Oral History of Juan A. Rodriguez

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Gardner Hendrie: This is Gardner Hendrie interviewing Juan Rodriguez in an oral history for the Computer History Museum. Thank you very much, Juan.

Juan A. Rodriguez: Thank you, thank you for having me here actually. I enjoy this.

Hendrie: Good. I think what I'd like to do is start out with you telling us a little bit about your family background. Where were you born? A little bit about your parents, what they did, some of your very early history.

Rodriguez: I was born in Santiago Cuba, in February of '41. I think this is an interesting story. My father and my grandfather had been exiled from Spain, from the Spanish Civil War. My grandfather was a Supreme Court Justice in Spain. He had actually been born in Cuba when Cuba was part of Spain. He was born in 1889. After the 1898 Spanish American War, since his father was a military man, they went back to Spain where he basically grew up, went to law school and became a judge. In early 1939 he was a Supreme Court Justice in Barcelona and they left when Franco finally took over Barcelona. And at that moment he was a Spanish citizen. Most of the, if not all, the Latin American countries had basically denied entry to Spanish exiles because they were considered to be very pink, except for Mexico. Mexico really got the cream of the intelligentsia of Spain. But my grandfather having been born in Cuba went before the Cuban Embassy in Paris and said, "When I left Cuba in 1898 I was under age. All who were born in Cuba were given the opportunity to become Cuban citizens. Here I am at 50 saying I want to be a Cuban citizen." So he did that, and my family that had been in Cuba since the early 19th Century had a house in Santiago and that's where they went. It was basically the only worldly goods that he owned. Everything else was stripped. My family at that moment was very interesting. My grandmother, my father's mother, her father had been a Naval Attaché to the Spanish Embassy in London. He had widowed earlier and he married an English widow during that timeframe. He had died by the time the Civil War came. So my grandmother actually asked her stepmother for money for the trip to Cuba. I mean they had absolutely nothing. Oh my goodness! And eventually my grandfather went to work as a lawyer for the Guantanamo Sugar Company in Guantanamo. So now, as I said, I was born in Cuba in 1941. My father couldn't find a job. He knew English. He was a lawyer by training. He wasn't very old at this time he was 29, 30, you know, spent half of his life-- half of his working life- fighting so that he had not a lot of work experience. But he knew English and eventually got a job in Venezuela with a fellow whose life he had saved during the Spanish Civil War. So he went in January of 1942 to Venezuela only to find out that the company that he was going to work for, which was a manufacturer of laboratory glass beakers kind of company, had stopped operating because the sand that was used to make those beakers had been declared a war material by the U.S. Government and they had stopped exporting it, so. So he closed the company-- obviously-- well the guy gave him a job for a few more months and eventually I think in June he went to work for Reuters, the news company, then went on to work for one of Rockefeller's many companies down there, who was very heavily invested in Venezuela. And in 1953 he took a competitive exam to become a translator in the U.N., got in and that's how I came to this country in 1953, in November. And I always like to say that I came in by boat by Ellis Island. We came in by boat but it was a cruise boat that went by Ellis Island, and we landed in Pier 38 or whatever it was. It was good, it was good. And I went to Bayside High School in Queens, New York City.

Hendrie: And that's where your parents settled?

Rodriguez: Yeah, that's where they settled. My father worked in the U.N. obviously and I went to high school and then went to college, at the City College of New York up in Manhattan, two subways stops past Columbia University, just in case you want to know where it is.

Hendrie: All right.

Rodriguez: And then I went and got a Master's at NYU and that same year, by the way, I became a resident of the United States. I had been on a diplomatic visa up to that moment. Five years later I became a citizen.

Hendrie: All right. Well I'd like to roll back just a little bit more into your childhood now. Did you have any brothers or sisters?

Rodriguez: Well I have three sisters and two brothers -- six of us. And I'm the second. My older sister was born in France. I was born in Cuba as I mentioned. My next three siblings, two brothers and a sister were born in Venezuela. And my youngest sister was born in New York. So you can imagine my father traveling with all those passports.

Hendrie: So when you were going to school or when you were young what's the earliest memory you have of what you wanted to be when you grew up?

Rodriguez: I wanted to be an astronomer. Loved going to the New York Museum of Natural History, the Hayden Planetarium.

Hendrie: Now in high school -- what subjects were you particularly interested in?

