Oral History of Gilbert F. “Gil” Amelio

Interviewed by:
Jeff Katz and George Scalise

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Jeff Katz: We're here at the Computer History Museum in Mountain View, California. We're going to have a conversation with Gil Amelio. We have two interviewers. First is Jeff Katz and second is George Scalise. We'll proceed in two phases of Gil's career. We'd like to start out with pre career; that is where were you born and how were you raised and educated? Can you elaborate a little bit?

Gilbert F. "Gil" Amelio: Sure. I was born in the Bronx in New York, 1943. My father had gotten married in 1941 and he was recruited for the draft because a war started in 1941. He convinced the army to let him wait until I was born, but after I was born he went off for the invasion of Normandy. He landed at Utah Beach and then saw the war with General Patton, and he was there through that entire experience. It shaped a lot of his thinking for later in his life, and without question had influence on me in that. He truly believed he was doing the right thing in the right way, and so forth. His job was real simple: keep the tanks rolling and make sure they had gas in them. That was his job. It was real simple. So I didn't see my father until I was about three or three and a half years old, because he then left [the army]. As an infant, you don't remember anything. I remember the first time I saw him he was in his soldier outfit and that was in 1946. The next year in '47 we moved to Miami, Florida; we moved there for a couple of reasons, one, my grandfather had moved there, but secondly there were no jobs [in New York]. A million soldiers had come back from the war and my father just couldn't find a job. So he asked himself "Where's the frontier?" and in those days, in the late '40s, it was a place like Florida. So he went down there and went into the construction business. That was what he did and that's how I spent a lot of my summers: I was out there with a hammer and doing my thing. I went to Miami Senior High School, obviously the grade schools before that, but Miami Senior High. It's a very large high school, a very high-reputation high school. Each class had about a thousand people in it, and so I was- graduated with a class of a thousand. I was not valedictorian. I was not salutatorian. Two of my very good friends were, friends I still have to this day, but I was number five or so. I had one other distinction, which was that I had come in second in mathematics for the state of Florida in a test that they did in those days for that. So it sort of indicated where some of my ability was. So I had to go to college, but my father was basically a construction guy. He didn't have a lot of money. I applied for scholarships and I got scholarship offers from three universities, MIT, Rensselaer and Georgia Tech. The one from Georgia Tech was the most lucrative, had the most money involved in it, and also—

Katz: And closest to home.

Amelio: And it was closest to home. So I made the decision to go there pretty much on that basis. Turned out it was a great decision for many, many other reasons. But I didn't realize at the time that I'd actually made a really great choice, and I wound up getting all three degrees at Georgia Tech. I mentioned earlier at our lunch that I had started a business when I was halfway through undergraduate school.

Katz: Tell us a little about that.

Amelio: Well, that was Information Sciences, Incorporated. What it was was an information [service.] You're looking for something, you're looking for some data of some kind, and that the whole idea was to create a database program that would take advantage of emerging computers. I remember in 1961 or '62 the first transistor computer, the Burroughs 5000 came out, and our school got one of the very first ones that came out. So I was all over it when it was there, and quickly started programming it. I got mentoring from lots of great people who were very passionate about their belief. I thought I had a great idea to solve this problem about what do you do with massive amounts of data that you need to access quickly. Prior to that it was all paper. So we came up with a way of creating a [computer] database that was searchable, so that if you knew what you wanted you could go find it. We also added one wrinkle to it, which was we also identified alternative choices for that part. So if you were looking for a [specific] part for the Redstone missile, we also listed parts made by other suppliers that did the same function. The users of the software could say, "Okay. That's the thing we used but we could have used these others," and that was important information to them going forward. So we did that and actually we were humming along. We had a contract with NASA or what was the predecessor of NASA—

Katz: Let me stop you there. How did you possibly get a contract with NASA as a college student?

Amelio: Well, the way that happened is I had a mentor— I had two mentors but one of them was a fellow named Jack Sellers. Jack was a marketing guy's marketing guy. I mean he was just very polished. He was obviously 25 years older than me, and very credible from his career and everything, and well known in Georgia and in the South. He had enough connections. When I talked to my professors about doing this project one of them suggested “You ought to go see this guy, Jack Sellers; he can probably help you get it started.” So I went to see Jack and I told him about my idea. He offered to help and he got it financed for me. Once I had the financing we then made presentations to NASA and ultimately to Lockheed and to the country of South Africa. We wound up getting contracts. In the early days of the C-5 program at Lockheed, inventory [management]. We were kind of figuring it out as we went.

Katz: How big a group did you manage there?

Amelio: We had 14 people; that was it. We were going to do it all. I was still a student but every minute I wasn't in class I was doing this, and it was a great experience. I made a lot of mistakes but I did a lot of things right too and the business was thriving; there was no question about it. Unfortunately, Jack Kennedy was assassinated and that just turned Washington and the whole government on its ear. The checks that we were getting every month from the government stopped coming, and they kept assuring us, "Oh, well, the new President will authorize this pretty soon." But they didn't. So we finally had no choice but to sell the company because otherwise we would have lost all value. We sold it to Brown Engineering of Huntsville, Alabama for, I think, a much too modest sum of money. But it was enough for me to make an important decision, which was: well I'm not much of a businessman, so I think I'll go on to graduate school and get my PhD in physics. So with that money I did two important things. I went back to school and got my advanced degrees, and I bought my first home in Doraville, Georgia. It was a three-

bedroom, three-bath home on a half acre that I bought for $19,500, which was to me a lot of money at that time. But I had a home.

Katz: It was a lot of money at that time.

Amelio: <*laughs*> So then I focused entirely on my master's and PhD work. When looking around for a subject I decided I wouldn't go back to that software stuff 'cause I was a little burned from the experience I had. But I got very interested in semiconductors.

Katz: Was that through your physics studies or—

Amelio: What happened is my thesis professor was an ex-Bell Labs guy. He just suggested as I recall, that this might be an area I might want to look at and see if there interesting problems that hadn't been solved. I started that work in 1965. Fairchild came around in 1957, right, George?

Scalise: Uh huh.

Amelio: —and by 1965 the industry was just beginning to become recognized as a viable entity, that was going to become a real industry. So my professor suggested that there may be lots of opportunities to innovate and to learn in this new era of technology. With my physics degree I had to have a physics angle to it, so what I finally decided to do my thesis on was the secondary structure of the Auger spectrum. Now just for those who don't remember from their school, Auger spectrum is you shoot and beam of electrons at the surface of a material and it will emit either photons or in some cases other electrons. You measure those ejected electrons and they have a structure to them, and the structure is unique to every material. Out of that, Auger spectroscopy was born, which I believe is still used to this day in the semiconductor industry to study the surface materials of semiconductors. That was my first sort of foray into the semiconductor business and it turned out to be I think a fairly important piece of work. I ultimately struggled through and I got my PhD in 1968.I did it in almost record time. I went from my bachelor's in 1965 to PhD in 1968, which is pretty quick for most PhDs. So my thesis adviser says, "I want you to go take a job as a professor at a university," and he says, "I think you ought to go spend five years in industry you're well grounded, then go back to the university." I said, "Well, that seems to make sense"

Katz: There was a formula back in those days. You had to work in industry either at IBM or someplace like it, to learn what to do and then live off the fat of the land with all that business knowledge.

Amelio: Exactly. So since he had been at Bell Labs he suggested that the first place I go interview was Bell Labs. Now I interviewed at a lot of places. I interviewed at Hewlett-Packard for example. I interviewed at, oh, a company in Minneapolis at that time, the computer company—

Katz: UNIVAC or CDC?

Amelio: Yeah, CDC. That's what it was.

Katz: CDC.

Amelio: Yeah, and I interviewed there and what I finally decided though was after I'd interviewed all these people was that Bell Labs looked the most exciting. What I think clinched it was they gave me an offer to go to Murray Hill, which was sort of Mecca, the center of it. There were 5000 people in one building, a thousand PhDs and 4000 people to help them. I had my own laboratory and my own technician, and I had an unlimited budget to buy any piece of equipment I needed to do my work. I was in heaven; I was absolutely in heaven. And that's what I decided to do.

Katz: Who did you work for at Bell Labs?

Amelio: My immediate boss when I first went there was Mert Crowell. He's not necessarily famous for anything else other than maybe mentoring me in the early days. But his boss, George Smith, was the guy who actually took me under his wing, and—

Katz: Is this the Smith that had worked on CCDs?

Amelio: That's the same George Smith—But we weren't doing that then. I went to my boss, Mert, and I said, "What should I work on?" and he says, "Work on whatever you want." And he said, "But you may want to talk to Dr. Smith about it." So I went to see Smith and I said, "Well, have you got an idea?" He says, "Son, you're at Bell Laboratories. You work on anything you want." I felt suddenly the weight of the world on my shoulders." But he said—it was sort of my first day there and he said, "You fill out all your paperwork and everything" and I'm thinking about what am I going to work on and he says, "We've arranged a little lunch in the cafeteria for you, a welcoming lunch," so he takes me to the cafeteria. And there's a round table there and about eight people there. We sat down and everyone said "Hi." And they're very nice, about then they started getting into technical discussions. Well, in about three sentences I completely lost what they were talking about. I had absolutely no idea what they were saying. There was stuff I had never studied; there was stuff beyond my comprehension. As the minutes went by my face went from this jolly smile for finally being at Bell Laboratories to being oh, my God, I am so outclassed here, <*laughs*> and just about the time I was about to cry, I think everyone started laughing. That was their hazing ceremony—

Katz: I see.

Amelio: —that was what they did: everything they said really didn't make sense. It was just a bunch of gibberish that they were trying to intimidate me with. But, that was the sense of humor that you had at Bell Laboratories. A lot of those people went on to be very good friends over the years.

Katz: The first project you did work on—

Amelio: The first project I worked on was Picturephone. Back in 1964 AT&T had exhibited at the World's Fair in New York this thing called a Picturephone. The problem was that the image sensors were vacuum tubes that were very light sensitive. AT&T's model was that if you're going to put something in somebody's home it has to last for 40 years. Okay?

Katz: Right.

Amelio: So they knew all that one kid had to do was point this thing at the sun coming in the window and it was going to be burned out. Well that wasn't a good solution, so they tried to make something— a vacuum tube with a silicon sensor, silicon target, rather than the more exotic materials because they figured silicon would be more rugged.

Katz: It was well known at that time that silicon was light sensitive?

Amelio: It was, but the difficulty was that there was over time a memory effect: that is, it was damaging the crystals just enough so that you would begin to burn in an image. After about a year of working on that I realized that that wasn't going to go anywhere, and I wrote a paper on it. I actually had filed a couple of patents on some clever ideas I had, but I really didn't think it was going to go somewhere. So George and I got together to kick it around. I think it was in his office knocking around one day and he says, "Those guys that did this bubble memory thing over in the magnetic area said they're getting an awful lot of attention. Wouldn't it be cool if we could do something like that in silicon?" And I said, "Yeah, it would be great" so I left and then a day or so later George called me up and he said, "Would you come up to my office?" I said, "Sure." I went up to his office and he said, "I've come up with this crazy idea and I want to get your opinion on it." It was the first thinkings about charge-coupled devices and—

Katz: They were done to emulate or replace bubbles—in a memory device, not as a light-sensitive—

Amelio: That's right. That's where it started. The idea was we're going to do a silicon version of magnetic bubbles and that's where the thinking was started. So George came up with the three-phase shift register that became the hallmark of the early CCD work and—

Katz: Was that the bucket brigade architecture?

Amelio: Well, it wasn't the bucket brigade, which was slightly different physics which by the way didn't really turn out to work. There is an important distinction between bucket brigade and CCDs. In any event, what we soon concluded was that the gaps between the electrodes was going to be the problem because you couldn't guarantee that you would get 100% transfer efficiency basically going from one capacitor to the next capacitor, without having a very, very small difference so that the field effect was insignificant. And sure enough that was the case. So the first CCDs we made were— if you did an image with it and scanned it out this part of the image was very clear, but this other part of the image, which was from the electrons, had come the longest distance, was more blurred, and that was the problem we faced in the early days and—

Katz: Let me back up a second. How did we get from making a memory to making a blurry image—the "aha" moment that said "Let's try it for imaging."?

Amelio: Here's what happened. When I say a blurry image what I'm talking about is a trace on my oscilloscope so let me make that clear. I basically had my lab taken over by this project. It was my decision to make and I said, "Look. We're stopping everything else. We're going to work on this." We set it up and then I had to figure a way how if I have some capacitors on there how do I measure them? Because I don't have an input and I don't have an output so I needed to have some way of doing some— Input you could put in, you could put- inject charge into it, but how were you going to get an output, and so what we decided to do was we would run the registers in a way so that in principle the charge would be transferred and when it got to the last capacitor we would then dump the signal. You would get a pulse in the ground line, and that's what we wound up measuring. So now by going backwards across that and collapsing successively earlier ones in the sequence you could see the difference in the amplitudes, which was a representation of the loss you were getting as you went through this. When I said "blurry image" that's what I meant.

