled, and through the architecture of Project Mac, the motion was instantaneous. All machines are built that way these days, as far as I know, but ours was the first. We had a comfortable market there for at least a year, which is an eternity in the business we're in.

England: Actually, Bob, the architecture of the Sigma 7 had the memory map, which was the basis for that switching, before the Project Mac had described it. In fact, Jerry Mendelson and I have a patent on the memory map, which is the thing that allows relocation, or virtual memory, as we call it now. We never actually defended that patent, but I have a copy. It was issued.

Adams: Great.

Mitchell: I remember he presented that at the Brentwood Country Mart. Remember that? We had lunch there, and you presented that whole memory map idea.

Hendrie: Very good! What year was this?

England: This was when we were doing the architecture, so that started in '64. We finished the architecture by the end of '65, because we built the machine, which the Sigma 7 was delivered in '66, as promised. I think December 33rd of 1966. <laughter> So it was done probably in late '64, early '65.

Hendrie: Now did all of you work on the Sigma series? I'm sort of interested in how long the original team stayed together.

Borgers: We were all there.

Mitchell: Until the Sigma 7.

Adams: Until the Sigma 7, all of us.

<someone speaking not well-miked>

Mitchell: I stayed an extra six months beyond our contract, because Arnie Spielberg...

Borgers: That was '66.

Mitchell: Right.

Mitchell: I left in 1966. As did Emil. We had four-and-a-half-year employment contracts.

Hendrie: Four-and-a-half years?

Mitchell: Well, that was an interesting story, which...

Borgers: Doesn't have anything to do with it.

Mitchell: Maybe I shouldn't go into that, but… It was initially five, and then for various reasons and negotiations became four-and-a-half. After that period I wanted to leave, but Arnold Spielberg -- Steven's father -- worked for the company at that point -- he wasn't known as that then -- he asked me to stay on another six months, which I did.

England: Steven was Arnold's son at that time. <laughter>

Mitchell: Arnold used to complain endlessly about Steven. "That kid wants a new camera! I just got him a new camera! He wants one-- this one's gonna cost $4,000! I just bought him one for $2,000! What is wrong with that kid?"

Adams: I, too, have a Spielberg story. Arnold took over my job when I left in '68. Arnold was from GE, a marvelous engineer. For a one-month period we overlapped where I tried to bring him up to speed. We would get together every morning to talk about what would happen that day. Well, Arnold one day came into my office, plopped himself into a chair and said, “He did it again.” And I said, “Arnold, who did what again?” He said, “That son of mine.” He said, “He once again climbed over the fence of 20th Century Fox. He skipped school, only so he could watch people make movies. They threw him out, and called me, and I had to go pick him up. ” I didn’t know for years who this kid was, until long after SDS, and his name was Steven.

Hendrie: That’s a good story. So the two of you left in ’66?

Mitchell: Having started in ’61.

Borgers: I wanted to run a company

Mitchell: I wanted to retire

Hendrie: Both perfectly good motivations.

Mitchell: But then I designed a desktop computer. But first I build a Sigma 2 in my den, from parts they were going to scrap. I knew all the guys in the department that was handling this surplus – they were going to sell it for the gold plating. So I got all these parts, built it, checked it out, made it work. Then I decided I needed a disk drive. One of the old SDS guys was Ben Wang, who had worked on the magnetic tapes at SDS, and had started his own company called Wangco, later purchased by Perkin-Elmer. I got a surplus disk drive from him, and designed an interface for the Sigma 2. So I had a magnetic tape with disk drive, paper tape function reader. All of this in my den. Had to redesign the whole power supply arrangement, as I was discussing with Don, because it was designed for a 240 3 phase, which I didn’t happen to have in my house. And when I contacted the power company, the price was going to be more than anything you could imagine. So I had to redesign the power supply for it, which I did, and finally got it working. It took up most of the den.

Hendrie: I bet it did. What did you use it…

Mitchell: I used it to play around. Then also I designed, in the early ’70s, a desktop computer using a microprocessor. We ultimately started a company building these things, but the market wasn’t ready for it yet. But it was an interesting little computer, which had...

Hendrie: What microprocessor did you use?

Mitchell: We used, unfortunately, the 6502. Which, from my point of view, as a logic designer, was a much better computer than the Intel x86 series. At that time the 8086 computer, which had all these weird-- I don’t know who designed that initially, but they were not computer designers who designed it.

