Radio Corporation of America (RCA) Laboratories Oral History Panel Session

Richard Ahrons, Steven Hofstein, and Ronald Schilling

Interviewed by:
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David Laws: Today is October 28, 2010 and we're here this afternoon to meet with three gentlemen who worked at RCA Labs back in the 1960s. We would like to try to gather a sense of what was going on in the labs in those days, what the motivations were, what the culture was like. Also to get a sense of the contributions of the lab to the industry in general. I will ask each of you to introduce yourselves individually. Let's start off with Dick, tell us a little bit about your background, and how you came to end up at the labs.

Richard Ahrons: Well, let's see. I've been in the semiconductor industry now for like 50 years. And in 1954 I went to RCA Labs. And low and behold I had more semiconductor [expertise] than most of the people in the labs, having done a master's thesis with semiconductors. So I walked into RCA Labs with a little bit of a semiconductor background in a tube environment. And I stayed at the labs for like ten years doing multiple projects until '64. And then went to RCA Solid State and then had a career in semiconductors.

Laws: What was your background prior to going to the labs? Did you get a BSEE?

Ahrons: I got a master's out at MIT.

Laws: And where was your hometown? Where were you born and raised?

Ahrons: Well, it was interesting. My hometown was like 20 miles north of Princeton, where RCA Labs was. So I went back to my hometown and I actually commuted to RCA Labs those 20 miles.

Laws: Steve, could you tell us a little bit about yourself? And tell us your name as well?

Steve Hofstein: My name is Steve Hofstein. And I joined RCA Laboratories in 1959 after graduating Cooper Union in New York with a bachelor's degree. And while at the labs I got my master's degree and my Ph.D. and I spent much of my time in the laboratories working in the solid state device laboratory headed by Bill Webster .

Laws: Ron.

Ron Schilling: Hi. I'm Ron Schilling. After graduating from the City College of New York with a bachelor's degree, I had some priorities. An important priority was to find a company that would help fund my masters and Ph.D. education. There were a number of institutions that did that. One was RCA Laboratories. One was Bell Laboratories and another was IBM Laboratories. And maybe later on we'll talk

about the relationship between those three activities and why I selected RCA Laboratories and was fortunate enough to work there. That started me in the semiconductor field. I was in that field for 15 years. And since '76 I've been involved in medical imaging.

Laws: Thank you, Ron. Dick, what was it that brought you to RCA Labs? Did you choose it? Did they choose you?

Ahrons: Well, I guess, it was a combination of both. When you're out of college you interview various companies and make a choice. My dad owned an appliance store so I was really focused on TV. I think that is one of the things that brought me to RCA Labs. When I was at MIT I did what they call cooperative course assignments where I went out and worked for a particular firm. So I worked for GE and I was at Electronics Park [Syracuse]. And they thought so much of RCA that I just went to RCA.

Laws: Steve. What brought you to the RCA Labs?

Hofstein: I had worked for RCA in a summer job in my junior year at Cooper Union which was 1958. And I had worked down in Camden. I liked the company very much and while I was in that division which was primarily military electronics I had occasion to meet some of the people that were at the laboratories and was very much impressed with their glowing description of the kind of place that it was. It was almost like a fairy land. It was research into all of these wonderful magical things that electronics was beginning to come out of with. It was like magic, and I loved magic at the time.

Laws: Ron, you gave us a little bit about your motivation, finding someone to fund your higher degree, did you know much about the labs beforehand? Was there a family history there?

Schilling: Well, Fred Heiman was at the labs. He worked with Steve. He graduated City College the year before I did. Knowing that he was at RCA Laboratories was one important aspect. But, again, the Ph.D. program was very important to me. So I went out to IBM and one of their colleagues was talking to all of us and he made the comment, "Let me tell you, we have a lot of beautiful secretaries in this operation." And that took care of the quality level for that organization. I went to see Bell Labs and I was very impressed with the people I was dealing with but they would hire about 60 people a year. RCA Laboratories made the distinction right up front by selecting only four excellent people. I'd like to think I was an excellent person as they thought of it. And it was just an incredible program. We became very good friends. And we all went on for our masters and Ph.D.'s.

Ahrons: That's a common threat between the three of us. We got our Ph.D.'s courtesy of amazing support from RCA Labs.

Hofstein: Hear, hear.

Laws: Dick, so how did the program start at labs? What did you do for your first year there?

Ahrons: Well, the first thing you do and, I think, all of us went through this in some way is you spent a year probably on three different assignments. And you and the labs chose where you're going to end up.

Hofstein: Dick, do you remember the name of that program?

Ahrons: It's the trainee program. I came in to RCA Labs and they sent me two weeks to school immediately. Two weeks at Penn State to study television. So it was very education oriented.

Laws: So you'd go into someone's lab and just be assigned a routine task each day.

Ahrons: You'd be assigned to work there.

Laws: So you'd get a sense of what goes on.

Ahrons: Yes. And one of my assignments was they had something called industry service lab. And the person that I was assigned to as my mentor was Tom Stanley of which we have an oral history.

Laws: Who was Tom?

Ahrons: Tom was at RCA Labs and his distinction when I came there is that he was one of the people that designed the first 6 transistor radio. So you're talking about pre 1954. And he went on to various assignments at RCA Labs. He spent his lifetime there. And very well known in the semiconductor industry. Very well known for scaling.

Laws: And what was your involvement with Tom? You were in one of the departments that he was running?

Ahrons: At that time, Tom wasn't running a department. It was a one-on-one. And it was very common the way the building was set up at RCA Labs is you had two engineers to a room with your desk plus all of your scopes and everything. So it was a lab room, two engineers to a room. And I shared that room with Tom. And, in fact, my assignment was to work on transistorized horizontal deflection for TV.

Laws: Interesting introductory challenge.

Ahrons: Yeah.

Laws: Steven, what was your entrée into the labs? What did you do for the first year?

Hofstein: The first year was a training program. I believe the very first year I was in a laboratory run by Jan Rajchman I remember the lab was focusing on memory.

Laws: He was the core memory guy?

Hofstein: Yes. He was the one that did the core memory. And he had a group doing super conductivity which I believe you were also involved with.

Ahrons: Yes, I joined that group with Les Burns .

Hofstein: You too?

Schilling: Mm-hm.

Hofstein: Everyone went to Les Burns. That's really interesting. But it was a fascinating thing. We got to deal with liquid helium and superconductivity and all kinds of exotic equipment. And it was a very fascinating four months. At that time, I guess, guys see if you agree. I thought at that period back in '59 it was a great search for the technology or a technology for mass memory. That was the big thing at that time because without memory everything else didn't go. And so the second assignment I had was with the electron device laboratory. It was interesting because by that time, Tom Stanley was a group leader, I believe. Does that fit your time schedule too, Dick?

Ahrons: Yes, definitely.

Hofstein: He was working. He had an office upstairs opposite Bill Webster. And as I mentioned this morning that was the chance to get involved with this whole new area of integrated logic in that stakeholder. They weren't using the term integrated circuits as I remember at that time. And that effort was headed a fellow named Torkel Wallmark really brilliant guy, still around and made great contributions. It was focused on a form of the field-effect transistor called the unipolar field effect transistor that Shockley invented after he had done the point contact transistor. And this was the use of a

junction to control current flow in a bar of semiconductor. There was no MOS or that type of structure involved. It was purely a junction-effect transistor. And they had taken an approach from which they took a wafer of silicon and actually cut it into little bars. And then they used mechanical techniques to etch out and to mill out little grooves that became the channels. You ended up with a bar containing a whole bunch of transistors in a row, source, drain, source, drain, source, drain. These then would be laid down on a ceramic [substrate] with the wiring and would become your integrated logic network. That was the activity I did for four months in my training period. And there was no such thing, no project at that time called MOS. I went on to a third group and I don't remember, it slips my mind now, but I came back at the end of my third training assignment I elected to go back to the electron devices laboratory and work under Tom Stanley and that began the MOS project.