Rodriguez: Well it was again due to a quirk in the educational systems I went to high school. I was 12 years old. I had just finished what they called grammar school in Venezuela. The next step was high school, but I was 12 years old and I didn't know any English.

Hendrie: I was going to ask. Did you know any English in Venezuela?

Rodriguez: I knew no English.

Hendrie: All right.

Rodriguez: And this is, as I mentioned to you before, this is November. This is kind of like the middle of the semester. So then we finally decide that we're going to live in Bayside. And so we're taken to the high school, I'm 12 years old. I had just graduated from grammar school. So therefore I must belong in high school. And I did. <laughs> In order to make up for my lack of English they enrolled me in a senior Spanish class where they figure, hey, you know, they talk enough Spanish that I could pick up English. They also gave me English. And the first day of class they were reading Shakespeare. I still remember that as a headache! And they gave me science and history, but I was very good in science and math. They didn't give me math, which was a mistake on their part. I could have done that. So I lost a year in math but basically in about a year I was fluent enough. Looking through my records I was able to find

some of my high school grades and I still-- I never did well in English. I mean my best grade there I saw was on my last report card where I got an 80. They used to give us the point grades. So, I was getting 99 in everything else, 80 in English. That was probably one of the reasons I decided to be an engineer, because I figured to study law, of which I had several generations worth of blood in my veins, you needed to be very strong in the language and I wasn't strong in the language. And so I went into engineering. At first civil engineering, actually, and but the first year was common so it didn't matter what I chose. And I heard somebody tell me there's a future in electrical engineering. So I said, "I'll do that!"

Hendrie: It wasn't you had any particular interest in electricity or anything?

Rodriguez: No, no. I did very well in my first year of college. Second year, I did badly, which is when you started taking your major courses in Engineering-- I started going around with a crowd from St. John's University. They loved to drink and party. I became 18 during my second year in college.

Hendrie: Oh, my goodness, yes.

Rodriguez: I mean I started at 16, right. Yes I was 16. I became 17 in my freshman year, 18 at the end of sophomore year. So I ran around with this crowd. I joined the soccer team. I played for the soccer team. We went undefeated that year. I broke out, in a sense, socially. But at the end of that year I got put on academic probation.

Hendrie: Because you didn't pay any attention to your grades.

Rodriguez: And unfortunately-- yeah so I worked very hard to get back. And this was a point in time when City College was extremely competitive. You could get admitted on an 85 point average, which I just barely made because my first year grades weren't that good and I never did well in English. So that always got me down, but it was good enough to get in. And it was at that moment the Hungarian Revolution, this is 1957; a month after I started school the Sputnik comes up. So I knew I was in the right spot. And the Hungarian Revolution had just finished the year before and the New York City offered all Hungarians free entrance into the university system, you know, the guy from Intel Andy Grove?

Hendrie: Yes, Andy Grove, yes.

Rodriguez: He took advantage of that. He was much better. So in a sense we're classmates by that. He was a lot older than I was and probably a lot more dedicated to his course work. We had a great soccer team because of that. We had a lot of Hungarians. And actually I think we went to the NCAA finals those two years. City College was free, tuition free, we were charged $14 a semester for athletic fees. And it was a subway college. I mean I commuted an hour and a half everyday to school each way.

Hendrie: Was it tuition free for you or everybody?

Rodriguez: For everybody. And extremely competitive, you know, we had a lot of Jews -- my class, if you will, had been born in 1939. I was born in 1941. So you can imagine Jews born in 1939 were probably not born in Germany. These were the children of the Jews who had left Germany in the '30s obviously, and they had come from many, many different places. You know, their families eventually came to the United States. They were not all admitted into the United States at first. So I had many Latin

American Jewish friends. Because it was free, it was very competitive, I mean these were children of an educated class who had no money at that moment and the selection process, the competitive process at City College was just unbelievably difficult. And they marked on a curve where the curve was C, right? So I got a few D's in that second year. I never flunked a course. And for me to get a B afterwards to make up for those D's was very difficult. I think it taught me to work very, very hard. I needed my last A in my last course, fields, as a senior, to just get over the C average I needed to get my degree. And I did of course.

Hendrie: Oh my goodness. Yes you got your degree, yes. Wow!

Rodriguez: Then I went to NYU for my Master's and I did very well. It was a totally different environment and I did very well.

Hendrie: Now why did you decide to go do a Master's or tell me about your decision process at the end of college?