Hendrie: You are actually correct.

Mitchell: The 6502 looked like it was designed by someone who knew how a computer worked. And it was much faster, in fact, in many operations.

England: And do you want to know why IBM selected the 8086?

Mitchell: Why?

England: Because somebody else at IBM had already selected the [Motorola] 68000, and IBM's rules said that if you used a component that somebody else was buying, you had to coordinate your buying through them. And the PC division didn't want to have to deal with anybody else in the IBM bureaucracy, so the only other alternative was the 8086.

Mitchell: Interesting.

Hendrie: And so Don, how long did you stay??

Cooper: I stayed until 1967. At that time, the company had grown to be quite big. I think two, three thousand employees. Kind of more bureaucratic and impersonal.

Mitchell: Like the favorite expression from Bob and Max was always, "We're a big company now, and we can't do things that way anymore!"

Cooper: I had an offer from another company in their peripheral business, Data Products. At that time they were a quite successful company making impact line printers, high speed line printers, and disk drives -- I haven't been to see if you have a sample of those, but I think theirs was one of the pioneers, certainly, in the field. At that time the disks that they used for memory were like 3-feet in diameter. They were huge! And I remember one of the things about them was that you had to be careful to run them up to speed before you ran the heads in because at rest the edges of the disks drooped down, which of course would not work very well _____________, and you had to wait until the centrifugal force made them flat before you could start really using them. The other thing was, of course, being they were fairly thick, too. So it was a big mass spinning there, so when you turned it off, you had to wait quite a while before it came to rest. I went there because they were looking for a manager for their component standardization.

England: I stayed. In 1966, we began in interesting project with a French computer company. This is the one that we had been doing business with; they were our licensee. They wanted to build a big computer.

Mitchell: Sigma 9.

England: Well, actually their problem was that there was no all-French computer companies left, except this little one, because de Gaulle had let GE buy into Bull, and so it was no longer all–French, and the United States wouldn't sell them CDC supercomputers at the time. They wanted it for their own nuclear research. So the French government started to fund CAE to build a French computer that was big enough to do significant research. They came to us for help. Max negotiated a agreement, and somehow he decided that I should run this relationship. The first problem was doing the architecture. We told them we really didn't want to build a supercomputer, but we were interested in building a multi-processor that could do lots of things. So we went to work jointly on an architecture for a multi-processor, which was being toyed with by a number of companies at the time, but there wasn't an agreed upon way to do a multi-processor. Many people thought you had one processor that was in charge, and it allocated things to others. My proposal was what I called an "anonymous processor" multi-processor. The whole idea behind it – it's a matter of getting your mind around a different way of looking at things -- is that processors, CPUs, are very strong, but dumb. They have to ask the memory for everything to do. So memory's the smart element, the processors always ask it. So if you think about that as the starting arrangement, you can build multiple processors; the memory, same program, feeding all of them. We built up the whole architecture around that concept. And the French built it.

Mitchell: Well, they never got it running. Henry Herold, who was one of our co-designers, consulted for that French company. He used to tell me about what would happen. What they had was different people designing different portions of the machine. And the interfaces between these two portions were not compatible. And so Henry would go to one…

England: That's very French.

Mitchell: Very French. He'd say, "You know, this is not going to work with So-and-So's part of this machine, you have to change this interface." "Why can't he change his?" So Henry would go to the other guy, and he'd say, "Oh, no! Not me! He should change his!" I don't think they ever really got it together to get the total design done.

England: We came back after that. By that time we decided we needed another machine, so we used a lot of the concepts, although we'd simplified some things to build the Sigma 9, which was also a multi-processor. We made some compromises in order to make it more implementable. But it was successful as a multi-processor. A lot of the installations were multi-processing and doing all that timesharing.

Hendrie: I know this was supposed to be about just the very early machines, but could the panel comment on the genesis of the idea that to build the Sigma line of machines after the 900 series, the 24-bit machines. Where did that come from?

England: It came from a lot of places, but I remember a story...

Borgers: The company had to build a bigger machine than the last one, okay? And do you build on the old, or do you create new? That's really what it was. You had to start somewhere with a new architecture.

Hendrie: <inaudible>

Borgers: No. You know, you couldn't sell them a new machine unless you had something better, right? So they didn't come around to ask you. Unless you had something better. You'd go see them.