Katz: I see.

Amelio: At that point I think we all said, "Another way to make an input is put light into this thing" 'cause after all that's what I'd just been working on. I'd been working on the Picturephone, and so since that was—I had spent a year on that, it was just natural to me that I would gravitate in that direction with this technology. George had no objections. He was ultimately the great boss. He basically said, "Hey, if you think that's cool go work on it. Maybe there's something there." I'd made the decision to redirect the effort away from memory and towards image sensors. So when we published our first paper in the- early 1970, which was the first paper to come ou—I think it was February—it was with a very simple image sensor. It was a sort of lousy image but it was an image, and it was done all in silicon. That was sort of the beginning. Here's an interlude—I'm going to come back to this but I want to inject one other thing in the middle of this story—

if you don't mind 'cause I think it's fairly important in the ultimate story—they don't seem to connect but they ultimately do. And that is the relationship I had with Bill Shockley. One of the things they did at Bell Labs in those days is they offered postgraduate courses. They would have guest lecturers come in and teach the course for the equivalent of a semester. In those days Dr. Shockley spent six months in California and six months at Bell Labs in Murray Hill, of course going to where the weather was the best in both cases.

Katz: By that time he had his own company in California—and he was still associated with the labs—Bell Labs?

Amelio: —still associated with the labs. He remained associated with the labs until he ultimately passed away. He won the Nobel Prize there, so they weren't going to put him out on the street. He sort of had the command of the place. I decided to take a course under him 'cause who best to learn semiconductor electronics than from Bill Shockley? Right? So what he'd like to do is with this little class we had—it was only four or five of us in his classroom—is he would take us to lunch after every morning class—it was a morning session and we'd do the morning session, then he would buy us lunch. We got to be quite friendly with one another and he—I think I could use the word "fond." I think he was very fond of me in a lot of ways. I'm not sure I honestly know why, but maybe I was clever or something about me reminded him of something. Whatever it was, he sort of looked after me. So one day he came to me and he said, "I just entered something in my patent notebook and I would like you to countersign it for me." I just felt like the entire weight of the planet was just put on me <*laughs*> He showed me where it was in his book. I said, "Would you mind if I take this home tonight to study it and trust me with it and I'll bring your patent notebook back tomorrow?" He said, "Sure. Fine. No problem." So I went home and I worked on it and I realized that he had made a mistake, and that the invention that he had come up with, which was a new device, wasn't going to work. So now I had even more pressure on me 'cause how do you go back to the labs and tell the Nobel Prize winner, one of the most famous people in the world, that he's wrong. I'm 26 years old, one year out of graduate school, and he's a Nobel Prize winner. How am I going to do this, what am I going to do? It was a very sleepless night as you can imagine. What I finally decided to do was the following. I decided to not tell him what I found; I decided to ask him a series of questions and the questions were arranged in such an order where it would take him right to where the center of the problem was.

Katz: So he would find his own problem?

Amelio: So he would find the problem. I went in there trembling. He always called me Gil. That was our relationship. He was Dr. Shockley but I was Gil and so I asked him these questions. He answered the first one and then I got to the second one. Then there was this pause, and you could see him with the wheels turning. He said nothing at first. He reached across and he says, "May I have the patent notebook?" I handed it to him then. He looked down at it and then he looked at me and he said, "Thank you, Dr. Amelio." That was what happened. I had pulled it off somehow. I had led him to discover the problem. He

knew that I had done that but he also respected me, and the fact that I didn't kind of rub it in his face; I let him gain the insight—

Katz: What was the failed invention?

Amelio: It was a device that used both a charge and magnetics and it just wasn't going to work. I mean it was a new kind of a device that was based both on magnetics and current.

Katz: Was it for memory?

Amelio: For memory. It wasn't going to work. So it would have been a waste of time to work on it. But that sort of cemented our relationship. When I finally came out to Fairchild he was spending his six months at Stanford. Right? He would call me up from time to time and I'd go have lunch with him or we just stayed in touch. The problem was having dinner with Bill Shockley was dangerous to your health because he was so loud. He was a very outspoken, didn't-care-who-he-offended kind of guy. We almost got thrown out of one restaurant once one evening when he got off on his race thing that he was doing in those days. I really didn't want to go there and I was trying to steer him into other discussions. Finally the maitre d' of the restaurant comes up and said, "Look. If you don't calm this down, move on to something else, we're going to ask you to leave," but he didn't know who the guy was. He calmed down. But it was that kind of a relation—we had a great relationship.

Katz: At that time you were at Fairchild?

Amelio: Yes. I flashed forward. I'm going to go back to Bell Labs. I'll finish the story of Bell Labs.

Katz: I want to get to the transition into Fairchild, but I'm curious. I thought Shockley must have harbored some resentment to anybody at Fairchild in those days.

Amelio: You know something? He didn't equate me as one of the “Fairchildren.” He equated me as the guy from Bell Labs from Murray Hill. In his mind that's who I was. I was this young man he mentored at Murray Hill and yeah, I happened to be at Fairchild but that wasn't important. It never bothered him.

Katz: Interesting.

Amelio: It was strictly a personal relationship. Our relationship sort of transcended what our other work was. Now let me flash back because there was an important story in all of this. I decided that we had to write down the work we were doing on CCDs. This happened all in the middle of that, and I decided that it

was my job to write it down because I wanted to make sure it got written down correctly because there could be potential patents.

Katz: Doctors Smith and Boyle just let you do it?

Amelio: They did. They just let me run with the ball, and put no restraints on me whatsoever, literally none. So I kept a meticulous notebook. I had these colored pencils in my drawer, and I would draw these diagrams in different colors, and I would annotate them and everything. It was a very detailed record of all the work we did at that time. Meanwhile George had entered in his notebook the basic concept, which was articulated in about a paragraph, and that was in his notebook. I don't know that Bill Boyle ever wrote anything in his patent notebook, but that's another story. When we got to the point where we think this could be made into a viable device and we really need to tell the world about this, I decided to start writing. So I started writing a paper on this. I went to George and I said, "Look. I've been working on this paper but I need your guidance on what I should do and shouldn't do" and the first thing he said he says, "Well, the authors on the paper have to include Dr. Boyle and myself, and you, and we will want to weigh in heavily on what it says." I said, "Absolutely. You're my boss but I just wanted you to know I'd written this paper, and it was because I think it needs to be documented." He agreed with that. There was no friction but he helped me edit the paper and got it to, I think, a pretty polished state. Then he took it to Boyle, who I think changed two or three words in it. It was—really was pretty insignificant what he changed in it. But he made one other change and then he decided that my name should not be on the paper—

Katz: Why do you think that was?

Amelio: I was an arrogant 26-year-old know-everything scientist, thought I was smarter than everyone else, and he just never had a liking for me. Now Shockley I think truly loved me probably because I was that arrogant kid. And George loved me for reasons I don't really understand but he really did; he really was a great boss and looked after me all the time. So he came back to me and he said, "We got a problem" and I said, "Did I write something wrong? Is there a mistake?" He says, "No. That's not the problem." He said, "The problem is that we need to take your name off the paper." He said, "However," he said, "I convinced Mr. Boyle that what we should do is let you write a second paper on the experimental verification of the CCD, not just on the—" So we took the paper I'd written, we split it into two papers. One was strictly on the concept and the other was on the verification of the concept. I was the number one author on the second paper. It was also authored by Mike Tompsett and George Smith. And then the other [concepts] paper was Smith and Boyle, Smith was the primary author on that, and you know something? It really didn't bother me at the time. I mean I had this little feeling that maybe it's not totally fair but I reminded myself that George had called me into his office and he went to the blackboard and he basically gave me the crudest concept of what a CCD was. And yes, I had picked up the ball and I'd run with it but it was his idea, it wasn't my idea. So what my feeling was, was if you wanted to get down to giving people credit then I would say that as far as the invention of the concept is concerned I would

basically think that was essentially 100% George Smith. And if I had the ability to call those shots, that's what I would have called. On the other hand, everything that was done to make it into a real device that could actually do something was done I think by me both at Bell Labs and then later on at Fairchild.

Katz: Was the emphasis during the writing of the paper, or during the lab work, on image capture or on memory or both or what?

Amelio: Early in the experimental program we decided to move to imaging mainly because it was an easy way to get a signal into the device, and so it was more out of pragmatism- experimental pragmatism rather than trying to actually make a device. Now I had done the Picturephone project so as I said in the back of my mind I said, "We can make this into an image sensor" and in fact Mike Tompsett and I actually had a discussion on that and he actually entered that in his patent notebook. Now the patent's issued, oh, a couple years, I think, later and there was—and I'll get back to the other story but again this is another one of these asides that's important. Bell Northern, as it was called back then, contested the patent. They claimed prior art. So it was this big lawsuit between Bell Northern and Bell Laboratories. As it turned out the matter was in court for a number of years. And during that time I actually moved to Fairchild, but one day I got a call from one of the Bell Labs attorneys, he said to me, "We've won the case" and I said, "Well, great. That's wonderful." And he said, "And your patent notebook is the one that won the case." He said, "You had described it in such detail that it was unmistakable that we had the prior art and they didn't." And so I visited a few years ago the archives in Bedminster, New Jersey, where AT&T still keeps a museum of the history of AT&T. That notebook is there, and I was so thrilled to think that someone actually thought to save that notebook. Like I said, it brought tears to my eyes, but the curator there went and he looked, and he said, "We have it. It's here."

Katz: If it was used to win an important case, I guess they couldn't throw it away.

Amelio: Yeah. I guess that's the case so that was that little aside.

Katz: Was there actually an intent at that time to make a device for an end product?

Amelio: No, no, no, not an end product. Remember Bell Labs didn't make products, we made paper, right, we published stuff, and Western Electric made products. What I decided to do is I was going to try to get the device to a state of readiness where it could actually be a crude image sensor. Again George just let me run with the ball on that. And so I started the image sensor work with very crude ten by tens and fifteen by fifteens kind of arrays, and in crude ways of getting the signal out and everything. But we actually had started to get some crude images before I left. And of course the paper got published. It was on the cover of Electronics magazine and there was a big story and everything else. During the subsequent year I was frequently asked to go speak at various events where I would describe the work that we did. That included the traditional conferences that we all have attended in that part of our career.

And somewhere around middle of 1971 my phone rang, and it was John Atalla, who was then at Fairchild. He said he had heard me lecture at the licensees' meeting we did every year. Every year all the licensees under the consent decree could come to the labs in the big auditorium and we would report on the latest developments. This was part of the consent decree that existed at that time. I had given a paper on CCDs and John Atalla, given the quick mind he had, instantly saw the importance of it. He called me up and said, "Can I convince you to come to work for Fairchild?"

Katz: Was his motivation memory or imaging?

Amelio: <*laughs*> Neither. He was a material scientist. He was interested in whether there were other kinds of materials from which you could make CCD materials other than silicon. That was his interest. Now it turned out to be, I think, a bridge too far. But if you're God and you're going to make the perfect material for electronics you're going to make silicon. I mean it's a big stretch from silicon to the next best thing. Maybe germanium's okay but after that it gets pretty thin. And so he invited me and I said, "Well, what would you have me doing?" He said, "Well, I would want you to work for Dr. Jim Early," who I knew had left Bell Laboratories to go become the head of Fairchild R&D. He arranged for me to meet Jim Early in New York. I met him and we hit it off, and he offered me a job and I ultimately accepted it—

Katz: What made you think you were ready to leave, not ready to arrive at Fairchild but ready to leave Bell Labs?

Amelio: Here's the problem I was having at Bell Labs: it was exactly the point you touched on before, which was we don't make products; we make paper. When you're part of discovering something that could be a game changer in terms of human experience, you want to see it built, you want to make something, you want to see it work just like the Babbage machine; you wanted to see it work. So I was getting more and more frustrated. By the time we got into mid '71—remember the first paper was released in February of '70 and here it is a little more than a year later—I was the only guy in Bell Labs working on CCDs, period. Everyone else had moved on to other things. Mike Tompsett had moved on, Carlo Sequin had moved on, George had moved on to other things he was interested in. I was the only guy working on CCDs, and I was a pretty minor player. I was a member of the technical staff, which means you're a lowest-ranking guy in the organization. I didn't really have a whole lot of clout, but in my little lab I was the king there and I could do what I wanted. But then the prospect of being brought to Fairchild R&D, being given my own department and a whole bunch of people that worked for me to make this thing real, was just too overwhelming. I didn't want to leave, and to this day I will tell you the years I spent at Bell Labs, which amounted to almost exactly three years, which seems a very short period of time, it still has to be the defining experience of my life in many, many ways. I still see that as a critical pivot point in who I ultimately became, because I came of age not only as a scientist but also as someone who was thoughtful about the ultimate uses of science. And so I went to work for Jim Early. On September 9, 1971, I showed up and started my work there, and—

Katz: What was that work supposed to be at the time you started?