Laws: Ron how did you get involved?

Schilling: Well, I was on the master's program where you went to school half-time at Princeton for your master's degree and you worked half-time. And during the first two years I was on a number of assignments, one with Les Burns on superconductivity and one with Steve and Fred Heiman in the CMOS area. Another was thin film transistors with Paul Weimer. Yes, that was very, very exciting.

Laws: In just one year you touched on three unique aspects of [semiconductor] history.

Schilling: You have to understand for a kid like myself this was just like an impossible dream. I'll never forget meeting Vladimir Zworykin, the inventor of the image orthicon. We met in the urinal. I hate to say that. He was standing right next to me and then I got to know him fairly well. And it was just an incredible place for a young kid like me to be experiencing all of this technology. It was just overwhelming. It was just great.

Laws: A little earlier you were distinguishing the style at RCA Labs from Bell Labs, could you elaborate on that now we're on camera?

Schilling: Well, for me personally when I think back over all of the years that I've been in industry and there was a quality element that always attracted me. And that quality element was the thing that I think I somehow recognized when I went on those interviews. It was a style. And it was very impressive to me. And then when I came to the labs it was just everyone I dealt with was just quite an outstanding person. And that's another one of the subjects I wanted to talk about is people, someone like Al Rose .It's just interesting that I'm working with someone now on a project, we're doing something on C-Arms for General Electric and this guy mentioned Al Rose. I said I don't know if you realize this but I worked with Al Rose at RCA Laboratories. He went gaga. He just couldn't believe that I actually knew Al Rose. Well, Al Rose taught me about the concept of "simple." If you really understand things well then you can describe it very simply. And later on I learned about the 80-20 rule which I converted to the high 5 for marketing

purposes. You only need five factors to market any product. That's because salesmen can't understand and handle more than five, a little bit of a joke.

Laws: Five? You must have smart salesmen.

Schilling: But it turns if you really focus on five and that all comes back, again, to the Al Rose time. I also worked on my Ph.D thesis with Murray Lampert who also worked very closely with Al Rose. And Murray, unfortunately, we've lost him, Murray always taught me to think more deeply and learn more and more about what I was doing. And he and I wrote a number of papers together about space-charge limited currents which tied to parts of my thesis. So the quality aspect and the people aspect, were just absolutely incredible at RCA Labs.

Laws: Steve, do you have any similar kind of people that come to mind that define the culture, or the style, or the quality at the labs?

Hofstein: The answer is just a lot of people. And you talk about people like Al Rose, you're talking about giants of the industry.

Laws: And what was Al's major contribution?

Hofstein: Al worked closely, I believe, with Paul Weimer. They had done the original work on the vidicon the first non-orthicon [tube], the first effective consumer level vidicon camera tube was the invention of, I think, was Harold Law

Schilling: Oh, my goodness, I remember Harold.

Hofstein: And Al Rose. And the wonderful thing about these people [is that] they were really nice people. There was no attitude. There was no jockeying for position. Maybe that's one factor I'm curious about you fellows and what you think of it. They had a very unique structure. And by that I mean typically in a company or a corporation people get in and you work, say as a scientist. But everyone wants to increase the station, make more money, get to a higher level. And so they jockey for management positions and so on. The net result is you'll take somebody who was fine technically and you lose that capability as he moves into management. And so the laboratories had, I think, a unique structure. They had parallel structures. You could actually rise up in rank and make as much money as a top manager by staying technical, to take away the allure of becoming a manager. And that was extremely successful. Instead of having a company where people were anxious to become a group leader and run people and then a lab director. And you've got people saying wow I can keep doing my work and I'll be a senior member of

technical staff and a super senior. So I think that was very unique to RCA. I've not seen that anywhere else.

Schilling: And they served as consultants, advisors, teachers, to others who came into their office. Al Rose always had a moment to spend with you, always.

Ahrons: I think Ron's picking up-- it was a much more relaxed atmosphere.

Hofstein: Yes.

Ahrons: The work week was more relaxed than in Silicon Valley. Or I'd say more compared to today. I mean the work week was listed was 37.5 hours, not 40. I remember that.

Hofstein: I remember that.

Ahrons: And you could go to school. You could take off time to go to school. I mean that was very positive. You can speak to anybody. So it was probably a little warmer atmosphere.

Hofstein: It was a family.

Ahrons: It was more family. And you've got to recognize what was in Princeton? Princeton University and then RCA Labs. Princeton was a monster. RCA Labs was a pretty good size. I think roughly a thousand.

Laws: About a thousand people?

Ahrons: Yeah. And so I just think there was a lot more warmth than I see in the industry today.

Laws: Who created this culture? Was it Sarnoff himself? Was he responsible for the way the labs worked? Or was there somebody else?

Hofstein: I kind of think it was Sarnoff himself. He created the ambience. He was the protector. He loved the labs. He loved the concepts. And no one would cross the General [Sarnoff]. It wasn't that they were all afraid of it. It was just that Sarnoff had said this is the way it's going to be. And he didn't say it that way. He just created the laboratories and he loved it. And his affection for the lab was always there and he set the tone from high up about how-- just by his going down and visiting and watching how he interacted

with the staff gave the clue, pretty quickly, to managers as to what the General expected. It was very interesting. I don't know I wasn't close enough, to say gee, did he ever call him aside and say here are the rules? I don't think so. I think he set an example. He loved the laboratories.

Laws: So he spent a lot of time wondering the halls like Hewlett and Packard at HP?

Schilling: Periodically. He did have an apartment there but he wasn't there that often. But when he came to town, and you knew he was coming to town because suddenly all of the walls in the building were being painted. And he came in to see us in the first experiments that Steve was doing with CMOS. And I'll never forget that and I was handling-- as the junior guy --the curve tracer. So I'm bringing up the curves and these curves come up and then they start to drift down. And we didn't think much of it. But he being a tube guy wasn't used to seeing things drifting. So he was a little concerned and raised the issue.

Laws: So obviously he was close enough to understand the technology to see and know what was going on.

Hofstein: Oh yes. He was very sharp, a very sharp man.

Schilling: And he made sure that we got to understand that and got it fixed. It was a major project, major, major project.

Laws: So he was on top of the MOS instability problem from day one.

Schilling: But there was no question in his mind that this is a must-do. And that gave me a major impression about what these kinds of guys are all about. They really understand a broader picture than just the technology. One of the things I want to talk about is process. In looking at start-up companies, for example, I go through a real/win/worth analysis. Is it real? Can you win? Is it worth it? And someone like David Sarnoff just had that in his head. He knew it was real. There was no question. He found out beforehand when they first funded it. So he was committed in terms of being real. Can we win and succeed at doing it? He was going to make sure of that by putting the money behind it. And I'm sure when he decided to solve that problem he knew what the risks and rewards were. And it was very, very impressive. I experienced that one other time in my career at that magnitude. It was with Jack Welch during the early days of the CT Scanners. I was the first marketing director.

Laws: This was at General Electric.

Schilling: Yes at General Electric. Because we were rotating tubes and detectors, we had a ring artifact. Welch looked at that thing and knew that it had to be solved. So he took a Sarnoff-type approach and started this huge program in GE Schenectady. “Whatever it takes we will solve this [problem] because this is an opportunity we cannot fail at”. And that’s incredible.

Ahrons: The other thing about Sarnoff is he always asked for birthday presents. And his birthday presents were new inventions, new creations.

Laws: Did you deliver?

Ahrons: I don’t think so. I don’t think I had one that really nailed it. I think one might have been in the superconductivity area. But by the time I joined that group it was well established..

Laws: The labs were they divided by product? There was the computer business. There was consumer TV. There was audio. How did the lab address the needs of these different aspects of the corporation?