Rodriguez: It was very simple. I couldn't get a job. As I mentioned to you it was-- I had finally gone through the paperwork to become a resident of the United States. I did that in the spring of '62, the semester I graduated. It's an interesting process. I couldn't get a job. I couldn't get a job because I wasn't a resident at the time of interviews and I certainly wasn't a citizen. And I would say that probably three quarters of the jobs were out in the West Coast in Los Angeles in the Aerospace industry, okay, in 1962. There were lots of jobs, but I couldn't get one.

Hendrie: Yes because you were still on a diplomatic visa?

Rodriguez: Yeah, I had a funny status, right. So I finally, I mean, I went through the process. I never gave it much priority. But I can tell you when all the documents were finally ready I had to fly out to the American consulate in Montreal because they are the only ones who could then - I don't know how it is now- the only ones who could give me a visa was the State Department. And the only place the State Department has offices is outside of the country. So I went to Montreal, the American Consulate in Montreal and basically I flew out on Wednesday night. Spent the whole day Thursday as a man without a country because at that moment I had to hand in my diplomatic visa and so on and by the end of the day I got it, flew back to New York and I had a test the next day which was really my concern during the whole trip. And so it's around the same timeframe I realized I was not getting a job. So I made a late application to NYU and they accepted me and I went. It was full of these people that had scholarships from Bell Labs.

Hendrie: The free tuition program for a graduate degree from Bell Labs, a very famous program.

Rodriguez: Yeah, yeah full of those guys. And I got the degree in a year and I had two job offers.

Hendrie: Now what did you specialize in, in your Master's degree?

Rodriguez: Control systems. But I had a year course in semiconductor design, circuit design, which turned out to be the way I started working as a circuit design engineer. But I took controls-- in undergraduate all of our circuit design was done with tubes. At the end of the chapter it said “and by the

way there's such a thing as semiconductors and they are just the same", totally different but…. And that was very interesting because well I got two job offers. First, I went to Poughkeepsie for an interview with IBM Poughkeepsie, right up the river. On March 1st, I remember on the day that I left for the airport for my second job interview, in the mail I received a job offer from IBM, $710 a month which was $610 normal plus another $100 for a Master's, so I got $710. So with a job offer in my pocket I went to Rochester with all the confidence in the world, and sure enough, I got a job offer from Stromberg-Carlson in Rochester New York, but I preferred Poughkeepsie. By the way Stromberg-Carlson offered me $712 a month. And I went to work for IBM in a tape data storage group.

Hendrie: And did they tell you what group you'd be working in, in IBM and at Stromberg-Carlson both of them to give you some idea?

Rodriguez: Yeah, at IBM I really knew nothing about computers -- I had a brother-in-law who was a very successful salesman for IBM in Venezuela. He was an oil engineer and basically he had the oil companies as his account -- he was great salesman, great personality. And he did very well. So I was very proud to have an older brother-in-law who was employed by IBM. Stromberg-Carlson offered me a job as some form of field engineer doing telephone something's. I don't remember. But that first day up in Rochester, New York, it was a beautiful day, you know, just a cloudless sky, blue sky. The streets and the sidewalks were clear but there was probably two feet of snow on the yards and it was a gorgeous day. So you can just imagine this is 1962 and we're getting interviewed, right. So I get interviewed by-- I have a schedule of about four interviews in the morning and then lunch. The first one the guy greets me "it's a beautiful day". I said, "Oh it's a beautiful day." It was a beautiful day anywhere! In New York the skies sometimes are cloudy but this was a beautiful day. The second guy, "It's a beautiful day." Third guy, "It's a beautiful day." I said, "Yes, a beautiful day." The fourth guy says, "It's a beautiful day." We go to lunch and they have a whole bunch of interviewees with their interviewers sitting every other one in the long lunch table and the guy sitting next to me says "It's a beautiful day." And I said, "I know it's a beautiful day but why does everybody keep talking about it?" And the answer was, "This is our first sunny day since October." I said, "Oh, okay, it's a beautiful day." <laughs>

Hendrie: And maybe I don't want to come here.