Amelio: I was strictly CCD. For about from September to November he gave me various assignments but all related to CCDs and he would ask me to report back to him. Now what I didn't realize at the time is he was testing me. He was seeing what I could do with the questions he was coming up with, and he came to the conclusion after the couple months that I really was a bright youngster. So he asked—he said, "We want to create this department around you called—like Atalla had promised you. We really want to do that. What do you need to make it happen?" And so there I was: offered the job and saying, "Okay. I want the model lab to report to me because I want to make something." I wanted these certain people, the people I had suddenly gotten to know, guys like Phil Salisbury and Choong-Ki Kim, both of whom were famous names in the industry, and others, Kamal Gunsagar and David Winn, a bunch of others. I got all of these people working for me. In fact, chief scientist at Intel, Carlo—?

Katz: I'm blank on that.

Amelio: Okay. I'll remember his last name.

Scalise: Gargini?

Amelio: Gargini, Paolo Gargini. He was another guy I hired to work for me in that department. My- primarily focus was on CCDs, but the way Jim justified this to management was: this wasn't just the CCD thing. We were going to be a SWAT team that would solve any deep technical problems any of the divisions ran into. That's how we justified getting me funding for this thing. So that's what he did.

Katz: Underlying it all was a desire to make product I presume.

Amelio: Exactly, that's exactly it, but to earn our keep when some problem came up in the analog division, we would help them understand what the problem was. We'd have to divert ourselves from CCDs for a few weeks or a month and then go back to it. But that was the price we paid for that. So what—

Katz: Were those CCDs again for imaging?

Amelio: They were for imaging. What we did was we had- by this time the NRL, Naval Research Labs, had found out what we were doing and they were very interested in making an image sensor, to deploy aboard ship for vision at night. Their idea was that there could be a cloud-covered sky, you're in the

middle of the ocean, it's like an inkwell, is it possible to see. So they let out a contract, which was bid on by ourselves, TI and RCA. And we won the award to do that project—

Katz: That was for a system or—

Amelio: For an image sensor, for a hundred by hundred image sensor. And there was one other requirement: it had to detect one single photon. That was the requirement of the project, a hundred by hundred image sensor that could detect one photon.

Katz: One twinkling star.

Amelio: One photon. You got it. And then we didn't have much time to do it. We had six or seven months to do it. I literally worked around the clock, Saturdays, Sundays, you name it, running people, hand carrying stuff through the Fab, and everything you can imagine. Meanwhile Jim Early had come up with a couple of really good ideas that he ultimately patented. One was the concept of the buried channel device. This helped get rid of a lot of the transfer efficiency problems. This was using ion implantation, bury the channel instead of having it run along the surface, and that solved a big problem. You lost a little something with it, that is you lost some of the signal amplitude, but you got a positive signal-to-noise ratio. The second thing he came up with was a floating gate amplifier, an amplifier that was only shot noise limited. He patented those two things and this was the stuff I needed, so I put those into the device we made. And when we showed it to the Navy at the end of the project, it used Jim Early's two inventions plus a lot of the stuff I had come up with. And mostly my ideas for practically how to manufacture this thing.

Katz: Was that the same floating gate amplifier that ultimately led to some of the nonvolatile memories?

Amelio: I think so. Yeah, it's a small industry. I mean you may not know this, but in the early days of Silicon Valley, and when I said "early" I'm talking about my early days, the early '70s, Jim Early chaired a— let me call it a club. We'd meet at Rickey's Hyatt House in a private room for lunch once a month, and every senior R&D guy from each company would show up there. And the rule was you didn’t talk business. We could talk technology, not business, so there were no secrets. Your colleagues were no doubt in that room at that—

Katz: Intellectual property lawyers would have a fit—

Amelio: Oh, they would have a fit. But I think it was one of the great things that happened in Silicon Valley, to be honest with you, because the spread of knowledge was so rampant that it just catapulted

this industry in warp speed into its future. I really think we never stepped over the bounds, but we did communicate fairly actively in it, so in any event that was a key point in those days.

But getting back to the NRL project we demonstrated to the customer on the very last day of the project the ability to detect one photon and—

Katz: Was that the product that ultimately was introduced as a commercial product as well?

Amelio: It was not but, a variation on it was. It was very close. It was a three-phase device. It had registers that you first moved the charge this way, then you moved the charge this way, then go to the floating gate amplifier. It had the buried channel features and all of that. If you look in the very earliest papers coming out of Fairchild on image sensors you'll see the very earliest one. In fact, it's in the article I wrote which I left on the disk I left with you. In 1974, I wrote a paper for Scientific American which is still quoted to this day. But anyhow it was a very detailed story about CCDs. Obviously as of that date that device, that sensor that won that award, is in that paper so you can look it up and see it in there, see what it was. And the Navy was deliriously happy. We got additional awards. And then the other services, being competitive, decided well, the Air Force had to give us a program. And then the Army had to give us a program, to make image sensors to put on the end of howitzer shells so you could shoot these things over the horizon and as they were coming down you could take pictures of the presumed enemy on there. It was all these crazy things. We did all of that stuff 'cause it got us money, so why not, and we kept the project alive.

Katz: Were the main customers then government and military?

Amelio: Yeah, it was only them. When we finally got a little bit better at our trade, and this wasn't that many years later, '74ish would probably be a good time, one of the things that we decided would be the first commercial application was fax machines. We got inspired to do that by Xerox. I'm not sure why Xerox wanted to push that but they did. The Xerox guy's name was—his last name was White. I can't remember his first name now, but he was the head scientist at that time. We got together and we said, "Okay. We're going to make a sensor for a facsimile machine. There were no standards for digital image sensors. Right? So—

Katz: Xerox by that time was already making copiers with linear sensors in them, weren't they?

Amelio: But they weren't CCDs. He and I sat there and we decided that the correct sensor count or pixel count would be 1728. Okay? Don't ask me why. I can probably speculate on why. But that standard still exists for facsimiles. If you look it up, you'll find that 1728 pixels is the standard. That was done between he and I, sitting there so the first device we came out with was a line sensor to be used in facsimile. And facsimile turned out to be important in my life later on in my career. All of the stuff sort of weaves its way

through there, but we were doing great. We were just humming, we were starting to announce products. And when they came out they were very temporary. Then I started getting invited to come give papers at [various] places. There were two very important trips that I took. One was to Scotland to give a paper at an international conference, and the second was a trip to Japan to make a presentation at Sony and other Japanese customers, but primarily Sony. Based on the presentation I made at Sony, Sony decided to make a massive commitment to CCDs following that, which I didn't know until years later that they had done that. But they made that decision.

Katz: And they were early pioneering digital cameras.

Amelio: That's right. It was the result of that work. Later on they gave me an award for that, which we can talk about when we get to that point. But it stimulated them. I mentioned the Scotland conference for a totally different reason. The people in our government interested in the image sensors went beyond the Army, Navy, and the Air Force. It included an organization called the Central Intelligence Agency. In the early days they came up with projects that were very, very black projects, very secret projects. They wanted us to make special devices that they could place at very appropriate places for their work. I wound up going to Washington fairly often in those days. My expense report always said I was going to visit the Naval Research Labs, but many times that wasn't where I was.

Katz: Did you have a top secret clearance at that time?

Amelio: I got one during that period of time. Actually, when we started working for Naval I got a lower-level clearance, then they included me to a higher level at that point. We worked on some exceedingly interesting projects. I think I can tell you about one of them now, since the party involved no longer exists, but I think it would be amusing for the people looking at this in some future time. The CIA wanted to get an image sensor in the ceiling above the desk of the ambassador of the Soviet Union, ambassador to the United States. They wanted to be able to read the documents that crossed his desk. And so we came up with a sensor that was tiny, ran on batteries, had a very weak signal but [strong enough that] you could pick it up. They planted some guy as part of some construction work that was going to put the device in its place, and we actually in those days started getting really important intelligence from the Soviets. It was many years before they figured out what happened. There are a number of other projects like that, that I should probably defer on talking about even though they were many, many years ago. But I would say there were three or four that had global implications, political implications based on the outcome of what was found. One of the ones that I can talk about is the first spy satellite because I think that is pretty well known at this point. The Air Force was launching the first spy satellite and we put up a CCD in that satellite along with the other stuff they had. They got their first CCD images from space from that satellite. There's a funny story about this if you're interested and then we'll move on. I had a cousin. He's dead now, but I had a cousin who had basically the same name as me, Gil Amelio. He was Gilbert Neil Amelio, and I am Gilbert Frank Amelio. He's a generation older than me. He was born to my father's oldest brother, and my father was next to the last in the line of children. So there was about a generation gap

there. He worked for the Air Force; he spent his whole career in the Air Force. So I went to the satellite facility they have in El Segundo—you may know where it is—and I went in to check in and they asked me for my ID and to sign in. I showed them my ID and I said, "My name is Gil Amelio." Well, I immediately had three guards jump on top of me, pull me back, and one says, "You're not Gil Amelio. I know Gil Amelio. You're not him." So I then had to talk my way out of this problem, that I really was Gil Amelio but not the one they were thinking about. It was all a big laugh later on but it was pretty funny <*laughs*> over there; I didn't know what was going to happen. When they finally figured I was okay we then went in and we saw the first images of the satellite coming back.

Katz: Was that an array or a linear—

Amelio: That was a linear device.

Katz: Yeah. Most of the space ones were ‘cause the satellite moved for you.

Amelio: Yeah. It takes advantage of that, but actually the images were pretty good. I don't think I have any more in my archives, but they were pretty good-quality images. Those were the sort of things I was working on in those days at Fairchild—

Katz: What was your total tenure at Fairchild?

Amelio: Twelve years.

Katz: Twelve years.

Amelio: We are a few years into it now, so maybe touch on a couple of other things and then we take a short break. I want to kind of finish this CCD segment of it. We then created two sections- parts of the CCD project at Fairchild, the one that continued to work on [image].sensors. Then we wanted to go back and do the memory thing we had dropped way back years before when I was still at Bell Labs. We wanted to come out with shift registers that were made with CCD and we made a number of successful devices, and it turns out though that ultimately they were not commercially successful devices for one very, I think, fun reason or interesting reason. That was that some of the techniques we used in CCDs turned out to have major significance in how you make dynamic RAMs. And in fact the basic cell structure they [the DRAM folks] copied almost verbatim, but they made the array different. It was a connectional array as opposed to a register. That basically wiped out the CCDs 'cause DRAM had all the advantages. It had the high density; it made the cell much smaller so it'd mean you get more bits in there.

Katz: How many transistors were in a CCD cell if any?

Amelio: There were no transistors.

Scalise: It was all a capacitor.

Amelio: It was a capacitor. Let me tell you something fascinating about CCDs. I'm glad you reminded me of this 'cause this is a really important point for posterity. The CCD would never have been invented by an electrical engineer. The reason was you cannot draw an equivalent circuit diagram for it. Okay? It's a device that operates continuously in a transitional state; that is, it's in a state that isn't—I'm losing the word right now but just think of a device that is neither a zero nor a one but in some middle state, some intermediate state. The CCD operates in that state, continuously [discharging]. The very cool thing about it was that in order to conceive of this thing you have to think like a physicist and not like a double E. George Smith and I were the physicists in the group and I think that was an interesting part of the history here because—

Katz: How is it that the DRAM cell got smaller than the CCD cell as you stated earlier?

Amelio: Well, it didn't get smaller, it got as small as. But DRAM had random access and the CCD was a register, so it lost out. So we indirectly made a major contribution to the DRAM business. Intel was, I think, the first guys to actually do that so it was really interesting. At this point I was told in 1977 that I was to be awarded an IEEE [Institute of Electrical and Electronics Engineers] fellow. At the grand old age of 34, I was an IEEE fellow. There are some documents in the material I gave you on that. It was a great honor for me. Shortly after that Wilf Corrigan decided that he shouldn't have a guy like me wasting his time in the labs, I should be doing something on the business side of things. That's when I made the transition to become the general manager of the MOS division. It was a monster job and a difficult transition for me personally. I was great in research but could I make the numbers. That was what I had to discover. In 1978 I got that assignment and my career after 1978 was essentially management, I continued to have an interest in science. I continued to file a couple of patents after that, but basically my patent days were over at that point.

Katz: This is probably a good time for a transition away from your engineering work and into your executive work. Before we do the transition over to your management career, I'd like you if possible to spend a few minutes listing some of the applications for the early CCDs that you were able to get customers convinced to use, and also a few more minutes about the structure of Fairchild and what led to your transition from a company that brought you in as an R&D person into one that made you into a manager.