Ahrons: It changed over a period of time. When I first came there it was very product-oriented but at that time RCA was in TV and just dominated [the market]. And we had an industry service lab which basically allowed RCA to get information out to its licensees. So we would continue a broad based licensing [program]. Then it was divided into, I would say, specific product type areas called applications. And later it was more general like in devices. But the application would be aiming some device at a particular application. And the groups cooperated because I remember the power transistors I was using, the device people would make. I would be putting them into horizontal deflection [circuits] and blowing them up.

Hofstein: I’m curious, Dick, what do you remember because you came in earlier than I did. One of RCA’s laboratory’s great successes, the thing that put RCA, the labs and the General and everyone on the map. was color television, was the shadow mask CRT.

Ahrons: Yes.

Hofstein: What year was that project? I’ve been hearing legends about it. Were you there in ‘54 during it or right after?

Ahrons: Yes, I was right in the middle of it.

Hofstein: Can you tell us something about the project?

Ahrons: Well, the project is that RCA did invent the shadow mask TV which was like putting a metal piece with holes in it which the electronic beams can go through with at different angles and hit different color phosphors. There were other things in the offering at that time . - CBS had the stripes and a color wheel.

Hofstein: They had a color wheel, yeah.

Ahrons: And there was a shootout, I think it was with the FCC or equivalent, and CBS won. And everybody was furious that CBS won that because it didn't make sense. And, within a year it was totally reversed.

Hofstein: I think the FCC gave RCA one year to come up with a competitor. They kind of stayed the decision. They said they were going to give RCA one year.

Ahrons: And when RCA came out [with the shadow mask] that was the dominant picture tube.

Laws: Were you involved in that business?

Ahrons: No. I was doing transistor stuff at that time. Dave [David Sarnoff?] started transistorizing the TV. But people adjacent to me were involved in that. And it was great for RCA. But also it created a problem within RCA. When they came out with color TV it didn't take off. Everybody figured it would just take over black and white. But it took a number of years for color TV to take off.

Hofstein: It was the chicken and the egg. The problem was that a colorshow about cost 50 percent more to produce than a black-and-white show. And the producers of the shows were saying that the stations and the networks should pay for that and the stations and networks were saying that the producer should pay for that. And I know personally of one example that breaks my heart. Does anyone remember the show, "The Munsters"?

Laws: Mm-hm.

Hofstein: Herman Munster, not the Addams Family, Herman Munster and everything else. Well, I happened to meet one of the people in the show over a period of a couple of years Patty Priest who played Marilyn the pretty girl. And I asked her whatever happened? You know, why did it go off the air? It was at the height of its popularity. And it turned out color TV did it in. Again, they wanted to go to color. And the station said, no, the producers have to pay for it. And the producers of a very successful show

felt they had a real winner here and the station would buckle. Well, they didn't. And so it was too late and we lost the show and it was all over color.

Ahrons: And you've got to remember that RCA also owned NBC. So there was some pressure on NBC.

Hofstein: Yeah. Nobody would buy color television sets when there's no color television programs. And the sponsors wouldn't pay the premium for a color program because there's nobody watching them.

Ahrons: RCA people were trying to figure out why? Why wasn't this taking off? It was so much better, so much nicer and so on. And somebody came up with the thought that if you have a house with an antenna up there [on the roof] you didn't know if there was a color television or not inside. The antenna could tell you nothing. So it was a lower prestige value. But finally in the late fifties it took off and the money started coming in.

Hofstein: So it was a huge winner for the company.

Ahrons: Yes. But there was sort of a lull before that winner.

Laws: Steven, this morning you were telling me about Thomas Stanley urging you to take on this monster that everybody else had failed at - making the MOS transistor reliable and working. Was that aimed at particular project within RCA? Something that they could see using it for?

Hofstein: The project in the laboratory was Torkel Wallmark's -- the industry was trying to make what eventually became integrated circuits. At RCA the term, at least in that year that I was there '59, even in '60, they were calling them integrated logic nets. If you look at the literature they weren't called integrated circuits for whatever reason. It was just a terminology. But Torkel Wallmark's group was very hotly pursuing the unipolar transistor. Mike Sike [ph?] was in that group working directly for Torkel, Achis Ravis [ph?]. And the function was to make these sticks of transistors and lay them on ceramic with wires. I had come back into the group and that was when Tom asked, "What would you want to do?" And I assumed I'll go back to work for Torkel and Mike as I had done during the training program. And that's when Tom said, "Well, that's an option but did you ever think of something called the MOS transistor?" and it was the first time I had ever hear the words. I said what does that mean? And he said, "It's a metal oxide semiconductor transistor." I thought to myself metal oxide that's iron rust. How do you make a transistor out of a rusty nail and oxide? What is he talking about? I said, "Well, I'm not sure." And Tom turned around and on a [black] board he showed me that it's actually a semiconductor with an insulated layer and a gate on top of it and he explained the basics of how it operated. I was fascinated and he said, "It's an old device. It goes way back, actually, 1928, a fellow named a Lilienfeld actually patented what was really a thin film transistor but basically a field-effect transistor." And I said "it looks very exciting. Why is nobody working on it?" It was like gee, I'm just joining the group and I'm being given an independent

project of my own. I report directly to Tom on this. And I was kind of wow. And I said, “How come?” And he said, “Well, let me tell you a story. That transistor may have been around for a long time but everybody who has tried to make it work has not succeeded. Very tantalizing, they get close, they show an effect but it doesn’t work and it’s killed their careers. So nobody wants to touch it. It’s a hot potato.” He said, “You on the other hand are unique. You have no career to ruin so why not?” And that’s a true story. It’s kind of an interesting comment.

Laws: And Tom’s support for the project was based on the fact that on he could see that it had merit in some application?

Hofstein: It had merit. It was a lot of politics. When he talked about the fact that nobody wanted to touch it there was a reality to that. The people in the group are anxious to get something to function. MOS [transistors] did not function. Unipolars did. So no one wanted to do it for a variety of reasons. And it was political. And they all wanted me. He said, “Look, Steve, I’ll tell you right now they’re all expecting you to go back to work for Torkel and he is going to be a little upset about this. But if Torkel comes to you and says anything you just tell him to come see me and I’ll explain it to him,” as it were. Tom, I think, felt that in my being independent, a new kid, that he could keep me working on something that he believed would work without having to worry about the politics of telling Torkel you’ve got to do work on MOS. I imagine and that’s up for Tom to say. But I do imagine he tried to get them interested. I just think that they felt that they were closer to some type of commercial success with the [unipolar device] path they were following. And they had every good reason to think so. I mean this [MOS] device had been around. Nobody could get the darn thing to work. I was in the right place at the right time. I stepped on something which was an iceberg built by a lot of other people but it was six inches under water and you didn’t know it was there. Look, Steve’s walking on water. Well, it always helps to have an iceberg when you’re walking on water.

Schilling: There’s another way I explain that kind of stuff. He [Hofstein] didn’t know it couldn’t happen.

Hofstein: That’s right.

Ahrons: Yeah.

Hofstein: Exactly.

Schilling: And especially this guy with the energy and creativity that he brought to the team.

Hofstein: I’ll pay you after the show.

Schilling: No, no, it's true.

Ahrons: Yeah, I have to admit he had a lot of energy.

Laws: At what point did you come into this story, Ron?

Schilling: I think it was my third or fourth assignment going through the educational program. And it was just very, very exciting being anywhere near Steve.

Hofstein: I love this guy. I really do.

Laws: He's saying all of the right things.

Schilling: Learning a little bit about hypnosis as he'd light a match and bring it close to his hand. Learning how the candy bars can be thrown up and on the ground they splatter because we had put them into helium.

Hofstein: It had no effect on me at all.

Schilling: So it was just very exciting.

Laws: And how long were you involved in that aspect of MOS?

Schilling: I think a little longer than just an assignment. I think it was more like nine months to a year.

Laws: And what did you move on to from that?