Rodriguez: Yes. I mean I had the job offer in my hand and I took the job in Poughkeepsie. I had interviewed several groups and this was the one group that took me. I started working on tape but actually as a circuit designer the interesting thing is that I was a new grad, right. And again, IBM design engineers had the same problems that which I had in undergraduate, they just knew tubes and they had started to apply semiconductors-- they already had a few machines working and one of them was a semiconductor machine and so on and so forth. But the analog guys were even in worse shape. I mean the semiconductors offered some obvious advantages in digital switching. In analog they're really backwards and I had had this year of circuit design and boy, I knew what I was doing! But the first problem that I was asked to solve and I say with great pride was a problem with a cross point switch, the IBM 2816 switch. Okay? It was a reed relay machine, okay, and we basically, you know, IBM had this big thick cables with big connections and stuff and this switch was supposed to go between the tape control unit and tape drives. It was a four by sixteen cross point switch. And they had a problem because they were saying that "when the switch closes there is an instantaneous spike of current of 2 amps." And the thing was only designed-- the reed relay was only spec'ed at 1 amp max. I went and looked at the problem analytically and I come back to my boss and said, "There's no problem here, there's only 10 milliamps max flowing through this thing." I mean this is the difference between 2 amps and 10 milliamps right? And he says, "You're crazy!" "No, no, I mean, you know, I went through the equations no, no

problem." "Prove it!" Well, I learned how to use a scope then. It was an interesting lesson in politics because, I mean, how could the senior group of engineers at IBM in product test had decided that the components are exceeding spec because some senior guy had figured out somehow or other- I can go through the issues- and said “2 amps”, and here a junior engineer two weeks out of school saying 10 milliamps! I mean, it was an insult!

Hendrie: Yes, yes, very much so.

Rodriguez: And, but I tell you, I learned so much in trying to prove something. Especially with a 5 megahertz scope. And the guys kept saying, "No, no, no there's got to be a spike in there that you can't see." I learned to use Polaroid film, for highest sensitivity of Polaroid film you got to use the negative. I mean so-- I mean I learned so much. It was such a waste of time. I could never figure it out until finally years later I saw the politics of the process. I had been given an assignment to fix a very serious problem. I could not complete the assignment in 24 hours! <laughs>

Hendrie: You were supposed to work three months on this.

Rodriguez: I was supposed to work three months on this, and I did. Yeah. Then they had me working on an IBM Hypertape product that was coming out at that moment. It was a ten track tape that had been a prototype, it was more than a prototype but it was basically that, that had been delivered to NSA a few years before as part of the-- it was called Tractor.

Hendrie: Oh part of Harvest?

Rodriguez: Harvest had Tractor as its tape technology. That was followed by a commercial Hypertape I. I was working on Hypertape II, which was a 1500 BPI machine, 10 track, 2 track error correction format, and I was working on a head amplifier for that. And then all of a sudden, I think it was Bucode. What is that outfit out in Long Island? Not Bucode, it was Potter Instruments.

Hendrie: They did tapes?

Rodriguez: They did tapes. We had 112½ inch per second, half-inch tape machine at 800 BPI and they came out with a 150-inch per second 800 BPI machine. So on that day, January 1, 1965, IBM had decided to respond two different ways; one, to come up with the D30R, the 2420, which would be a 200 inch per second single capstan machine. And the second one was to do the 1600 BPI on half-inch tape and we based that on the Hypertape format. But it was only nine tracks. And so I started working on the head amplifier for that and again as a circuit designer got involved with the whole read channel. And in the process we actually found to have a most difficult problem. I think we were the first ones to have what we called “downstream shift” and what the rest of the industry call “dynamic bit shift”. What do you call it? Intersymbol interference. I mean everybody has had that, but we were having this problem of phase shift, which was ruining the clocks. The clocks were just going out of synch on us and we had this problem that the machines 1600 BPI but by the time, well, I'm sorry. So that was in Poughkeepsie. IBM basically opened or told the world that they were moving tape to Boulder in the middle of 1965. By the end of the year they made me an offer to go out there and it was one of those interesting moments in life where basically the more senior engineers in the group didn't want to move. By senior I don’t mean by title but by experience. And I wanted to go. I had just been promoted from junior engineer after six months or so

to associate engineer. We came here for a site visit in February of 1966, beautiful day, loved Boulder, went up to Flagstaff Mountain, and boy it's just a great job. I had a raise to come here to $12,000 a year and bought a house.

Hendrie: Now, were you married yet?