Amelio: I think it would be fair to say that based on the success we had with the Naval Research Labs in developing that hundred by hundred image sensor, it pretty soon became obvious to everyone that image sensing was a unique application that CCD could clearly do better than anything else around. What we needed to do was to perfect the material science so we could actually manufacture these things at a reasonable cost. And of course back in the old days 30% yield was considered good, right, and—

Katz: That was until the Japanese proved otherwise.

Amelio: I remember that was in the late '70s, and they showed that you can actually do better. We finally got serious about our material science and we cleaned up kind of our factories, cleaned up the way we handled things. We stopped using tweezers and that other stuff. That made a big difference there. On the CCD thing it was clear that image sensing was the way to go. Where we had opportunities to productize either for secret work or for commercial work it was almost always related to image sensing of some kind. And as I mentioned earlier the very first [commercial] application we did was a line sensor to be used in a facsimile machine. That was the first thing we made that was intended to be a practical device and it was in fact used for that purpose. However, it didn't escape the attention of the people in the Air Force, among others, that if you've got some object moving through the sky you could take one of those linear sensors and get a scan below and you could do mapping, map terrain. So a lot of people don't know this but Sherman Fairchild, who was a very good friend of Howard Hughes by the way, was in the mapping business. To make maps you had to have good cameras. Okay. So he started Fairchild Camera and Instrument. Later on he also started an aircraft company. The reason he started an aircraft company was so as to be able to carry properly his cameras so they could take the mapping pictures. Here we are later on, and in the time I was in R&D at Fairchild, there was a division of Fairchild that was part of the original company, which was in Long Island, New York. I can't remember, George, where it was, Iso something.

Scalise: It was Islip.

Amelio: Yeah. Anyhow it was in Long Island, and that's where Sherman Fairchild had his office when he was alive. Those guys would come to me, and all they did was military work, they did 100% military, mapping, some commercial but very limited; it was almost all military. They would come to me with these applications that would use these sensors to do various things. Ultimately it—we became part a part of, I guess it's the law of unintended consequences. <*laughs*> We didn't realize we were getting into the political domain here but it wasn't our decision it was somebody else's. We wound up making some of these devices available to other countries who were our friends, and for purposes that were intended to tilt the level of knowledge in our factor by their application. India and in Israel were two of the more prominent ones of that.

Katz: Again for satellite linear—

Amelio: Not necessarily the satellite. There were also aircraft versions that were done. I want to give you an example of one device we made which I think would be an application. As I said, the CCD [cell] operation is constantly in a dynamic state. What's intriguing about that is that, because of that, it is a sensor which is shot noise limited. That was the reason we were able to detect one photon because actually there is no noise in the device at all, no extraneous noise coming from anywhere. That made it good is for very, very low light level applications. And in fact the Navy wound up using that rigorously for that. Because of that factor you could also do one other thing, and that other thing was to eliminate haze. So imagine it's a hazy day. My home in Corona del Mar has a big picture window and we look out over Catalina Island. But a lot of days it's hazy and I can't see the island. If you're a country and you want to see what your neighbor's doing and it's hazy there, it's hard for you to see through the haze. So we made a device that subtracted out the haze. And because the signal-to-noise ratio was so high we could throw away 90% of the signal and still have a great picture. That's what we did. Israel used that to determine what their neighbors were doing. We all remember that preemptive strike on Syria that was based on the knowledge taken by one of these devices. That was kind of an example of one of the things that was used. I didn't know about this until later. I made the device for the guys in Syosset, New York—that's the city I was trying to think of before. I made it for them but I didn't always know where the device was going. They would spec it. They would come out and they would say, "We want it to do this. This is the spec we want." Later on I would find out what they were doing with them. That was typical. It was used for mapping purposes as well, the old- sort of the traditional historic thing about Fairchild. I think the punch line I would say here is that I think if Sherman Fairchild had been alive during the time we were doing this work, he would have loved it. I mean I think it was right up his alley. I never had a chance to meet him.

I want to now talk a little bit about some of the managers that had an impact in my life at Fairchild 'cause—

Katz: Please do.

Amelio: I was at Fairchild for 12 years, the longest I stayed at any one place. I went from being a kid to being an adult and a serious manager in that period of time. I would say there's a lot of people who were influential on me. Let me just name the characters, and then talk a little bit about each one. Obviously, I start with Jim Early. He clearly was my first boss. We had a magnificent relationship. I loved him like a father. I mean I could not have loved him more than I did, and I miss him terribly now that he's gone. He was a famous guy for Bell Labs. He's famous for the Early Effect and other things he did. But also at the human level he was the father of—how many children did he have? Eight? Seven or eight. He had a lot of kids. He was a very devout Catholic, Irish Catholic. We just had this relationship that was second to none, that benefited me, and I think, benefited him in some ways. I really give him a lot of credit for mentoring me in those early days. I was a little bit cocky and arrogant like a lot of bright young people tend to be at that point in their life, and he was so fatherly and trying to gently teach me how to tone it down without killing—

Katz: Keep you out of trouble, huh?

Amelio: Keep me out of trouble. I will give him a lot of credit for that, because I'd sometimes put my foot in my mouth when I shouldn't have.

The next person I saw less often, but, I think, was a mentor to me was Les Hogan. Again, Les Hogan was basically first and foremost a scientist. He had gone to Motorola but he had also started at Bell Laboratories. So there was a kindred spirit. Whenever he saw me in the hall or something he'd always take—stop and take time and say, "Gee, Gil, what are you working on? What's happening? Are you having fun?" and when he'd hold a party at his house where he invited his managers, which he did maybe once a year, I would somehow be on the invitation list and get there. I remember that that's when I first met Bob Noyce, at one of Les Hogan's parties. Bob and I became very good friends following that, so I think he was very, very important. He coached me in a lot of ways that I think were difficult for him 'cause there was such a gap. I mean I'm down here and he's up here but nevertheless he saw something in me that [told him] he felt like a little coaching might be useful. I gave him a lot of credit for that.

The third guy I would put in that category is Tom Longo. If you only looked at our bios, you would say I was a Tom Longo lookalike. We both had PhDs in physics, we both started out in the sciences and were migrating into business and so forth. And by the time I went to work for Tom Longo he was running half of Fairchild, maybe even more than half at the time. He decided that he wanted me to come in and sit in on his staff meetings as a learning experience for me. Once a week he would have all his division heads, general managers, show up, they would make their presentations on the health of the business and how things were going and so forth, Tom would make his comments or an insight. And my instructions were very clear, sit still, don't say anything, and look like you're paint on the wall. And that's what I did, and I did that for probably a year and a half. I learned an awful lot especially about running a business. There were a lot of discussions based around financial performance. Obviously, there were products and there were customer relationship issues and so forth. But fundamentally it was all in a business dynamic, even though Tom himself had a very deep scientific background. And suddenly a lot of the pieces started to come together about oh, so that's how a business really gets run. It was exceedingly important.

And then I guess I have to mention Wilf Corrigan. Wilf and I had, still do have a unique relationship which I think—

Katz: Had Wilf arrived at the time you were still there?

Amelio: Wilf was there before I was there. Sixty-eight, around then. I came in '71, so Wilf and I are exactly five years apart. We were both born in March, but he five years before me. So he was very senior to me management-wise. We still were within throwing distance of each other's age in a sense. He was the ultimate pragmatist in the group—if you can't make money with it forget about it. I was sort of the

daydreaming scientist on this end. He tried to tug me a little more in his direction, and so we had a couple of interesting examples. I'll just mention two of them that were kind of funny. One was in the mid '70s, maybe '77, maybe—yeah, it was around '77, '78 so it was the late '70s. He decided he was going to take the smartest people he had in the company and they were going to do research on everything we were doing and make recommendations whether we should continue things, kill things, what we should do. My assignment was to make a recommendation on semiconductor memory—whether we had lost $50 million in semiconductor memory, and should we continue to do it and hope for the best, or should we not. I did a lot of research on that. When the point of time came, I went in to the boardroom with- Tom Longo who was there as being my boss at that time, and I made my report. My report was we should get the hell out of the memory business, we don't do it very well, we don't have the financial strength to win on that basis, let's go do other things we do well. In particular I talked about analog devices and analog functions and so forth, which we clearly were very good at but could be better at if there were more money invested in it. There's a silence in the room and then-Tom said, "We are going to stay in the memory business and everyone who works in this company is going to support the memory business or they're not going to be here anymore. Do you understand, Mr. Amelio?" I didn't say anything at first. Tom Longo [later] described the expression on my face and said, "I saw smoke coming out of your ears" and said, "You wanted to say something but you were really fighting it hard" <*laughs*> After a long pause I said, "Yes, Sir," and that was that. And then later on, roughly in the same period of time, maybe a year before or after but- we had one other encounter with Wilf that I think is very interesting. He invited me in to his office. When I had first gotten the job to run MOS I was still running CCD so I sort of had two jobs. He wanted me to drop the CCD thing. Obviously, that was my baby and it was really hard to let go, but he figured he was going to impress upon me the importance of letting that go and moving on. He came in to me and said, "I'm going to ask you a question, Gil" and I said, "What's that?" He says, "Why is a grown man working on CCDs?" <*laughs*> And I said, "Because they're of earth-shattering importance." And he said, "Well, we're not making any money on it, the revenue levels are miniscule still even though we have some interesting applications, they don't look like there is a meteoric rise, the guys—

Katz: The military didn't buy them by the millions—

Amelio: No. They bought them onesie-twosies, right. He said, "So yeah, you've helped sponsor some R&D but that's not what we're in the business for. We're in the business of growing products and building product. I want you to spend more time worrying about helping grow this company and not just piddling away on your CCD stuff" so—

Katz: Had Sony not been one of the big-volume customers?

Amelio: Actually, they were a customer but I don't think they were ever a really big. We were much closer to Toshiba and we had a relationship with Toshiba that I was a part of. But no, Sony was a little more esoteric; they were a little more we-can-do-it-ourselves sort of company at that time. And so it was another one of those occasions where I had smoke coming out of my ears. But I decided not to say

anything. But I have to tell the rest of the story and the rest of the story is years later when I'm working at Rockwell I went to an SIA meeting that was in Monterey—at the Hotel Monterey where we sometimes had our fall meetings, usually in November, Thanksgiving week usually in fact. All of us CEOs would show up for this thing. I was at that time on the board of SIA, and Wilf comes over to me and says, "Let's go for a walk," okay. We go out in the garden and he says to me—he says, "Do you remember when I told you that grown men shouldn't play with CCDs?" And I said, "Yes, Sir, I remember." He said, "Well, I was wrong and you were right." Coming from someone like Wilf that was a big effort for him to make that admission and the fact that he actually did it elevated him enormously in my eyes. He was a guy who I thought just hated people. It turned out he was just trying to save his company and I wasn't really smart enough to understand what he really was saying. It all became clear at that time because I think he finally realized that what I had given birth to was fabulously important and it was changing the world as we—Who doesn't have a digital camera? Go figure. The Hubble space telescope, you name it, every telescope in every astronomical observatory in the world has cool CCDs in it, I mean without exception. He was starting to begin to see the impact and he felt he needed to say something. I don't how to describe it but I suddenly felt much closer to him than I had prior to that time. Frequently he was a great adviser. When I finally left Fairchild to go to Rockwell, Wilf had already left and started his new company, LSI. He called me up when he heard I was leaving. He said, "Look. Those guys called me"—"guys" meaning Rockwell—"called me and asked me for comments about you. I'm going to tell you what I told them so you know." He told me and mostly it was positive stuff. He says, "Let me just give you one tip or advice." He said, "These guys are very concerned about the lack of financial performance in that division so while yes, you got to innovate and yes, you got to do all— please really pay attention to the economics and that would be my advice to you." It was great advice again coming at exactly a very important pivot point in my life.

Katz: That's a perfect time to transition into, or make the pivot, and let's let George take over and talk about your executive careers.

Amelio: Okay.

Scalise: Clearly you got your baptism of fire in management at Fairchild so now you moved on to Rockwell. You had some important discoveries there. You did some important things that really helped develop the PC industry. Why don't you talk a little bit about that?