Schilling: My Ph.D. That was the next step in the program where you went to school fulltime and got paid half-salary. I went to Brooklyn Poly and focused on RF type systems and stuff like that. But actually did my thesis with Al Rose and Murray Lampert as my real advisors, on space charge limited currents. One exciting thing that came out of that was analyzing the transistor equations. I was using a program called SNODE, simultaneous numerical ordinary differential equations. And this was the RCA Spectra. The Spectra 70 was a new computer series, new software. I was debugging the software. And you use this stack of cards and you're using these terminals and the printer paper is coming out and coming out. And I started at one end of the transistor and electron density is moving along, moving along and suddenly it goes negative. Well, the electron density can't go negative. So I went and sat down with Al

Rose and that's when we realized well why don't you just define it right there as the end of a region. Oh, wow. And then just go to another set of equations for the next region. And basically, that was a large part of my thesis. We had linear equations instead of the third order non-linear differential equations to deal with. We had a linear equation going all across the transistor structure by dividing the transistor into regions.

Hofstein: Al was remarkable that way. He could get a concept. He'd have this ability in this mind to see it. It was like well, do this.

Laws: So this was fairly early computer modeling of transistor operation.

Schilling: Yes, very early. Actually, in 1971 I was fortunate to create one of the very first books in computer-aided design.

Hofstein: It cuts. It slices. It dices.

Schilling: "Semiconductor Device Modeling for Computer Aided Design." I was one of the editors.

Laws: Just hold it up to the camera for a moment so folks can just see it. "Semiconductor Modeling for Computer Aided Design" by…

Schilling: By Herskowitz and Schilling. We were the editors. And the paper of my transistor analysis is all in here. But it's just interesting I went back and looked at this the other day and there are key guys from IBM Laboratories, from Bell Laboratories, Motorola Semiconductor products division, RCA Limited, Montreal Canada, Northern Electric Company. It's just amazing.

Laws: No Fairchild in there.

Schilling: No, Fairchild. They were busy manufacturing things, not researching or analyzing them.

Laws: Interesting story. Did you stick with modeling for very long?

Schilling: Actually, following my thesis work one of the things that I did was observe a major thing happening at the labs. There was some sort of I don't know if I'd call it a dictate. Again, I was a kid, I didn't know about the political part of this but there was sort of a decree that any project had to be tied to one of the divisions. You needed a supporter. And a number of key players left and went to university of

Arizona, And I always like to think that any issue has three sides to it. Their side, our side and perhaps what we might be calling the truth if you could ever figure it out. And when I really dug into this thing I said, “Is it really so bad to be able to take an idea and bring it to a division and find that they have an application that’s really meaningful for that technical idea? And then you work with them in developing it”. Later in life, as I got into the medical field I called it the clinical/technical tie. A clinical need on the part of a doctor, very often at UCSF in my own case; a technology in an early enough stage so that it’s adaptable to really meeting the need, not a want, but a real need. And that’s what really has made the medical device industry the success that it has been.

Ahrons: And a lot of that depends upon people. If you’ve got the right people at that particular time who are interested, okay. And I think we can mainly ask Steve because my background was in superconductivity, superconductive memories. And then I transferred to RCA Semiconductor.

Laws: So you left the lab and went right down the road to Summerville.

Ahrons: Right. When I got there it was all ready established with CMOS groups doing CMOS work. So the question to Steve is how did that stuff move, all of that work, successful work that you did, move over to RCA Semiconductor let’s say before ’75, or ’75 when I know the story.

Hofstein: Well, I was gone there. I was at RCA up to ’68.

Ahrons: No, I meant ’65, excuse me.

Hofstein: Right, okay, good. It was kind of seamless. In other words, even during the work we were doing on MOS you always-- at least I always felt there was a great closeness to the division. Somerville was only a 30-minute ride.

Ahrons: Yeah, 20 miles.

Hofstein: And I’d go out to Somerville a dozen days, a half-a-dozen days a month, just to talk to the people. Jack Olmstead [ph?] was out there heading a group that I worked with.

Schilling: Oh, yes.

Hofstein: And they’d come to the laboratory. So even though they were physically separated, it was not a division as in a division. It was kind of a natural flow. You did the research and your basic technology. At some point, when it got ripe enough and you started to say gee, how are we going to make this thing?

That's when you took it to the product division because they had the equipment and the know-how to make things. The laboratories did not have like a pilot production facility or anything. Once something came close to being doable it was moved into a productive product division, I think. What has been your experience in that, guys?

Ahrons: You had to have the people in the product division want to take it.

Hofstein: Exactly.

Ahrons: And in the case of CMOS it was just timing was just right. The people that wanted to continue it…

Laws: This is fascinating to listen this because that is so different from the experience of Fairchild Semiconductor of here in the valley where they set up R&D in Palo Alto, manufacturing was in Mountain View and never the two should meet. There was huge resistance to taking anything from R&D and trying to put it into production because the folks in manufacturing thought they were crazy.

Hofstein: That stuns me. It really does to hear that.

Laws: Which is one reason Intel was organized so differently. They did not have separate R&D at Intel because of that experience.

Hofstein: That may be another reason that the guys left Fairchild to form Intel.

Laws: So why did it work at RCA and not at Fairchild?

Ahrons: It didn't work throughout RCA. It did work for MOS and CMOS. For some reason it turned people on because by the time I got there in '65 there were people working all ready. I mean Jack Olmstead was there, Joe Scott [ph?]. And there was a whole group. In fact, by the last part of the decade let's say '68 to '70, there were a lot more people working in the product group on it. They were enthused about it but it did work.

Laws: Are there other examples of stuff developed at the labs that easily moved into production.

Hofstein: Oh sure, if you go back to the original it was color television. There was an extraordinary close relationship between [RCA Labs and the product group responsible for] color television.

Ahrons: Both television and color television.

Hofstein: I guess one could say that-- what surprised me to hear the story about Fairchild is that it's difficult to conceive of a productive environment where the research and development work is being isolated from the people who could use their work. That surprised me because I don't remember seeing any examples of that. You never heard in the culture of the laboratories people deriding the product divisions. You never heard, you know, table talk or out at lunch time, "Oh those stupid guys down at Bloomington blah, blah," there was none of that, at least I found none of it.

Schilling: By the way, I'd like to come back to the computer-aided design stuff. I felt when this group left the importance of perhaps doing things for divisions became very important to me. For me, specifically, it was the semiconductor division. There were two brothers there, the Turner Brothers.

Hofstein: Carl and Norm.

Ahrons: Yes. Twins.

Schilling: I went to see the Turner Brothers. And I told them about what I was doing with computer aided design for transistors. And they said, "Okay, we'd like to give you a contract." I'll never forget this. "We'd like to give you a contract for transistors for high deflection TV" just the point you were making before. I was blown away. And they said, "How much do you want?" That's when I really goofed. I said, $15,000 or maybe in those days it was a lot of money. I don't remember. But I did come back to the labs with a $15,000 contract and worked with them. And then after that completed they asked me to join them at the semiconductor division which I did. And working with Jack Olmstead you mentioned him and several other people like Dr. Adolf Bleaker.

Ahrons: Oh, Adolf. Yeah, I reported to him for a while.

Schilling: An incredible group of people over there as well. And there were a number of people from the labs who had come to the semiconductor division. And as Steve said, it was a very close relationship, working back and forth. So I learned the importance of the customer and really understanding the customer. And I've used that ever since and it's always been the right thing to do.

Laws: So this is one of the valuable lessons you learned at labs that you've taken through your career.

Schilling: Besides people we talked about process, the customer, quality and there's one other it has to do with communications, perhaps I can go into that one.

Laws: Sure.

Schilling: Remember the lecture series they would have? Somebody wanted to talk about something they were doing.

Hofstein: Seminars all of the time.

Schilling: A seminar. Now, it wasn't talking to you. It was talking with you. And here I was, again, just a kid and if I'd raise my hand and ask a question, it may not have been a very bright question at times, it was looked at with respect. No one made fun of me. I was participating. And it was everyone participating. It was a wonderful, wonderful environment. Perhaps you guys want to reflect on communication.