Adams: I think the-- correct me-- I think the impetus was the need for timesharing. True timesharing. Our earlier machines did not have it. Other people out there were doing it the wrong the way, we talked before. Architecture had advanced to the point that true timesharing machines were possible. Hence the Sigma series.

Cooper: I think from a hardware standpoint, we were encountering limitations on the 900 series. I think, from [my] memory, a couple of things, I think, were driving hardware design, were (1) the advent of integrated circuits, becoming more and more available, more complex functionality. And the other thing was the whole back panel design. As you increase clock speeds, the memory, seems like 10 megahertz was really a critical point for us. I remember we went through all kinds of gyrations to be able to distribute the clock signals to the different modules that needed it. The conventional wiring wouldn't work. There was too much reflection on the line, too much cross-talk to the signal lines, and too much...

<overlapping conversation>

Mitchell: Too much delay through the length of the wire.

Cooper: Yeah, that's right, yeah. And so there were a number of issues there that had to be resolved. We did come up with a solution to that, but it required a whole new kind of architecture. I think also, probably Bob or somebody could address this, but we also needed to pack more circuits into a given physical space, in order to get the total complexity of circuitry needed to implement a bigger machine. You can't just keep growing the machine bigger and bigger; you need bigger and bigger rooms.

Borgers: The bottom line, though, in a company like SDS was at the time, the product planning people were available for something else. The computer design team's available for something else. The circuitry people was available. And the software people were available, too. So you need that availability to do something dramatic. If you have a lot of painters, and you want to paint a house, I mean, you gotta put them to work some kind of way, so you don't lose them. I think there was a lot of that, too.

Hendrie: That you just needed to have a new challenge for the team.

Borgers: Yeah.

Hendrie: For this, too.

Mitchell: The competition was getting a little-- that would do it, too.

Borgers: Competition was there, too.

England: We had the first indication of timesharing when we were doing the 9300, which was the last machine of the 9-series. Max came back from one of these trips, talking to some professor, and he came back and talked to us about multiple people using the machine at the same time. I don't know if Jack was in the room-- I remember Henry Herold was in the room-- we looked at him like, "Where do you get these ideas?" And we finished that machine. But then when we started thinking about what we were going to do next, and this started shortly after IBM announced the 360, April, 1964 they announced the 360. July 24, 1964 we had an offsite first five-year planning meeting, where we were gonna plan where we were going. I remember the date, because it was my wife's birthday. It turns out to be Max's birthday.

Borgers: And my daughter's birthday.

England: And we talked about where we were going next. Max had just hired Jerry Mendelson to head Product Planning, which was a misnomer. It was really the architecture group, that's what the product planning was concerned with. And we took all these inputs, all these requirements. You know, what was IBM doing, how it was going to change the industry, what were demands from our customers in real time, what was happening with this whole timesharing phenomenon. And there were a number of experimental machines by then built by SDC. Other universities had experimental timesharing machines. And we went and talked to a lot of them. We talked to our systems designers about what was required. We looked at the interrupt requirements. Over the next year or so we did the architecture for what became the Sigma 7. It had a lot of new ideas in it, and when I look back at all my engineering colleagues here to make all this stuff work, which they did. It took a little longer to make the software work. But we did get a machine out that had all kinds of capabilities. And we put a lot of emphasis, I remember, in the interrupt system. IBM had very long instructions. They could do decimal instructions, they could do string instructions. And these things were not interruptible in the normal course of events. We didn't know if we absolutely had to do some of those things, but we did them, because we were gonna try to make a machine that could be used in a lot of different environments. Business environments, as well as our real time scientific. Jerry Mendelson and I gave a paper at a computer conference where Gene Amdahl was the moderator for the panel. We put a lot of emphasis on how the machine was interruptable, even in the midst of long instructions. We had done the architecture so you could do that. Amdahl was very antsy about the way we were talking about this, because he got up afterwards, and said, "Well, an interrupt, just getting through the hardware, is only the first part. You've then gotta go through the saving of the interesting status, and all these other things." He just really didn't like the way we were talking about what we could do, which was a reflection of what the 360 could not do. Something he was a little protective about.

Mitchell: He didn't understand interrupts either.

Hendrie: All right, I think we've run out of time.

Borgers: Now I really have to go.

Hendrie: I want to thank all of you for joining us here in this panel. I think it was very interesting, and lots of good stories, and lots of interesting facts. So we really appreciate all of you coming in and taking the time today to be with us.

Adams: Well, we've enjoyed it, too.

END OF INTERVIEW