Amelio: I would have to say that one of the most rewarding experiences of my life was the turnaround at Rockwell. It was indescribably phenomenal from my personal point of view. I moved in to take over a division that had lost money for eight straight years. They were ready to write off the division and shut it down. Don Beale who was the president and COO, not the CEO at that time, personally interviewed me. He decided to hire me and have me make a shot at this thing. Here's the instructions he gave me when I accepted the job. He says, "Gil, here's what I want you to do. I want you to go spend three or four months studying this business in depth and then I want you to come back and give me a report. And if you don't

think it can be saved I want you to tell me that and we'll write it off. But I will guarantee you a job that will not harm your career and I will take care of you." He said, "Don't be worried about that. I just want you to come up with the right answer." Then he gave me some other advice saying, "Whatever the strategy is, it has to be a differentiating strategy. You have to differentiate yourself from your competitors." So those words sort of rang in my mind. Obviously we've all learned this in school and everything, but learning it and doing it are two different things. So I went back. I spent my three or four months studying and I went back to Don and I said, “Okay, I’ve got good news and bad news. The good news is I think we can save this business.” I said, “It’s iffy, but I think we can.” I said, “The bad news is I’m gonna need at least three years to do it.” I said, “There’s just so much that needs fixing that doesn’t happen overnight.” And I said, “If you don’t have the stomach for that then you probably ought to shut it down.” He thought for a while and he said—remember, Don had gone to school in Silicon Valley. He’s a San Jose State graduate. He knew what Silicon Valley was about and he didn’t want to give up on it. So he said, “I’ll cover your back for the next three years, but don’t screw up.” You know, basically do it. So I had his unwavering support and I went back [to work]. What the company had been doing was doing what I think can be successful in some instances but weren’t in this case. What they were doing is they were trying to make the same products everybody else was making but using a different process, a non-industry standard process. So that was their definition of differentiation. Well, I said, “Life’s too short.” I said, “All of Rockwell’s billions of dollars in assets are not enough for you to pull off that strategy. That is totally impossible, so forget about it. We’re gonna go back and we’re gonna go mainstream MOS technology, right down the middle of the road. I want to be dead center in the middle of the road. I want it to be exactly what everyone else is doing. We’re gonna differentiate in the products we offer. We’re gonna stop just copying other products and we’re gonna start doing things of our own.” And so, it was easy to say but then the question was okay, what are you gonna do. So I’m looking for ideas and I’m walking through the engineering room talking to the engineers and I finally ran across this little group that was in a corner. I said, “Hey, what are you guys doing?” They said, “Well, we’re working on a modem. We think we’ve got an idea for a cool modem.” And I said, “Why are you doing that?” Well, there was a modem company that was in Massachusetts, and they were trying to give them a better product. I looked at what they were doing and the light bulb went on, because what they were doing was fundamentally making what is normally an analog device, made totally with analog. They were making it digital. They were making it programmable but still having the analog part of it. It was a microprocessor or digital processor, but it acted on analog functions. And then I suddenly realized, okay, if I want a 9600 baud modem, I program it this way. If I want a 4800 baud modem, I change a couple of pieces of code in the firmware, what was embedded in the chip. I said, “This is too good to be true.” I said, “We can make everything.” So I told these guys that I was going to throw the weight of the division behind their project. What stimulated me at that is, remember—well, I’ve got to tell you this part of the story. The fact is, I apologize, but I have to go back to one thing that I didn’t mention in my early days when I was in Fairchild. It was before I started running MOS but when I was pretty high in the totem pole, around 1977. It looks like I was going to get that business and I had a lot of impact. A young guy came to see me and he wanted to buy defective memories from us. The guy’s name is Steve Jobs. And he wanted to buy defective memories because he figured he could afford them and he could figure a way to program around the defects. Well, I saw a nightmare coming with lawsuits and arguments, and I just flat told him no. And he didn’t do it. That is a little piece of that story that I didn’t cover. Where was I?

Scalise: On the modem.

Amelio: Modem, okay. So when I was at the modem thing, what I realized—by the way, as a result of that meeting with Steve Jobs, I became an Apple fanatic. I went out and I bought the Apple's and I programmed them at home and I did all the geek stuff that everyone else did, or at least people like me did. When I went to Rockwell, what I realized was that this could be a very important product for the computer industry because once you have a personal computer, the very next thing you want to do is communicate. And the only means of communication at the time was the modem, but modems were very expensive, slow, [and] inefficient. You name it, they had the problem. And what I saw with this programmable digital processor was the possibility for a very low cost way of making modems. And that's what I presented to management. I said, "This is what we're gonna go for." We decided the first one to make would be a facsimile modem. The reason was simple. We had a customer named Sharp that we sold products to. They were in the facsimile business. They were willing to be guinea pigs if we came up with a new product, so we just went for it. That first product came out about 1983. I'm sorry, 1984. I arrived in 1983. It came out about a year later. And between 1984 and the end of 1986, we went from basically selling a trivial amount of product, modems, into the business, to basically having 85 percent of the world market share, no matter what country. It was the most overwhelming success I could imagine outside of some of the stuff that Intel has done. I mean, it just really was phenomenal success. There was a number of elements of that, so I'll begin at the business stuff here. The reason it was successful was because it was programmable, and if you make it programmable, you can make it cheaper. That was the history of the microprocessor. We were now learning it in a new device that was more analog intensive as opposed to digital intensive. But nonetheless, the same formula was still relevant. We just went after this thing and we announced a whole family of modem products of all different speeds, of all different modulation standards and you name it. This was all the same chip. It was a semiconductor manufacturer's dream. Every wafer we're making is exactly like the other wafer except for a little programming that was put into the middle layer. This was like a dream come true. The manufacturing guy could optimize yield—amazing improvement on our yields. Cost went way down. When I saw this happening, one of the things I did was something that was crazy at the time but don't ask me why but I did it. I went out trying to get customers to lock into the facsimile thing. I wanted them to make a full commitment to us. I didn't want them buying anything from our competitors. So I told them, I said, "If you become our customer, I will guarantee next year's pricing and I will guarantee to you that next year's pricing will be 27 percent less than this year's pricing; however, how much you're able to buy from us will depend on how much you buy this year." That was the formula. I went into all of our customers and I made that presentation. And needless to say, the purchasing managers loved it. They could put it down, so they immediately gave us orders. Then we had the challenge of delivering and we really delivered hard. There was one point in the middle of all of that that I just woke up one day—remember, we had this light recession, '85, '86. Remember that?

Scalise: Good old '85, '86.

Amelio: You remember, right? Okay, so we were feeling it. Gee, maybe we ought to cut back. Maybe we ought to reduce our inventories or something. So we were sitting in our staff meeting and I said, "No, we're gonna do the opposite. I want you guys to build every fax modem that you can. I want you to run the factory full out." My CFO was fainting over in the corner and everyone was worried, but we did exactly that. A few months into the New Year, the market just lit like a Fourth of July rocket, and we had the inventory, so all those guys came back saying, "Okay, we agree to your terms, but do you have the product?" We had the product; everyone got it. And I locked them into contracts that basically kept everyone else out. I did that from roughly 1986 through 1988 and actually into '89, so let's say four years. I cut the price 27 percent every year for four straight years. We just wound up owning the market. Hitachi went out of [that] business. Emulex changed and went into some other stuff. We totally owned the world market. The pitch we would say is if you want your modem to talk to the other modem—it's nice that they're the same modem. It's nice if they're the Rockwell modem. We got one help by sheer coincidence in all of this. That is we were selling modems into Scandinavia. Scandinavia kinda gets cold in the winter and they have lots of ice and things like that. The brand X modems they were using were not working well in the winter. They would work okay in the summer but they wouldn't work well in the winter and they didn't know what the problem was. So we looked into it and what we found out is that the ice on the telephone lines—of course, their lines were still above ground—the ice on it changed the impedance. That changed the propagation of the signal and led to bit errors that were too large to correct and therefore the circuit would fail. Well, we had actually anticipated problems like this in our design, so what we did is we told the guys in Sweden, "We don't have that problem." We gave them some product and they tried it and sure enough it worked just the way [it should]. Now this becomes a news story and suddenly everyone who was buying fax modems at that time then basically decided it's got to be a Rockwell modem. It can't be anything else but a Rockwell modem. We went from being a business that had lost money for eight straight years to being the most profitable business in 25 divisions in Rockwell in a three year period of time. During the midst of this, when it's becoming clear that we were doing something very important and of epic proportions, Harvard asked if they could have one of their people come out and spend time with us. That was Bob Miles. Bob came out and spent time with us, and my boss endorsed it. He said, "Yeah, can't hurt. You'll have smart, Harvard guys coaching you, and they're not gonna charge us anything. Go ahead and do it." Bob was fascinated by what I had done and he wrote a case study on the turnaround of Rockwell's semiconductor. That was published in 1988, and to the best of my knowledge, they are still teaching that case study at Harvard. The only reason I know this is that every now and then I would run into a young man, a recent graduate, and the first thing he'll say to me is, "Oh, I studied you in school." I figured if I keep hearing that, they must still be teaching it. Bob has obviously moved on to other places. He left Harvard and became the dean at Emory and now is sort of out on his own. He did a good job in the case study and I think he captured the essence of what we did to make that business a success. We were printing money. I mean, it was almost embarrassing how much money we were making at the tail end of that period. What Rockwell decided to do was to give me another challenge to do. They asked me to fix the telecommunications division, which was in Dallas. So in 1988, I moved to Dallas, and my job was to turn around that division. That division made hardware equipment for the Telcos; transceivers, microwave towers, all that stuff. We didn't make central office switches, but we made call director switches in a branch of the division that was in Chicago. All of this was new stuff to me. One of the big problems we had when I got there was quality issues. So I put a lot of emphasis on quality and just basically putting in [place] all of the things you're supposed to do to fix

quality. That started to get the problems to go away. I'm like six months into this maybe and one of the senior guys from MCI—we all remember them, right—came to us and said, "Look, we want to buy a whole bunch of your gigabit transceivers for our new fiber optic network," which was new at that time. They were just applying it for the first time, and they decided that we were going to get the contract for all of it. They said, "There's only one catch. We don't have enough money. Can we work a deal with you guys where you help fund part of this?" I talked to my boss, again, Don Beall, and Don said, "Okay, give them a 75 million dollar limit." So I gave them a credit card for 75 million dollars, which they used to buy product from us. Ultimately, they got revenues from their ultimate customers and paid us all back so we didn't lose anything on them. But it was the thing I needed to get the momentum going in that division. Then profits started to come and it started to get a lot better. We killed a lot of things that I thought were peripheral to what we had to do. Then in the division in Chicago, I felt I needed a new general manager up there because the guy just wasn't cutting it. I hired a new fellow, and the new fellow I hired was Rich Beyer. Rich had been working for another telecommunications company prior to that, so he knew telecom, but I saw something in Rich, that this guy is special. He's really an exceptional guy, so I hired him. I put him in there. I backed him. We got the call centers business turned around. There's still a lot of Rockwell call centers out there to this day, although they ultimately sold that part of the business off. But we got that business fixed as well. Then in late 1990, when I'm there about a little less than three years, Alcatel came to us and said, "We want to buy your division. We want to buy Rockwell Telecommunications." So I went to Beall and I told him the truth. I said, "Look, we made a go of it now. The business is solvent. We'll be around for a while and it's okay, but we will never be able to compete with the mega companies in this space who make equipment for this. We are not big enough." We were a one billion dollar division fighting against 20 billion dollar giants. If you can get a good price for it, my recommendation is [that] you sell it. He did and we got a good price. We made a gain of 500 million dollars on the sale, which I thought was pretty good. It would take me a long time to make 500 million dollars in profits, so it was a pretty good decision. That was taken over by Alcatel and they run that campus now. The division in Chicago was then later sold off. That went with my ultimate successor in Newport Beach, but then he ultimately sold it off.

Saclise: You had a string of successes then at Rockwell and it set the stage then for your next step, which was replacing a legend at National. Charlie Sporck had been there from the very earliest days when they took it over from the guys that really started the company back in Danbury, Connecticut, Bernie Rothlein and that bunch. But now you had to replace Charlie, so tell us about that transition.

Amelio: Well, someone called me up and told me that they were looking for a new CEO and felt that I would be a qualified guy for them to consider. And so I went out and I interviewed with the board, pretty much one on one. I think of the interviews, the most important one was with Richard Danzig. First of all, he has this legal mind and he's brilliant at that--

Scalise: Richard being a board member?