Hofstein: Oh, you've awakened lots of happy memories in my mind about that. If there was something you were doing it was like, Steve, why don't you give a talk? And so you prepare your talk and you get up in this room and there's a lectern, the audience, and everyone was friendly. And you'd talk back and forth and have a good time. You asked in the beginning the key question what was the atmosphere in RCA Labs? Two things that shouldn't go unmentioned. We had a laboratory in Switzerland in Zurich. And we had a division up in Canada. The division in Switzerland was very interesting. It was an RCA division. And once a year as a gesture or signature [ph?] or whatever you want to call it, one the managers at RCA Laboratories was sent to be quote the director for a year in Zurich. Now, the lab was actually run by the Swiss out there but he became the director, an honoree. He did stuff and whatever for one year. And just doing this and the communication and this whole type of environment is what made RCA Laboratories so attractive. I mean if you wanted to give a talk no matter who you were, sure. Put the notice up in the bulletin board, whoever comes, comes, [and you just] set up your slides and give a lecture. At one point they asked me to become scout master, this is not a joke, of an explorer troop, a technology troop they were starting. So I never got past tender foot tall [ph?]. I was catapulted into a scout master position. And that was called rising fast in the ranks like General Sarnoff. Anyway, wonderfully civic minded. Switzerland was interesting. Does anyone remember Harwick Johnson?

Ahrons: Oh, yes.

Schilling: Oh, of course.

Hofstein: Very, very lovely. Quiet guy.

Schilling: Of course.

Hofstein: Very, very smart.

Schilling: One of the elder statesmen.

Hofstein: Oh, absolutely. And so he went to Switzerland for one year and he came back. And we were sitting at the lunch table and asking-- Carl was here, Carl Zaniger And we said, how did you find Switzerland. He said, "Oh, I liked the labs a lot." I said, how did you find the Swiss people?" He said, "Well, I think the word I would use is they're very correct." And I said, correct, what's correct? "So I'll give you a true story of my experience." He said, "All of the secretaries out there are trilingual. They have to speak English, French and Italian. And one of the business acquaintances I had met over there called me up one day and said Harwick my secretary is out for the week, she's ill, can I borrow Joanna, yours? We'll pay her off hours and we'll pay her 30 cents a word to do it but I have to ask you first, is it okay. And I said, fine it's okay. And so she during the evenings worked on it and at the end of the project which is a week or ten days there was a manuscript. So I sat down and I took a look at it. I had to fill the bill out and I counted oh, there's about an average of 9 words a line and 50 so that's 450 words a page and there are 9.5 pages so 9.5 times 450 plus half the page and I sent them a bill. It came back with a check thanking me very much but pointing out that the count that I had given him of 9,462 words was incorrect. There were only 9,322. And that made me a little annoyed. So I took the paper and I counted the words and guess what it wasn't 9, 322. It was 9,346. So I sent them a bill for 128 words. And it came back with a note. Dear Harwick, thank you very much for pointing it out. The words in question are proper nouns and did not require translation. That's correct." It really happened. They wouldn't pay for [translating] a proper noun.

Ahrons: There's one experience, my experience was somewhat different than Ron's. Ron went to RCA semiconductor division and got financing. Well, in all of my days it was the other way around. Some financing would come from the labs. When I went to RCA Solid State I was a group leader. I had a number of people reporting to me. And I would say at least 25 percent of my financing actually came from money from RCA Labs. It came along with some projects, or it came along with just development of the whole area, mostly CMOS. So, again, that was a power of RCA Lab of being able to fund at the same time [as receiving funds]. Another point is that a lot of the funding in CMOS and in MOS came from the U.S. government to RCA Labs, to RCA Solid State because I was flying around the country getting the funding.

Hofstein: You know, I found on the Web just about four months ago the entire MOS project that I worked on and that Fred Heiman worked on was fully supported by the U.S. air force.

Laws: By the air force by Wright Patterson probably?

Hofstein: No. I'm not sure. But I do have a copy of the report, I'll send you it.

Laws: Ron was mentioning about his experiences in the lab and how they served his career later on in life. Did you have examples of stuff you learned at the labs that helped you perform later on in your career?

Hofstein: I would think so. I think I grew up in the labs environment and I adopted it. It was a happy environment for me. And that's the kind of environment when I formed a business I tried to maintain. I ran the company pretty much the only way I knew how which was my great enjoyment was RCA Laboratories and it was a great model. It worked our very nicely for me. How about you guys?

Ahrons: I guess mine is somewhat different. The labs was a research environment and the solid state division was a business environment. So there was a conflict between that because one [RCA Labs] was driven a lot by publication, where the solid state was driven by product. And product had to go all the way to getting out the product fully into production. And it took actually took the product group to take MOS and put some static protection on it or else it would never have flown, never been practical.

Laws: When did you leave the labs and move to Solid State, Dick?

Ahrons: I moved to Solid State their advanced group [in 1955] so it was almost like a bridge. And we had three levels. We had research, advanced development and the actual product group. And the product group was the one that developed the CMOS CD-4000 series which was very successful. I was sort of like in between.

Laws: You came down from the stratosphere.

Ahrons: I didn't have to deal with P&L but I still had to deal directly with results and a product.

Laws: And you stayed at RCA until when? When did you leave?

Ahrons: I stayed at RCA until 1969 and then organized an LED firm called Opcoa.

Laws: Opcoa. Was that based on technology that you had learned about at RCA?

Ahrons: It happens [that] it wasn't. I mean generally, yes, but not specifically which was good because I had no conflict [with RCA] because of that.

Laws: Now, you had some experience with LED you were telling me about this morning, Steve.

Hofstein: Oh, it was a funny anecdote kind of thing. There was the excited word had come to the labs the Somerville had replicated-- I think IBM did the first LEDs, am I correct in that? Was that Westinghouse or GE?

Ahrons: I don't remember who did the first ones.

Hofstein: Their very first announcement that there could even be light coming out of a diode nobody believed it.

Ahrons: It was either Bell or…

Hofstein: It wasn't us. But anyway, the word came that Somerville had achieved it. And so I went over and I believe Joe Scott was there. And I'm not sure about-- no, it had to be Joe. Anyway, they had this thing set up under a microscope. And when you looked in the microscope there was this red glow which turned out later to be a piece of phosphorous that was stuck on the surface but it was exciting nonetheless.

Ahrons: Well, heck, that's the way they make white LEDs today. Stick some fire [?] phosphorous on a surface. Yeah. RCA had some LEDs. And the group actually, I don't know if you remember the name was, under Mike Lamorte.

Hofstein: Yes, I do remember the name. I always was fascinated. It means death. Michael Death.

Ahrons: Mike broke away and actually used RCA's technology. And he started a firm with the first laser diodes. , The firm that I was in made plain ordinary light emitters. And we used the Bell process. We became a licensee of Bell. So I began to understand Bell Labs more. The researchers there were directed at Bell's [telecommunication] application.

Laws: Specific Bell needs.

Ahrons: AT&T applications. And they could not sell to the outside world. That was a big difference between them and RCA, very big. RCA had a history of having components because they were in tubes. They had a vacuum tube division. And they were the largest producers of these peanut vacuum tubes for radios and TV. But the Bell people could not go outside the Bell world. And so they were delighted that somebody else did use their work. And we were the recipients.

Laws: This was gallium phosphide you were working in?

Ahrons: Yeah, we worked in gallium phosphide. And we'd go over to Bell for meetings. And they would extend courtesies above and beyond normal to us. Plus, it was a New Jersey-New Jersey thing. We knew people personally.

Laws: Steve, we have five minutes left. You had another interesting project at the labs, I understand, putting liquid crystals together with chips to make digital watches.

Hofstein: George Heilmier discovered the so called nematic effect of liquid crystals. Dick Williams had been working with liquid crystals and I knew that George was also working with it but all of a sudden one day George became incommunicado kind of thing. His lab door was locked. That was very unique because the lab doors were not locked anywhere. And his door was locked.