Rodriguez: I had gotten married, yes. That's another story. That's another story because the Vietnam War was going on and I didn't know it was going on. When I went to graduate school I got a notice to report to the recruiting, to the recruiting board, right, the draft board in Flushing, New York. And I asked for and got a scholastic deferment. A year later I got a job with IBM and IBM says, “Look we can get you a year’s deferment for job deferment, but no more than that”. I said fine. A year later I got married in 1964 and a month later the Army came out and said, “No more job deferments” but you could get a deferment if you were married. And a few months later they said no more married deferments, you've go to have dependents. At that moment my wife was pregnant so that qualified me. And I was actually rereading those things last night, those letters from the draft board. Interesting, and I didn’t know, I mean apart from, was it Goldwater saying that he wanted to nuke Vietnam, I really wasn't aware of Vietnam. And somehow or other I never went to Vietnam -- without really trying.

Hendrie: Right, it just happened that you...

Rodriguez: It just happened, right.

Hendrie: Well, that's pretty good.

Rodriguez: I consider myself lucky in that sense. I grew up during the '50s. I went to, like I told you, I went to high school and I still remember, you know, I made up for the one year lost in high school math. I started a year late. I made it up in the summer after my junior year in high school. I went and doubled up in summer school to basically take a third year of Math. I still remember this old guy --I was what 15. This “old” guy who was a Korean War veteran that was going to school on the G.I. Bill trying to get his high school diploma. He was 25 and he asked me to tutor him. I couldn't believe that I was teaching this old guy! <laughs> I grew up in that generation after the Korean War where nobody went into to be Army. I mean there were enough volunteers, and actually my draft board in Flushing had enough volunteers that they never needed to call up anybody. It wasn't really until Vietnam that they started calling up people. And even then they said, "Oh it was easy to get a deferment out of them because they have plenty of volunteers." So that was my luck. So we came to Boulder. I was one of the more senior engineers. I mean three years out of school, right, and I was one of the more experienced engineers! And by this time we had this basically this block shift problem with the signals and we worked on what we called write pre-compensation. And before we could get out the D30R, we had to prove interchangeability between three different performance machines, the new machine, the 200 inch-per-second machine, which became the 2420 and the 2401 series, which were a 45, a 75 and 112½ inch per second machines at 1600 BPI. And also the 2415, a 30 inch per second low end tape drive. They had already come out just about the time we came to Boulder.

Hendrie: They'd solved the 1600 BPI problem?

Rodriguez: Yeah, yeah.

Hendrie: It had moved from 800 to 1600?

Rodriguez: Yeah, that was all pretty straight forward. We had all the technology. We made a mistake in the format, which we really didn't discover until later on and was never fixed. I mean that format went on for 40 years with some very basic error correction problems. But that's beside the point. Talk about things that work. That format as I mentioned to you earlier, you know, that format was still in existence and with new machines still being built in the year 2000 for it. I mean this is the issue of vaults and archival storage and so on, right. The first thing you need to have an archival process is not necessarily a media that lasts, it's the machines: the systems and the software to read them, right? And very few people understand that, okay. I was actually-- well I'll get to that in a minute. But what was I saying? So this is 1966, we had the interchange problem between the different tape drives. In late '66 I was put in charge of product testing this downward compatibility issue. And IBM wanted to make sure that the new machine would be able to read and write tapes that the other machines wrote and read. And it was a big, big problem. And fortunately for me they gave me the job; they assigned me to product test to run the test. When we originally talked about testing this we said, "If we tested every machine with every feature and combination of features one at a time, we would need 1200 machines."
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So I said "I can't do that." I mean it would take the more space than the whole Boulder lab and more current then the whole world would have available at that moment. So we finally settled on 55 machines. This is tape drives and control units that would be full feature machines. Okay. It took forever to get the things to work, to get the machines to work period.

Hendrie: Yes much less compatible.

Rodriguez: No, no just turn them on would be a problem. I mean just very basic problems. Interchangeability was the last thing that we got to test. When we finally got all the machines working we got the test done in less than a month. It took about nine months to get to the point where I could say, "I have machines that are working on their own. They write a tape and they can read it." I mean, I have 55 machines and, you know, we had to read-- I mean the control units had to have 200 BPI odd parity, even parity, it's 556 BPI, odd parity, even parity. I mean there were four or five or six different formats in each one of those different things. Eight hundred BPI, 1600 BPI and I mean all those features in one but you had to have machines that could read. But what a great experience I had because it was really-- it taught me! I was working third shift because that was the only shift we could have the computer. It was a 360 model 50 and you can imagine one evening, it had an LROS memory.
[Editor's note: Production IBM S/360 M50's used CROS (Capacitive Read Only Storage). An inductive ROS, TROS (for Transformer), was used in other IBM S/360 Models, such as the M40, see "A Brief History of Microprogramming," Mark Smotherman, March 1999.]