Amelio: He was a board member. Richard Danzig was on the board and he gave me without question the hardest interview of any of the interviews I got. But at the end of it, he decided I was the guy who was gonna save the company. He then spent the rest of his time convincing all the other board members that they should hire me and not the other candidates who were being considered. Ultimately that's what the board decided. Charlene and I remember those early days because I was living in Dallas and obviously National is in Silicon Valley. So some of the [board]—Peter Sprague in particular, found us. If he had a reason to go to Dallas, he'd come. He'd spend the night with us at our house and do whatever he came there to do plus talk [to] me. He'd get a free dinner and all that sort of thing, but the long story [short] of it was as much as I loved that place we lived in Dallas, that I in my heart, I was really a California guy. I mean, except for the Bell Labs days, all my successful were California based. I decided that I wanted to go back, and decided to take the change. And as you remember, George, the company had been negative for four years at that time, negative profits, and when I got there, Charlie made the following pronouncement. He said, "I'm not gonna step down until the end of May." I arrived on February 2. I said, "What do you want me to do in the time?" He said, "I don't care what you do, but I'm gonna call the shots until I leave." So I showed up at meetings and basically was a fly on the wall. I just listened to what he did. I made no decisions. I made no comments. In hindsight, that turned out to be a blessing, because it gave me four months, where I wasn't under the pressure of performance, to really study the business and really get my own opinions formed on what the problems were. What I felt—and this oversimplifies the problem a great deal—what I fundamentally felt was that our strategy was flawed. But that we had people that were capable of implementing a proper strategy. Whatever [the] strategy, they could implement it. But what we were doing wasn't the stuff that was going to get us successful. I mean, they were trying to compete with Intel and their microprocessor. They were doing all this other crazy stuff where you're going to spend hundreds of millions of dollars and get nowhere. That was number one. Number two thing I decided was that we had not been investing sufficiently in the company. As I walked through the fabs, the various fabs around there, I'm always drawn back to the one that was near Salt Lake City, Utah. I was walking across the floor and I tripped on the carpet and fell over. The reason I tripped was the carpet was torn and buckled a little bit. and I hadn't noticed it because I was walking, talking to people. I said, "Well, that's dangerous." "Not only could I have hurt myself but someone else could have. Why don't you guys fix it?" "Well, we don't have the budget to fix it. Charlie won't give us the budget to do that." Charlie even stopped mowing the grass to save money. But while those were symbolic things, and I can understand why Charlie did it, I didn't think that was the right way to run a business, candidly. I thought we needed to invest in the company. That would be not only good for our competitive positioning, but also would be good for the employee morale and everything else. George, you came on with me shortly thereafter. I think it was in August, wasn't it?

Scalise: That's right, yeah, August.

Amelio: You came and this was pretty [much] following onto this. Really what we needed to do was to clean out all the weeds and the underbrush, get the company focused. What we decided to do was a couple of important strategies. Number one was I decided that we should focus on mixed signal technology and forget the microprocessor. We cannot be competitive. Just shut it down, get rid of it. The second thing was that our factories were in pitiful shape and as a consequence of that our yields

were not very good and our product cost was too high. Our gross margin when I arrived was [only] 19 percent. You cannot run a semiconductor business with 19 percent gross margin. It's not possible. You have to have 40 plus percent to make it. You can make it go at 40 percent, more is better. I set out in my first round of talks with the market, with Wall Street and others. They said, "What are you gonna do?" And I said, "The problem is our gross profit's too low." I told the company, "We're gonna target 40 percent and we're gonna have to do all the things needed to do to get that gross profit from that 19 percent to that 40 percent, and we're gonna do whatever it takes." And that's what we did. The third problem we had was a customer problem. We had some quality issues, again, associated with these kind of shabby factories. The harshest one was Hewlett-Packard. Hewlett-Packard are really sweet guys but they were really upset with National at that time. And they called me over there as the new guy and they literally were about to hand me [my head]. They said, "Look, we know you're the new guy. We know you're just starting. We are so fed up with this. You have got to fix this quality problem." They just reamed me. Ultimately, I became really good friends with Lew Platt, but it was a really tough meeting. I went back sort of hat in hand and got back to the team and said, "Look, we gotta get serious about all this stuff." There was a big problem, though, and the problem was that we were a company that was scattered all around the world. We had 34 plants at that time. They ranged from Scotland to Cebu, Philippians and everywhere in between. We were in Thailand. We were in Malaysia. We were in Hong Kong. You name it, we were there.

Scalise: Israel.

Amelio: Israel. You name it. We were everywhere. The problem was that managing such a far-flung empire is very difficult. But if you have what I believed was a flawed strategy and if you don't have a management process in place that everyone understands is the management process, then the left hand never knows what the right hand is doing, and things get totally screwed up. What I felt we needed to do is we finally needed to state some fundamental principles about what our management philosophy is. That's what we did in those early days. And then we had to inculcate those into the managers around the world, so what we did was to take the top 2,000 managers in the company and we brought them to school. I brought Bob Miles back and I created a program called Leading Change. Everyone took this course. I hired some other professors who were also very, very good at particular subjects that I wanted to focus on. I opened and closed every one of those classes. It seemed like every Monday and Friday I knew exactly where I was going to be. That worked beyond my wildest dreams because these people were just hungry for guidance. We inculcated in them what I believed were the proper values of a good management process. And I encouraged them to reach out across the oceans to their colleagues, their peers, and don't worry about hurting anyone's feelings. If this plant manager, you've got an idea and you wanna ask questions to another plant manager, fine. You don't have to go through it like this. Just call each other and talk. Let's keep it going. Make sure you report on what you're doing, but don't wait around. Get going. And then we started just cutting out stuff we didn't need. As you recall, in the five years I was there, we went from 33,000 people down to 21,000 people. We took out 12,000 people a lot of that due to the fact that we were able to shut down some plants because our productivity was getting better and we didn't need those extra plants. And by the way, we doubled our top line at the same time, in those same five years. So the gross profits went up meteorically. They were well above 45,

approaching 50 percent at that time. And we were doing well. I remember being at some occasion where I was with Gordon Moore. I've got to give a background story. Let me give the background. Once I decided we're not going to do microprocessors, I said, "I'd really love to have Intel as a friend as opposed to an enemy," so I'm going to go over and talk to the Intel guys, which I did. And I'm going to say, "You guys need support circuits, the satellite circuits that go around your microprocessor. If there's something in there you think we can make, we'll make it, but we want you to spec it on your spec sheets, and you can test it and do anything you want, but we want your approval of it." Intel agreed to that and we agreed to it, and so every time Intel sold a microprocessor, we sold like eight or nine of the circuits. And what that led to was a great relationship between our company and Intel. I had been friends with Gordon and Bob [Noyce] for a long time and to some extent, a little less so with Andy, but I knew all three. And so during the course of that relationship, one day I was talking with Gordon Moore and he said to me, "How many chips a year do you guys make?" I said, "I don't know. I'll go look." So I did. I went and looked at them and figured in the prior year, we made nine billion chips. So I went back to him and he said, "That's a lot more chips than we make," and I said, "Yeah, but we make these little things that sell for pennies and you make these big things that sell for hundred dollar bills." I said, "So you want to move tonnage, we're good at moving tonnage." Long story short, they gave us that special real estate we wanted, which was to be called out on all the Intel spreadsheets as the parts to be used, and that had an amazing effect on us so that was a good deal. And then we made—you remember, George, because you were involved in this one—the deal with Scott McNealy at Sun. Scott and his team came in. We had the meeting, we cut a deal with them in terms of making products for them, so we were slowly but surely getting our customers back behind us and we were showing signs of clear progress and success. The losses were going down and then ultimately turning into profits, and it was fun. I want to relate a couple of anecdotes. One was I'm going to flash back to the time when I was on that first road show that I did after I became CEO. I'm in New York speaking at a luncheon, which by the way, at these luncheons I never ate because I was speaking and everyone else was eating. <*laughs*> But in any event, there was this fellow in the back. I was going on about my gross profit and what we're going to do—and all this thing. So this guy raises his hand, "Wait a minute, wait a minute. Are you telling me that, you know, in a few years, you're going to make 25 million dollars of profit in a quarter?" I said, "Yeah." He said, "Well that will be the day." And just going on, like a New Yorker, just went on and whined and whined about this. So he got it out of his chest and I went on to finish my remarks. I went up to him afterwards and I introduced myself and I asked for his business card and he gave me his business card, and nothing more was said. A few years later when we had a quarter where we made a hundred million dollars in one quarter, I called him up and I said, "How are we doing?" And he was a pussy cat. <*laughs*> He was so embarrassed at his conduct at that [meeting]. I did it to please myself and probably shouldn't have done it, but I just had this tremendous urge. I guess it's the human factor, right? You gotta reach out. And besides, Wall Street was important to us. I wanted the guys on Wall Street to say good things about us, and as you know they did. We did a couple of fundraisers. I wound up doing two fundraisings, one with Goldman and J.P. Morgan, and the other with Morgan Stanley when Frank Quattrone was at Morgan Stanley. Frank did the road show with us. He was one of the guys on the Morgan Stanley side. On the prior fundraising, we also had some prominent people on the road trip with us. The real benefit that those road trips had other than the fact that we raised about 400 million dollars, which was good, was that we were getting our story out to the people on Wall Street. I use Wall Street generically; Los Angeles, San

Francisco, all of the places, but the economic community. And we then won most improved company of the year one year, and we got a medallion, and then all of that sort of stuff.

Scalise: So it was a five year period that you were with National, and during that time, first of all, you had to take on the issue of how do we get this thing under control and get focused on the right products, and get rid of the things that we don't really do well with and shouldn't be in and so on, as well as skinnying down all of that manufacturing capacity and getting reoriented so it's working properly. But in the midst of all that, you did that and got the revenues moving, got the profitability moving, all in the right direction. You did the transformation of the company. You also pretty well rebuilt the board during that period. And by the time 1996 came along, you had pretty well accomplished the original goals that we set out to accomplish during the time that you were there, when we had our first discussions about, what are we going to do here, what are the issues and how are we going to get this thing back on track. I don't know if you want to spend any time on the board transformation—probably not necessary. But at that stage, then, you got a call from Apple about going on to their board. That was in probably '95.

Scalise: '94 actually.

Katz: '94, that's right, '94.

Amelio: Yeah, I just want to say one other thing about the National Semiconductor rebuilding, and that was we brought in a lot of new management talent, or we reassigned management talent we had to new assignments. Guys like Bami Bastani. He went from being R and D to running a business. And Kirk Pond was put in place where he could be more successful; and then I brought Rich Beyer back in to run our mixed signal program, and so on. So ultimately, we had Ellen Hancock there. We really strengthened the top tier of not just the board, but of the company. And I think that was really important. I felt at the time you're talking about, in early '96, that we had a first class management team; that I could take a long vacation and probably no one would even notice I was gone because they were really doing well, and they knew what they were doing. Their strategy was clear. Their implementation was good. So I guess in that sense, I was vulnerable. What happened was—I'm going to go back to 1994 because you mentioned Apple so I need to bring up Apple in that time frame. I had met Mike Markkula. Well, I had met him a number of times, but I ran into him, let's say, at one of these charitable dinners that were held. It was NCCJ, National Conference of Christians and Jews. Now they call themselves something else, but that's what they were then. We were at that benefit and we ran into one another and he said to me, he said, "Would you be willing to come on the [Apple] board?" And I said, "Yeah, I would." So in November of 1994, I went on the board of Apple. When you first go on a new board, especially of a company that's not in the semiconductor, was a totally different business and you have a learning period. So I didn't say a whole lot for, say, first eight or nine months. I mean, I was there. I was just listening. I asked questions. I listened to the conversation, but really, I was the newcomer and I wanted to listen to what was going on. It was pretty clear to me that this was a train—I was running head longed toward a very steep cliff. There was one conversation that sort of pushed me over the edge, and I'll share it with you. It was a board

meeting. The CFO was presenting the financials for the prior quarter, which weren't all that great. And there was an item on there, a charge, of 50 million dollars on one line item. It wasn't clear to me what that item was. So I raised my hand and I said, "What's that 50 million dollars?" He said, "Oh, that's our currency exchange." And I said, "You're losing 50 million dollars a quarter in currency exchange?" And he said, "Oh, yeah. That's pretty much what we do every quarter." I said, "That is totally unacceptable. That is insane." And for the CFO to be saying that. So I went to Markkula and I said—you know, he's the chairman, right—I went to Markkula and I said, "You've got the wrong CFO. You gotta get rid of this guy." He talked to the rest of the board members. All the other board members said, "Yep, yeah, Gil's right. We need to get rid of that guy." And he was marched out, and then they started looking for another guy, which turned out not to be hired until I got there [as CEO] quite a while later. They were working with second team up until that point in time. Maybe the question that would be most interesting to the people listening to this is what was wrong with Apple? What was it that they were doing poorly? They made what I view as one of the most fundamental mistakes you can make in business. They were embarrassed by their market share, less than 5 percent points. I think it even got as low as two or three percent points in market share. They wanted to get more market share, so what Spindler did—now remember, Spindler was a marketing and sales guy who had been their head of Europe and got brought back when Sculley left to take over. And being a marketing and sales guy, he thinks of all solutions in terms of marketing and sales. So he figures, "Okay, we're going to make a whole bunch of computers, and we'll somehow find a way to sell them." So he crammed a couple of billion dollars worth of Performa computers through the system without orders for them—just piled them up. The problem was the Performa was a flawed machine. The System 7 was exceedingly buggy even with improvements. The replacement program, Copland was going nowhere fast. And they'd been working on it for years at a couple of $100 million a year. And it still was no end in sight on getting that finished. And then, finally, the quality—the factory quality was horrendous. We were getting back—some months—as much as 10 percent of the computers we shipped, we were getting back again. And that is a very expensive process, to process all of that stuff. We just had a company that just wasn't doing the fundamentals right. It wasn't—well, there was an important element of strategy in it. There's no strategy that can be implemented if you can't execute. So it seemed to me the first thing that I needed to focus on was getting people to execute effectively. Then, we can dream up a great strategy. Nonetheless, the board was calling for a strategy, and I did come up with—in the spring of '96—the document that became known as the white paper—famously known as the white paper. It's about a seven-page document that described the course—the road map that Apple should take to get back to prosperity. And I—jumping ahead a little bit, I think it's fair to say that that—essentially, unchanged—was the strategy that was followed for many years thereafter—even after I was gone. And, fundamentally, it just said that—and I'm going to see if my memory's good enough to remember. There were five imperatives, I said. And we had to be competitive or superior in these five things. Number one was Ease of Use—the user interface—friendly. Second, was Performance. We could not concede to the PC world better performance standards than we were achieving. We had to be able to meet or beat or beat those things. We had to have Connectivity—number three—because there was this emerging thing called, a newfangled thing called the Internet, which just come on to the scene in 1995, and Netscape and all that stuff. Number four—we needed—recognizing we were only a three or so percent market factor. We had to have Compatibility. While Microsoft didn't have to let Mac content work on their machine, we wanted to have any Windows document to be able to be opened and managed on an Apple product because we were the small guys,

and we needed to do that. So now I call that Compatibility, and then, fifth, was Industrial Design. We had to have the best-looking machines out there. I put Jonathan Ive who was already with the company, but I elevated him to a level of more importance. He never even used to show up for the staff meeting because he felt he was so unimportant. So we elevated Jonathan Ive to work on it. I think—if you think about the last 16 years or let's say 15 years since I left Apple, I think they implemented all of those things pretty well. They did more than that though. Had they only done that, it would have been good, but they also innovated in ways I probably couldn't have done.