Ahrons: Yeah.

Hofstein: And a little curious about it. I didn't pay much attention at the time. I love watches, just one of these people that likes watches. And I was fascinated by the Bulova Accutron. You guys remember that, the one that hummed? It had a little tuning fork.

Schilling: Yes.

Hofstein: It was the first electronic watch and you could actually listen to it to hum. And if you wore it one way on your wrist it gained time, the other way because the pendulum should go-- it depends on what position the pendulum is in it turns out. So in any event I took the watch apart and I measured the current from the battery. I was just curious to see how much power that thing took. And it was about ten microamperes from a one-and-a-half volt battery so it wasn't much at all, ten microwatts, eleven microwatts. And I kind of thought boy, that's a possible maybe but we don't have a display. Anyway, what turned this whole thinking on was that Tom Stanley had come to me, called me in the office and said, "George has seen something that's very unique. You may notice his lab door is locked because we don't want many people to know about this. This is very exciting and could be very powerful commercially but we selected a half-a-dozen people or so that I think have been so creative that maybe if they see this something will come of it." And I went downstairs. And they unlocked the door and let me in and there was a microscope set up. And on the microscope were two glass slides in a sandwich and a battery, just a plain old B, it was a 75-volt battery. And George said, "Take a look through the microscope." And I looked through it and there are these slides. And I can see there's something but it's basically transparent. And he says, "Now, watch this." And he puts the battery connector on it, bing, a little house appears that's been etched into the glass. He says, "Now, watch again," he takes it off and boop the house is gone. That was the very first liquid crystal display that the world has ever seen. I wasn't the first to see it but that fascinated me. So I went home that day and I was thinking about it and I thought well it's obviously good for television if they could ever solve the problems it's slow and it's not in color but things

get resolved. And I thought to myself, I wonder what the power is to run that? So the next day I went back got George and said, George how much power does that display take? He said, "You know, I never measured it." I said, can we take a moment and go measure it? He said, "Sure." So we go inside and he takes the battery and we connect a little ammeter up to it and he measures it and guess what it's about eight microamperes. And I thought oh boy, you've got that and you've got CMOS which takes almost no power. You could make a clock out of that. You could make a wristwatch out of that. So I started to work-- I went to Tom Stanley and he said fine, just put down your thoughts. And I started to work on it. George was nice enough to make me an eight segmented LCD display and I put a binary decoder to make it work and I put a battery on it and it actually sat there and counted. So they locked my door. I come in and my door's locked. Am I fired? It's not a joke. I come to work my door is locked. What, what? There's a note like Steve go home. So I went to see Tom and I'm all shaken up. And he said, "No, no, now that you've got this thing now your door has to be locked too." And I said, I don't want the thing now. Take it off. So I began to experiment with it and I wrote it up and they filed for a patent. And actually the patent did issue. But it was sad. I had done some original research. I actually went in I think it was through a stock brokerage, I can't remember, but I got some reports on the financial industry showing-- you know, the yellow sheets you used to be able to get. And it showed you what they did and watches out of Switzerland were $500 million a year which was a lot of money back then anyway particularly. And what's interesting I learned a lot of peripheral stuff, for example, what do you think the most expensive part of watch is or was at least in those days.

Laws: The case I imagine.

Hofstein: No, the face. The case was cheap. The works in a fancy Rolex that sells for thousands of dollars [the cost] is about 35 bucks. They're all the same. They're mass produced. Anyway, the face is. So I went in armed with figures and all excitement and Tom took it and he was excited. And some week or so later he called me in to tell me that he had bounced the idea upstairs. I never knew who upstairs was. And they said RCA is not in the watch business. And I thought to myself, well this is not really your ordinary watch. This is an electronic device. So I don't know what you guys think. I somehow think that over the years RCA missed commercial opportunities that others were able to follow up.

Schilling: Oh yeah.

Hofstein: They kept inventing wonderful things that other people made money out of.

Laws: Ron, you were about to expand on Steve's comment about people.

Schilling: Yeah, Steve made a comment about bringing things to market. And I was very impressed by these key guys, you know, leaders to me. They're very, very bright. They're running businesses. My first time, again, I was a kid. And suddenly this particular leader failed. He was removed from his job. And he

was in the semiconductor division. And he was running a business there. And I couldn't understand it. I tried to determine, what is it? And I searched and searched and spoke to a lot of people. And I found out that he failed because he didn't know marketing. He was a techie. And he couldn't move into the marketing area. Okay. That stayed with me. And then I asked around who are the marketing companies in our industry? Motorola. Great marketing company. And low and behold an opportunity came up with Motorola. And at that point I was a project leader at RCA and I went out and ended up running a large part of the marketing at Motorola Semiconductor, ultimately ending up running MOS against the Intel 8080 which is an incredible story for another time. But what I learned there was that if you're going to become a business leader you need a number of skills and one of them clearly is marketing. And the way this actually played out at Motorola someone failed. Of course I asked, "What were they lacking?" Strategic planning experience. What's the company that has [that]? GE. And low and behold, several years later a GE opportunity came up. At GE someone failed and it was well noted that he's not an entrepreneur. And an opportunity came up to be an entrepreneur running Diasonics MRI, just at the start of MRI. Interestingly enough Bob Noyce was on the board of that company. And it's just interesting how that initial experience from RCA with the marketing led me to this whole concept of rounding out the game. So I have a strategic tool that I call the core tool. Consider a bagel with a hole in the center. Consider a position, let's say a CEO. The center represents the CEO. There are sections around the outside of the hole that represent all of the key applications or skills you need to be an excellent CEO. You don't need them all but you need a number of them. And that's been something that I've found useful ever since.

Ahrons: I'd like to continue that because Ron and I have a certain experience together. And actually Ron brought me to Motorola about a year before he left. And Motorola had a CMOS group. It was pretty low dollar volume [revenue] at the time. You brought me into Austin, just starting [Motorola was transferring its MOS operation to Austin from Phoenix]. Because our main competition was RCA, we could now look at RCA from a different perspective, from the competitor's perspective, and in a space of about two, two-and-a-half years we went from very little sales to exceeding RCA sales in CMOS. That was about 1978. So we could look and see the failings of RCA as a total product picture. Remember now, the semiconductor business is starting to mature, starting. And so we could see it. I went back to RCA in the late seventies and I began to understand the differences [between Motorola and RCA] --- in why RCA didn't succeed better. I mean I couldn't understand why we at Motorola, coming in from way behind, were able to overtake RCA. Even though we had a fantastic team there [at Motorola], which was one of the things [that made the difference]. But it was what [puzzled me], you're [Motorola] coming from way, way behind. [RCA just "dropped the ball".]

Laws: And what did you determine the factor was that allowed Motorola to accomplish that?

Ahrons: One part was a better team but the other one there was one part of marketing. We had a better marketing team at Motorola, [which was] part of the complete Motorola CMOS team. And we did out-market them. And I still remember because I led the project. RCA came out with an updated version called the B series of CMOS 4000, so it was {named] 4000B. And Motorola jumped on board in

developing all of the [current] parts into the B series [specification]. I had to run a lot of the advertising campaigns and it turned out that after a year they thought Motorola invented the B-series. RCA just fumbled.

Hofstein: Right.

Laws: Was that lack of marketing prowess a direct result, of the Sarnoff influence?

Ahrons: No. But this is after Sarnoff.

Laws: But the culture.

Hofstein: It's always been that way. The question, that's an interesting question, why? I think it would feed into what you were saying Sarnoff was not necessarily a good marketing guy or market sensitive guy. Number one, he was not from the country originally, so I don't know what his first job was when he came over here. Oh, gosh. He was the little kid out on Long Island who received the signals from Titanic when it went down. He received it. But was he ever in an area where he had a chance from what you guys know in his rising up, if you will, where he went through something that was market oriented and picked things up. How did he transition from the 14 or 15-year-old, 20-year-old, I think, who picked up the Titanic signals to the head of the corporation? What were his experiences in that item? I don't know, does anyone know?