Scalise: Well, let's step back for a minute though. I think about the level of technology that was available at the time for the kind of products that were being thought—so, for example, a Newton. There was some real capability in the Newton, but given today's technology and what you can do, clearly, it looks like an ark. In today's world, it would just never, never, never, never get close, but that's what the technology was, and that's what they were trying to do. Was that something that, in your view, was even a good idea at this stage? Or was that—it had already missed its mark, and therefore—

Amelio: Before I answer that, George, let me just give you one perspective. One of the major problems I had at Apple, especially, in my first year there was a relatively undisciplined staff—not—just people, but the culture of the company was, "Hey, Steve Jobs can get away with whatever he wants, so I'm going to do whatever I want." And so we had this culture where they didn't respect management's guidance—no one had done anything in the intervening years to cull that back and to make people accountable for decisions they were making and for results. When we got there, George, there were 300 R&D projects—300. I could make a case that maybe we needed 20 of those, and that might even been too big a number, but 300 was ridiculous. And they were on the craziest subjects that—there was no justification. The R&D guys, who were very much admired for creating this wonderful machine, were out of control. And so what we did was we started, with great agony, cutting out a lot of these programs. I think we may have gotten it down to about 50 from about 300. That made an enormous difference because that simplified everything. It reduced our level of complexity—made it easier for our manufacturing guys to focus on fewer things and so forth. Remember, we put Mike Connor into the job of doing the quality thing, because I took a trip where I went to visit our factories around the world. And once you've met a semiconductor guy, you can walk into any factory you want, and you know immediately whether it's a good factory or not. I walked into Apple's factory and I said, "This is a disaster. We have a lot of work to do." The best guy I had for that at the time was Mike Connor. He worked for Ellen Hancock, and I said, "Ellen, you've got to get that fixed." So she took on the manufacturing quality issue, and, actually, we made great progress there. The other thing, of course, is, as I mentioned, the operating system was unstable, and Copland was nowhere close to getting done. And I finally decided that even if we had Copland, it would improve the stability, but there was not a sufficient improvement in the capability of the program where it would allow us to claim senior competitiveness. And as a result of that, I decided in those days that, we needed a new operating system and that it needed to be Unix-based.

Scalise: Now, before you go into that, step back for a minute and talk about the licensing of the Power Mac and what that did in terms of pricing pressure on the rest of the product line as well as the lack of

earning power because of the licensing and the pricing that was taking place with the licensees and so on. Just give us a little bit of background on that whole power vacuum. <*overlapping conversation*>

Amelio: Yeah, well, we were still in the mode of believing to some extent that we needed a greater share of the market whether it was made by us or a clone. We wanted to get more share, and we thought, ultimately, that would give us more market power, and, ultimately, it would link to more financial success. In hindsight—hindsight is great—there was nothing wrong with that thinking. It wasn't the right time probably to do that. And, frankly, if I had to do it over again, I wouldn't have done it. But it was reaching out to try to spread our genes over a wider distribution. That's what it was about.

Scalise: Okay, so we've given away our franchise in a sense by licensing the Power Mac and giving away both the revenues and the margins that came with the pricing power that we did have with that. And that was a battle that had to be dealt with along the way then. But then the operating system became a real issue because we were losing ground. It was later, and later, and later in the implementation prior to your coming, and now you're trying to address that. So what was your thinking, and where did you go with addressing the—<*overlapping conversation*>

Amelio: The first thing that came up was the—was Sun and Scott McNealy wanting to buy Apple. That, actually, started when I was a board member, and carried into the time I was CEO. So it straddled that. I've had many fun conversations with McNealy over those days, and both of us wish it could have turned out a little differently. As you know, Sun's operating system is a Unix-based system. It is got a great reputation in the marketplace, and being very stable—very capable, very fast. The only question was could we put the Mac interface on top of that platform, which was a nontrivial task. I became convinced after a while that that was tough, but a doable task. So we tried to make that deal with them happen. At the end of the day, Scott McNealy's board turned us down. At that time, John Doerr was on their board, and I think he was, perhaps, most vocal in saying, "No, we shouldn't make this connection." And so once his board voted it down, there was no place to go. I had a situation where I thought I had a way out of the woods, but now I had to go look for something else. We're talking of a period of only less than 12 months when all of this was happening. Jean-Louis Gassée approached us about the Be operating system, and I'm kind of glad he did because it gave us another contender in the stack. And we, basically, did the following. We said, "We're killing Copland. We're going to take whatever we can salvage out of the Copland version of the finder, which is the main program that manages the Mac, and put that into a new system called System 8, which will replace System 7." That would make the operating system much more stable, which it did. It made a dramatic improvement in stability to the operating system. We then made a few more tweaks to come out with System 9, which was just a further enhancement of that. So that was taking the best pieces of Copland and backing them into the original System 7 and making something that was now stable. The problem was, okay, we'd solved the stability problem. The quality issues were getting better all the time—the manufacturing side of it as well as the operating system side. Less machines were coming back. So that was starting to get better. But the question is what do you do for the long term. Is this going to take you somewhere? And the reality was that the operating system—the Mac operating system had never been properly documented. No one really knew what all the

spaghetti code in there was, and to reverse engineer it would have been a monster job. It's architecture was based on the thinking of 20 years earlier, and the world had come a long way in those 21 years—protected memory and a whole bunch of these other concepts that weren't as common in those earlier days. So I decided we needed a grown-up version of an operating system, and I was convinced that it had to be Unix. And so that's what I looked for. I was happy that Jean-Louis Gassée was a stalking horse for that because I could play sort of one against the other. After we went out and we looked at it, the best Unix platform was the NeXt machine. And that had its own series of interesting developments, but that's when we decided that we had to pursue a new course.

Scalise: So that took place around December, I guess, of '96. <*overlapping conversation*>

Amelio: Well, actually, it started in the late summer.

Scalise: Well, Be started in late summer, and then about in October and November, so you began to engage with NeXt in some—

Amelio: And then it was concluded in December or announced in December. It was not concluded.

Scalise: Right, right, right. Okay, anything more you want to deal with as far as the operating system, the acquisition of NeXt and any part of that transition? I'll leave that all up to you. Anything you want to get into here?

Amelio: Well, a couple of things—I want to fill in some—sort of—pieces that are missing. 1996 was the hardest year of my life. That was the first year I was at Apple. I mean, I worked seven days a week every week including Christmas Day. And it was just the hardest thing I've ever done or even come close to doing. But the ratification was that I, actually, began to see improvement as we moved into 1997. And something we hadn't done in a long time, was we started to get products released on schedule. It was supposed to be released on February 1? My God, we actually released it on February 1, and it was a pretty good product. That was starting to happen. We actually released six products in the first six months of '97—all on schedule and all to favorable reviews. There was clearly some positive momentum building. We still had a lot of financial issues. We had this inventory problem we were getting rid of. So the numbers didn't look pretty, but the underlying performance was starting to move in the right direction, and that was critical. It was at that point, as I said, that I decided that, "Okay, now, we need to get serious about the strategy, and the strategy had to include Unix." The hard part, as I said, there was—it was a couple of hard parts about this. Number one was Unix—the NeXt operating system was the best choice out there. I would say virtually everybody felt like we shouldn't touch it because of Steve Jobs. Every one of my board members and most of my staff told me forget about it. Nonetheless, I continued to have talks with Steve, and I couldn't find another path we could follow. If I couldn't get Sun, then the third—whatever was third on the list was so far down the list that it really wasn't a viable strategy. So, finally, I said, "You

got to have guts. You got to go for it." I knew that Steve would cause us lots of problems. He was just a contrarian kind of personality. But he's brilliant. And the reality was that if I'd learned anything in 1996 trying to get the company back on its feet it was that although Steve had been gone for something like 10 years from the company, it was still his company. People still reacted like a Steve Jobs reaction. His DNA was so much in that company that even after a year of massive change; you could still see the echoes of Steve Jobs in the company. And so my feeling was that that would be a positive for the company. That while Steve may be a total pain in the neck to work with, that he would resonate with the workers, and he would inspire the innovators and engineers. He was a really smart guy. He didn't understand technology, but he did understand user interface better than anyone on the planet, and I would say he did that until the day he died. Steve was a completely unique individual. I mean, there's no other way to say about it. Everyone's written books on him and everything else. Ninety percent of everything you read is probably wrong, I mean, to be honest about it. He was an adoring husband and father to his children. Although, he had major problems with Lisa. And when he got to working on a user interface issue, he was so intent on it, you couldn't get his attention he was so [single minded.] But he had this remarkable record of always being right. When he made a decision on the shape of the cursor on the screen, and the angle the cursor had to be placed at, he, personally, made that decision. He knew that was exactly the right thing to do and every other detail. Every one of those details on—what you experience when you turn on a Mac is Steve Jobs. That is his interpreting—that's his canvas. He painted that canvas. Now, he had no idea about how the technology behind it could be done. In two sentences, I could completely lose Steve Jobs in technical discussion, but that wasn't his gift. His gift was this ability to know what people would love, and he was never wrong. I never saw it—maybe once or twice on some minor things, but for the most part, he was never wrong. And that was the great gift he had, and it was great for history, and ultimately, great for him personally. Finally, I agonized more over the decision as to whether to bring Steve Jobs back more so than I think any other decision I made in my life. I really had a lot of conversations with Markkula. I had a lot of conversations with my wife, Charlene, about that, and each day, I'd wake up—maybe I'm leaning one way or leaning the other way, but at the end of the day, something told me that I had to do it. And I went and I convinced the board to do it. And as I said, the rest is history.

Scalise: Well, you've kind of said this. Although, you didn't because you were dealing in a very, very compressed timeframe to make all these decisions. I think that's another issue that many people really don't understand. We're talking about days.

Amelio: Days and months, yeah.

Scalise: Days—we weren't talking about months and months and months. <*overlapping conversation*>

Amelio: I didn't have time. I didn't have time to ponder some—<*overlapping conversation*>

Scalise: —from November to January was probably one of the most intense periods of my career—as I can recall. I mean, all the things that we were dealing with during that period, and all the decisions had to be made because MacWorld was coming up in January, and there were lots of things that had to come forward at that stage.

Amelio: There was just too much on our plate to be counted. You're absolutely right, George. I would agree with that 100 percent, but there was no alternative. I mean, we had to just do what we had to do, and not all of it was pretty. But I think history—I think the decision that I made to bring Steve back—and I think history will say that I made the right decision. Most people thought I was crazy out of my mind when I did it at the time, but I would say I think history has justified that choice.

Scalise: But I think also it's important that you touch on the fact that we also restructured the company during that same period from a business unit structure to a functional structure, and that was a huge task in and of itself. You didn't have to do any of the other things that had to be done. That task in and of itself was so monumental. <*overlapping conversation*>

Amelio: Yeah, we ultimately turned over almost every direct report. Remember we brought Fred Anderson in to take over the CFO role.

Scalise: Finance.

Amelio: —and then Mark Olandi and a whole bunch of other people. We brought it in.

Scalise: We brought on John Rubinstein to do the hardware side. We brought Avie Tevanian to do the software side. I mean, there were just a number of major changes that had to be made during that whole period.

Amelio: From the beginning of '96 to—let's say—January of '97, everything changed. There was nothing about the company that was the same as it was a year before that time. And when you try to think about a company of the scale of that—I mean, we were making a lot of money even at that time. I mean, I think we made—my first year there, I think we had $11 billion in revenues, which for that year, it was a pretty good number. The year before we had had 14, but that—a lot of that stuff came back to us because the Performa problem. By the way, there's one other thing I want to get on the record here, and that has to do with iMac. Everyone sort of assumes that the iMac was originated with Steve Jobs, but that really isn't true. When I killed the Performa because I had to kill it, it was a disaster. We needed a new all-in-one computer. We didn't have an all-in-one. That was the only one we had. So I gave Ellen Hancock the task of coming up with a new all-in-one computer, and we called it something else at the time—not the iMac. We didn't give it that name, but we were at least six months into that thing—maybe longer—when I ultimately left. And that went on to become, I think, a very, very important part. Now, it

got renamed the iMac, but that didn't fundamentally change how it had been defined. That was an important product I think. There were two things I think that totally changed Apple, and you knew at the time that you had just turned the corner. And that was when System 10 first came out and worked for the first time, and it had bugs and everything else, but you could see how much more elegant it was going to be. And when we got the iMac out there. And both of those happened in the late '90s—98—about—say—six to eight months after I left. Although System 10 came a little longer after that, they were dribbling it—some parts of it out there. That totally redefined the company. Those two decisions totally redefined the company, and then this other thing. As you recall, George, I did a fire sale on all that Performa inventory. I cut the prices to the bone because I just wanted to move all that stuff. We had $2 billion of inventory on the Performa, which was known to be a flawed machine. I cut the price. We ultimately got a $1.5 billion out of it. So everyone we sold was a loser, and that showed up on the income statement as a loss, but the fact of the matter, it was going to be a $2 billion loss no matter what you did. We then brought in $1.5 billion. In addition to that, I did the road show in the spring of '96 where we raised $660 million. And so in a period—from the time I got into the company until June, which was—I like to say my first 100 days, which is pretty close to being accurate. We had a new strategy develop. We made major decisions on the direction we were going to take the operating system. We made major decisions on the structure and the organization of the company, I wrote a strategy, which turned out to endure for many years, and, lastly, we raised an amazing fundraising of $660 million.

Scalise: Overnight transaction—$660 million.

Amelio: Well, I hired Goldman Sachs to do it for us. I'd had good luck with Goldman in prior experiences, so I hired them. And they had this beautiful three-week road show planned for me including The East Coast, The West Coast, Europe, and all this stuff. I pulled a Goldman Sachs' guy aside, and I said, "This company is in a state of crisis. There's no way I can be on a road show for three weeks." I said, "We need another plan." So over a period of days, we discussed it. And, finally, we decided it was risky, but we were going to go for the overnight thing. And the thing was that we ultimately did—which I think the people who are watching this would probably want to know because it was a gutsy call, and that was what we would do would be to make a presentation about where we were going to take Apple including the key elements of our strategy—key elements including the roadmaps for the operating system—roadmap for the computer design, et cetera. The fact that we were going to come out with a new replacement for the Performa—and that when the market closed on that day—five minutes after the market closed, I got on a conference call with every salesman in Goldman. And I gave a presentation that lasted about 45 minutes. I answered questions about another 15 minutes, and then it ended. When the market opened the next morning, we had $660 million.

Scalise: It was oversubscribed.

Amelio: No one else had ever done that in history, and it was amazing what you can do when you just galvanize. And I think it really is a testimony to the sales force of Goldman. I don't know if anyone else

could have pulled that off. But what I was pleased by was we were oversubscribed. We actually raised $600 million, but we got the greenshoe, which was, at that time, 10 percent not 15 percent. So we got a 10 percent overage on it—on the greenshoe, and we could have taken in more money had we wanted—that was a real endorsement. I think that was a psychological lift for the company when we brought in that money. Clearly, we needed it, but that wasn't the biggest benefit. The biggest benefit, in my mind, was a sense of positive energy it generated for the lot of the people in the company.

Scalise: So at that point then, you had $1.6 billion in the bank at the end of June.

Amelio: Right. And frankly, we didn't squander much of that. We—I think I remember—and I'm going from memory here, but I think when I left, in the summer of '97, I think we still had $1.5 billion of it on the books. So Steve inherited a very different situation than I inherited. He had some ammunition to do his magic with, and, obviously, it was well-done.

Scalise: You want to move on beyond Apple then, and just talk a little bit about the years since Apple?

Amelio: Yeah, let me talk about a few things because again, in the bigger sense of my career I consider that even what I do today to be Silicon Valley-embedded regardless of where I happen to live. In 1995, I went on the board of Pacific Telesis. In 1997, Pacific Telesis was bought by SBC, and then a few years later, SBC bought the original AT&T and renamed itself AT&T—went from AT&T Corporation to AT&T, Inc. Today, it's AT&T, Inc., and I was part of that whole transition. I was starting off—with a small $10 billion a year company, and winding up with a $130 billion a year company. When I finally step down from the board, I will have been on that board 20 years. It was an amazing set of experiences. I mean, we acquired so many companies—massive deals. The ability to pull those off and to get them integrated into the company without customers having problems and so forth and so on, was an unbelievable feat. The board was very involved in that. Ed Whitacre, who was the head during most of those years, is a master. I admire him as much as, I think, anyone I know. It was brilliantly done, and to top it all off, a year or two ago, he came out of retirement to go turn around General Motors. And he did that well, too. Charlene and I recently went to spend some time with Ed in San Antonio, and he's the same guy. He's just a great person, and we just really enjoyed it. Back on the board thing though—I dabbled with a few things in the late '90s, but they didn't catch hold. I went with the Parkside Group. I then tried to do a start-up called Amtech, which I then renamed Beneventure—didn't get traction. I then finally decided to go with Sienna Ventures. Dick Rosenberg basically said, "Look, these guys could use your help." And so I said, "Fine," and I went there. We closed Sienna December 31, 2011—a few months ago, and it was a tough year—tough 10 years for that—for the industry. We started off pretty good. We made 11 investments, and six of them wound up being public companies, but none of them were spectacular successes. Glu Mobile is probably the most well-known of those, which is still a well-known company. And so that went away, but I got very involved in technology and looking at new companies. I still now have in my daily inbox—I still have hundreds of business plans almost everyday coming in that I go through quickly, and see if there's any exciting things in there. I think there are a couple that I'm working on now that I'm very excited

about—a little too early to go public on them, but they look very good. And then in 2009, I got invited to become an advisor—hired to become an advisor to InterDigital Corporation. InterDigital is an intellectual property company that specializes in mobile communication interests—intellectual property. They are second to Qualcomm in terms of people in that space, and a very successful business that has done really quite well. They asked me to be an advisor, which I did for a year. They were happy with that. So they asked me to come on to the board, and in the beginning of 2011, I went on that board, and I'm still on that board. That's been very rewarding because as we transition from 3G/4G to LTE, the patents that InterDigital has is the largest LTE patent set in the world. No one has a bigger one, and as the world transitions to that, that's going to be critical—not only with the patents they already have issued, but the new ones that are coming out. They get something like 300 new patents a year—a little more some years. So they're very good at what they do. Then, about the same time, I got asked by a company that was called Pro-Pharmaceuticals—a biotech company in Boston, to go on their board. The chairman of the company was a friend, Jim Czirr. I probably wouldn't have done it, but he asked me as a friend if I would come and help them out for a while. That company's now changed its name to Galectin Therapeutics. What they're doing is they're using galectin science to tackle some of the hardest diseases out there—cancer, fibrosis, and severe arthritis. And the results are amazingly good. We think this is going to be breathtaking, and is going to be a huge step forward in battling those diseases. So it's just one of those things you do to make yourself feel good. I mean, you do it because it's the right thing to do. If I can help them, and they can save people's lives, then I should do it. So that's what I've done. I guess, the last thing I'll say is I do have a consultant assignment. At this point, I'm pretty much a full-time board member/consultant, and I have about all the clients I can have the time to handle. So I'm having fun. But what I love about it is every new client I get has gotten some new challenges—new issues, new problems to work on, new exciting things to dream about. And so, although, I'm not the guy steering their vehicle, I have a pretty important role in those companies I advise. And it's been a lot of fun and continues to be fun. I intend to keep doing it.

Scalise: Well, congratulations. I think, first of all, we want to thank you for taking the time to come and give us all these comments. I want to turn it back over to Jeff here in a second. Having worked closely with you for many years, you have, certainly, had a brilliant career both as a technologist in the early days. And you built on that along the way, but then in the later years, as a very successful business manager taking on some of the biggest, toughest roles that anyone could imagine and having won and won big. So congratulations on all you've accomplished over the years.

Amelio: Thank you, George.

Scalise: Jeff.

Katz: Well, speaking of all those years, we just had a good conversation that described you starting from young kid in the lab and ending up on 25 or 50 boards—whatever the number is. We like to look forward at the end of these discussions with a little commentary from you on what you would advise other young

kids who are interested in having a brilliant career in technology. What should they be looking at? What should they be trying to make themselves good at? And who should they be trying to culture as mentors?

Amelio: First of all, let me say I come from a school that believes in the technology industry whether it's semiconductors, computers—what have you—in the technology industry. First and foremost, you have to know the technology. I mean, there are exceptional people like Steve Jobs that don't need to know that and are still successful. Believe me, he's the exception. You have to be really good at your craft. And so I would advise everyone no matter what your ultimate ambitions are make sure you start up with a solid foundation and understanding of the technology because it's totally imperative. I think the other thing though is that you need to come up with a management process that works for you. You need to conceptualize it. Management is not something you just walk in and start barking orders. It's not that way. I mean, at least it shouldn't be that way. Although, some people try that. It doesn't work when you do that. You have to have a process, and you need to think it through in great detail. And I was blessed in this, when I came to Fairchild, and I was asked to take over. We're taught to run a business and having been just a scientist all my life, I went to Stanford, and I asked [the folks at] Stanford, "What do I do? I didn't take any business schools in college, and I don't know any of this stuff. What do you suggest I do?" And the fellow I talked to said, "Actually, it's not that hard. Just read everything Peter Drucker ever wrote."

Katz: I'll do that.

Amelio: And I did that. And I would say my management style mirrors that because that's what I learned. I mean, that's that and—his tome—a book just called, "Simply Management" is, I think, the best book ever written. So if you're going to aspire to being a manager beyond just being a scientist, I would say to the people out there, you have to treat that skill with the same intensity that you treated learning your technical stuff. You have to become a student of management not just a practitioner, and do that. Another point I would say as I look back and when I think about issues that I ran across in managing people, one of the things that I think goes underappreciated and, perhaps, under-corrected is a lot of people simply can't write or talk very well if they're engineers. I used to get letters from the guys at National, for example, and every other word was misspelled. The sentences were poorly structured. I'd find myself with a red pen going through it and marking all the corrections. So what I would say to people is learn how to communicate. Work really, really, really hard on that because you can't do anything unless you can communicate it. If it's one thing I could say to every kid coming out of college is if you didn't take enough in communication skills, do it on your own, but just get it and learn it. Make it happen.

Katz: How did you get it?

Amelio: I was in this situation. I was working on very esoteric technology—Auger spectroscopy. I mean, it—and, especially, at—the secondary or the second derivative of the weight structure. Yeah, that's—it's very esoteric. I mean, it's crazy. I was put in a situation to try to explain to people in English, like my

wife—"What is it you're doing?" And make it make sense somehow. I really worked hard at that. And I published a lot. I wrote probably more than a 100 papers in my career—published works. And all of it was the art of saying clearly, simply, and directly what it is you want to say. And do it in an interesting way. Make your sentence structure not crazy, but keep it interesting. Have a rhythm to it. I think, to me, the task of explaining to people what the heck I was working on helped me build that skill. Maybe some of it was innate, but that's what I would say there. The other thing, I guess, everyone should do—and it's almost a cliché now, but it's not practiced as often as it needs to be, and that is you should learn for the rest of your life. When you graduate from college, it's not the end of something. It's the beginning of something, and what it is, it's the beginning of teaching yourself. You learned how to learn in college. Now, you practice that for the rest of your life if you're smart. And so, I continue to do that. I still read technical books—almost always a technology book of some kind on my bedside table. And I'm still dabbling in inventing new things. I think if you do what you do, you do what you're good at. If you're good at it, you just keep doing it. It's real easy to get lazy. I would say that—especially, after you've had some success. At the end of the day, it's always hard work. I don't care when you're coming up with a new invention, you're writing a paper, you're giving a speech. You're restructuring a company. It is really hard work. And if it isn't hard work, you're doing something wrong.

Katz: Well, very good. We want to thank you very much for the intense session we've had and the wonderful insight you've given us.

Amelio: Well, thank you so much. It was my pleasure.

Katz: We'll close the discussion.

END OF INTERVIEW