Schilling: I mean clearly in color television they marketed pretty well.

Ahrons: Yes.

Schilling: But I remember in one area, do you remember the Olson baffle?

Hofstein: Yes, Harry Olson.

Schilling: Harry Olson, one of the acoustics experts. I have two Olson baffles known as the LC1A. They're eight cubic feet. In 1961 when I joined the labs I was living near a couple of guys who were part of that group. And he invited me to hear the system. Once I heard this thing and I had to get one. I could only afford one. It was $360 if I carried it out of the Deptford Factory if you remember that. So I got one. A few years later I got the second. But that was not a marketing product. That was the executive recording studio speaker. So then they came out with something that was going to go to the market, the LC1B, a small one like a KLA-6 type speaker. They wanted $1,300 for a pair of those. It made no sense

whatsoever. It was spectacular. The performance of these speakers is another whole story. They're just incredible. And they just didn't have a concept. They believed that if we have this great technology people will pay anything for it because it's great technology.

Hofstein: Yeah, in other words, you develop a better mouse trap, people will beat-- I think that's kind of them. If you develop a better mouse trap people will beat a path to your door. I think that was their marketing philosophy. You got color television, you don't have to market. People are going to knock the door down and get it. It's color television. And indeed, for some products it works. But there are people out there who can do that with the best product and also can do it with the not-so-best product. And that's real marketing skill.

Laws: Another area where RCA failed in terms of strong marketing was in the computer business.

Hofstein: Well, there's an interesting story they used to tell internally, I'm not sure if you guys heard it. They went to Honeywell. I was talking to Matt Gordon [ph?] who ran the computer laboratory for the company in Alsiers [ph?] with the big machine. When RCA decided to go into business with computers against IBM they went out and they asked Honeywell for advice, off the record kind of thing. They were friendly companies ever since they settled their lawsuit. And the advice they were given was the following, which is, it's not good enough to make a better computer than IBM for the same money. And it's not good enough to have a computer that's just as good for less money. If you want to get after an entrenched competitor you've got to have a better computer for less money and RCA couldn't do that. That was the problem. They had a better computer but it was comparable in cost. They didn't try the market of the same computer for lower money. That wasn't their nature. Kind of interesting, you have to have both.

Laws: Could they have done that? Did they have the margin but choose not to try to compete?

Hofstein: I don't know. What do you think? This is really an interesting discussion? Given the nature of the market back in those days if one decided to go against IBM what would have succeeded? What did IBM have that we, we being RCA, unable to take a piece out and we tried?

Laws: Service.

Hofstein: I think that marketing and sales was a large part of the game. They couldn't play.

Schilling: They didn't have that capability.

Ahrons: I think RCA had the sales but marketing, no. Marketing was not looked at…

Laws: Right. And they didn't have the established customer base coming from the punch card business that IBM did.

Ahrons: So RCA did not learn the improved techniques in marketing.

Hofstein: Yeah, that's interesting. In all of the years that I was there you never heard-- you would always hear cries of admiration for the latest discovery, wonderful stuff. What you never heard was this guy these fantastic sales he's taken his division and blah, blah. It wasn't negative. It just wasn't there. People were not being brought in to be good marketers. People who were good marketers weren't being told you know what I'm saying? I agree with you. There was this great admiration, admiration of technology and technological achievement. There was no such feeling about marketing at all.

Schilling: There was one exception, I believe. Marketing for government contracts.

Hofstein: Yes.

Ahrons: Yes.

Hofstein: That's not real marketing, though.

Schilling: The guys in Morristown, the guys in Camden.

Ahrons: They did very, very well.

Schilling: They were incredible. Those were marketing geniuses who knew how to get government contracts.

Ahrons: Very successful.

Hofstein: They had a lot of government support.

Ahrons: But it's a different type of marketing.

Schilling: It's not consumer marketing.

Ahrons: It's not a product marketing.

Laws: You mentioned earlier that there were quite a lot of inventions that probably came out of RCA that RCA did not benefit from. Again, it sounds like the Fairchild story. Are there any that come to mind? Well, I guess, LCDs is one that you mentioned, Steve.

Hofstein: LCDs. Digital watches. Audio equipment. Again, Harry Olson was an absolute genius. And you don't see high-end RCA audio products, never did. And they had the laboratory for it. They had the anechoic chamber which was enormous. Harry Belafonte actually came to the labs one time.

Schilling: I saw him there.

Hofstein: Yeah, right. Big guy.

Schilling: Yes, I saw him. I just saw him on TV and I told my wife I remember him at RCA Labs.

Hofstein: He was an incredibly a good-looking guy. And I'll tell you he's kind of strolling down the corridor with all of the lab directors surrounding him and all of the secretaries going oh, God. And he came and it was very interesting. He has a very weak voice, beautiful voice, but it's not a strong voice. And so Olson himself had a little group that were constantly trying to get a better microphone for him to use. He was a big RCA recording artist at the time. And periodically he would come down. They'd set him up in anechoic chamber which is this big room, dead room as it were and they constantly worked on a better microphone. So that was the first glimpse of royalty as it were.

Ahrons: I would say starting in possibly the mid sixties, RCA couldn't get people to pick up products. Somebody would get enthused and grab the idea.

Laws: You mean people internally?

Ahrons: Throughout the organization. The labs would start something, do a prototype. Unless there was an established division to do it, it was very hard to do the entrepreneurship type of marketing. So we want to put watches, electronic games, and there were many things like that. LCDs, just were too advanced for the times. They weren't ready. And that's where RCA did not get the end products. Now, why wasn't RCA creating a watch business?

Hofstein: Because nobody pushed it forward.

Ahrons: In the seventies, the latter part of the seventies, RCA was the largest producer of watch chips. For about two or three years, they were the largest producer of watch chips. Until the ex-Motorola [manager] called Carm Santoro which came there and said you can't make any margin on that.

Laws: He was probably right by then. So when did the influence and the importance of the lab peak, do you think, late sixties?

Hofstein: That's what I was told.

Ahrons: Well, I would say the fifties.

Laws: And General Sarnoff died when?

Hofstein: He was inactive in the last few years. He was alive but not active in the last few years that I was there. So I guess he stopped being active, the early sixties?

Laws: Early sixties.

Ahrons: I would guess that. I don't remember.

Laws: Are those two things related? Or are there other factors?

Hofstein: Yeah, they're related in one sense which is you're right, the company itself from the top down, the General down did not take marketing as a very serious thing to be done. And not negative. It just wasn't. I mean the products, color television. And, again, it was build a better mouse trap and the world will beat a path to your door. And while the general was there and energized things and kept them running it was kind of working. Maybe it's just coincidental that at the time you kind of retired and the company then tried to become more financially oriented and begin to think about dollars but they were ill equipped to do it. They hadn't built the infrastructure. And they hadn't built the people in it. It wasn't part of their culture.

Ahrons: But I think marketing was changing and learning.

Laws: I'm thinking more here about just the general importance of the labs to RCA's future began to decline, apparently about the time that Sarnoff was stepping away.

Hofstein: Whether it was because or just coincidental? I don't know.

Ahrons: There's one other coincidence there, I would call it the burn of the RCA computer and its demise. That was a very down beat. And I think that-- you no longer had Sarnoff to pick up things. You had a very bad defeat with the RCA computers. And I think that combination just slowed down the momentum of new products which were just started by RCA Labs. And RCA Labs also many times didn't follow through. They put it out there and said take it. If you didn't want to take it, it would die, finally because there it was a very small group at RCA Labs to start something but it was the start.

Hofstein: Well, we had a special project that we talked about (Harry Olson) that people don't realize, take the eight cubic foot speakers you mentioned. I don't know if you realized this but that laboratory, Olson and his laboratory had a really special relationship with part of the physics group at Princeton University. And they had developed this fantastic machine that could actually fold space. So the eight cubic feet were packed into a six-inch by six-inch by six-inch cube, a remarkable feat. Never been done since. You didn't know that, did you?

Ahrons: No, I didn't know.

Hofstein: It's called the space folder. It's still in the archive.

Schilling: I went over to the semiconductor division in '66, '66-'67 timeframe. And by the time I left the company in '71 to go to Motorola I would say the labs clearly went downhill in the eyes of those in the semiconductor division from '66 down to '71. We had our own advanced development group with Adolf Bleaker.

Ahrons: Adolf wasn't that big in there. It's Bob James.

Schilling: More and more it was being done in the semiconductor division.

Hofstein: You're absolutely right. It's funny, I'm thinking about the fact people asked me what did you do in the last few years? And I was working on liquid crystal watches and some other stuff and not MOS any more. And you're right, it had been shifted into Somerville. Not negative. It just had been. There was no work going on any more at the labs. It was over.

Schilling: Somerville had some power houses like the Turner Brothers. Roy Pollack, another powerhouse who then went to Fairchild and tried to hire me there.

Ahrons: Yeah. But he came back to RCA and sold off RCA. There's no love for Roy.

Schilling: Well, unfortunately we lost him in an airplane crash with his family. That was very sad.

Hofstein: That's really sad.

Ahrons: But it wasn't Adolf, it was more Bob James who ran the whole…

Schilling: Bob James, absolutely.

Ahrons: And Ed Johnson, remember Ed?

Schilling: I remember, Ed.

Laws: So the fundamental things that the labs used to do were then essentially being done within the divisions. So there was no real role for the labs to contribute to a maturing business.

Ahrons: It matured. Yeah, but what took its place?

Laws: Where did the microprocessor come from? That came Out of the labs?

Hofstein: No, not from the labs at all.

Ahrons: Yes it did.

Hofstein: The microprocessor came from the labs?

Ahrons: Yes, it did.

Hofstein: Who did that?

Ahrons: Under Jerry Herzog there was a guy named Harry Weisberg . And the reason I know so much is because about it because when I went back to RCA that's the group I ran in Somerville.

Hofstein: Wait, that's Somerville, not the Labs, right, though.

Ahrons: Right. But I asked the question where did you guys get this thing from? A 5000 transistor CMOS microprocessor, oh, somebody decided they wanted to develop a microprocessor chip in the labs.

Hofstein: Who was it?

Ahrons: Harry Weisberg or something like that. Jerry Herzog would know.

Hofstein: News to me.

Ahrons: I wanted to get started on the next generation. So we put in a request only to find out [if] Weisberg would architect a new 16-bit MPU but he didn't want to do it. He did it once that's enough. So there was Somerville with an excellent chip group but no chip architect for microprocessors. So that was one of the things that the product group started without a follow through but there was definitely people.

Laws: So the basic idea came out of the labs.

Ahrons: So definitely the chip was architected out of the lab and the designed in Somerville.

Laws: Are there other aspects of the labs you'd like to talk about at this point?

Schilling: Just one thing comes to mind. It was an incredible place to start your career. An incredible place. It kind of just set the angle at which you were going to project the take off of your career.

Laws: Steve, any thoughts in that direction?

Hofstein: Just hear, hear. Ron has it right down. He knows every time you mention RCA Laboratories the three of us here smile.

Ahrons: Right. It was sort of a homey place.

Hofstein: Yes, it was.

Ahrons: It supported you through your Ph.D. You went to school full time and got paid half-time.

Hofstein: It was family.

Ahrons: It was family.

Schilling: But one thing I just might throw out is that among the four of us that were brought in that year was Judea Pearl and Judea Pearl lost his son Daniel Pearl just recently

Laws: The New York Times correspondent?

Hofstein: That was Judea Pearl's son?

Schilling: Oh, yes.

Hofstein: Oh my God.

Schilling: And I didn't know that initially until Paul Schnitzler, another guy from the labs, and I had lunch and he said are you aware that that's Judea's son? And I wrote to Judea. And Judea then came back with a note saying, oh is this the Ron Schilling that I worked with at RCA Labs? And since then we've gotten close together. And there's a musical event at Stanford every year honoring Daniel Pearl.

Hofstein: That's a sad piece of news.

Schilling: Judea Pearl, by the way, is a world expert in artificial intelligence at the computer science department at UCLA.

Laws: And he came out of the labs as well?

Schilling: He came out of the labs, yes.

Laws: Are there any other big names that come to mind in the industry?

Ahrons: There were a lot of different people that worked there.

Ahrons: Bernie Lechner just got an award. I don't remember what he exactly worked on. I mean there's a lot of things, successful things that we never came up [such as] with the next generation great memory after the core. But there was a lot of work [going on at RCA Labs].

Schilling: Do you guys know Al Macovsky?

Ahrons: Yeah.

Hofstein: No.

Schilling: I didn't know about Al Macovsky until later on. Al Macovsky was a professor at Stanford for many, many years in medical imaging. One of the foremost MRI experts. And he recently retired from Stanford. And is one outstanding fellow.

Laws: And he came out of the labs?

Schilling: He left the labs a couple of years before I ever got there.

Ahrons: I worked on a short term project with Al putting color on to videotape. And it was just he and I and a massive videotape machine. So I knew Al. I didn't know anything about any of his imaging background, which may have come later.

Schilling: World renowned.

Ahrons: Yeah.

Hofstein: There was a group-- something I've always wondered about, maybe you guys know. We had a nuclear magnetic resonance group among many of things that we were doing. Do you guys recall that at all? I'm serious. It was up on the third floor, it was in the corner, just before you would turn and go to the library. And they had this big huge magnet. This is before it was cooled by superconductivity. And NMR was kind of the predecessor to MRI. The theory of it was based on the fact that if you built up a big magnetic field and collapsed it that you would get distinctive radiation signatures. The hope was that somehow cancer cells, for example, would have a different signature. So you would examine the spectrum and you would see is there something different in your body chemistry. And it really didn't go anywhere until they turned it into an imaging thing. Just the way you took X-ray, if you will, and then made CAT scanning, MRI is that kind of offspring from NMR. The NMR wasn't really functionally diagnostic enough, but it had interesting affects, for real, among other things, people that worked in that room were

loony. They built the gaussing coils, remember the old sets before they put the gaussing in color television?

Ahrons: Oh, God.

Hofstein: Every once in a while the earth's magnetic field would distort the color and it would start turning patches of green, patches of red and it had to be magnetized so you had a de-gaussing coil. Well, one of these guys, we went in to ask about the magnet and we had to take everything out of your pockets. And they had this big de-gaussing coil. And they said, if you put it over your head, whoa, you see lights. And they were real. They were taking turns putting the coil over the head and looking at lights. I thought to myself I don't think I want to work with those guys. That's a true story. Just build tremendous magnetic field.

Laws: Did any of that NMR work result in RCA products?

Hofstein: No. They did get the lasers, though. The lasers were very successful. They developed some of the earliest lasers, these were gas lasers, not even solid state. And you could actually cut things with them but it was very limited. And one of the things they had, it's not a joke, they sold a big laser unit to the Trojan rubber company in Trenton, New Jersey for piercing nipples, and this is not a joke. Cutting holes in the nipples were very difficult, that's why you got-- you used to buy them blind and stick hot needles in them to cut a hole. And they hadn't really developed a technique for mass producing putting holes and the laser would go pop, pop, pop and it would just punch the holes in them. And they had a tour. The second part of the story is a little bit unsupported but apparently they went downstairs to take a look at the division just where they were making prophylactics. And there was a second laser going bing, bing, bing and they asked why do you have a laser popping holes in the prophylactics? And they said that's to protect our nipple business. That's called marketing.

Laws: Okay. On that note, I think ….

Hofstein: It sucks doesn't it?

Laws: Okay. Well, thank you all very much for your contributions.

Schilling: Thank you.

END OF PANEL SESSION