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END OF TAPE 1

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Rodriguez: Two reels, and one-inch tape. One-inch? I think it was one-inch tape. Yeah, one-inch tape. Very expensive. Very reliable. Extremely reliable. They had actually gone from-- in Tractor they had an NRZI, 800 BPI. They went to Hypertape-- actually, I don't even think it had NRZI. I think it had a complex form of NRZI. But I'll tell you about the Tractor machines. I'm sure it's not a secret anymore, right? I became manager of tape head development in late '68.

Hendrie: In Poughkeepsie or Boulder?

Rodriguez: In Boulder. In Boulder-- my first manager's job. We were asked to refurbish Tractor heads. Whereas tape heads at that moment the body was made of brass; these heads were made of steel, and they had slots in them. This is to collapse the air bearing around the head. And we couldn't figure out how to make the slots. I mean, we had lost that tribal knowledge, and we researched back to whoever had done the slot cut. The problem was that, yeah, we mill the slots, but they had so many burs in them, they slit the tape. So we had we had this tape slitter, that slit into ten different ribbons. Yeah, it turned it to-- yeah. We finally were able to get this little old German guy from Poughkeepsie, who came in and got some kind of a steel wire, and he immersed in diamond dust and proceeded to do it by hand. And they worked. But the story I heard is that when they built those machines, they built a whole set of spare heads for them. So what we were getting were the first set of heads that had worn out. They had just replaced them. This is like eight, nine years later. And they were in NSA at the moment. That's the only thing I knew about them, because we weren't supposed to know anything.
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But that was very interesting. Boy, what a system that must have been, the Harvest system. I guess it made IBM, right? Because I think it became the 7000 series, right? The 7090, and then the 360 SLT. So this is 1967, finally we get the compatibility test done.

And by the way, as an aside story, about three months later after we finished the test, we approved the whole change, we get a call from France. They had a tape facility in France; I'll think of the name in a minute. They called up saying, "The change doesn't work." French, they don't know how to build machines. About half an hour later, we get a call from the line:" It doesn't work!". Just very simply, they were starting to build the minimum feature machine, the no-feature machine, and it didn't work with no features. With no features, and it didn't work. Again, relatively complex problem: we had a lot of noise without all those other cards that were supposed to be in there, that were actually helping the noise level tremendously in the machine.

Hendrie: The cards were doing some sort of shielding or something.

Rodriguez: Well, they had enough decoupling capacitors in them to keep the power supplies from bouncing all over the place. Yeah, so we had to make a few more changes. It taught me another very, very, very, I think important lesson in life, at least in the computer life, is that these machines are building blocks of a system, and any change in the configuration can bring a problem. I mean, you can test a single configuration to be absolutely perfect, and then the next configuration will have a problem. I think that's when we started to do the early ship programs, where we actually send it out to maybe 50 installations and see whether it works or not. And typically something didn't work, but at least you didn't send it out to 2000 installations where it didn't work. I became very philosophical and said, "Hey, you know, our job in development and manufacturing is to find as many of these problems as possible. Finding a problem is a great victory in the process." Because I think a defeat is when you find it in the field. Whereas many people said, "Boy, this machine is perfect." And you'd say, "No, you can't assume the machine is perfect. At no time can you ever assume the machine is perfect." You have to assume that there's going to be a problem and you have to be able to react to it, and act on it, right? And as time goes by, as you get into more different environments-- by environments, I mean configurations-- you will find your last problem. It always happens so many times, after that point, where you have machines installed forever at one account, and then one day the big problem shows up and you finally find it and you say, "Who made this stupid change?" You know? "We've had these machines for three years. Obviously they were working. Now they're not working. Somebody must have done something wrong."

Then you figure out that nothing has changed; it's just that they added another computer on the other side of the room, someone just changed the configuration, and that's the thing that was causing this problem to manifest itself. And you say, "Oh god." But people are always surprised by this, but at the same time, I think it's the nature of the business, that systems are so complex...

Hendrie: That there's always another configuration that has something peculiar.

Rodriguez: Yeah. There's always another configuration that hasn't been taken into account. If you can close your environment, if you can limit the complexity of your environment, you should be in pretty good shape.
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But even something like the iPhone, of course-- the thing hangs up on me.

Hendrie: You understand complexity, so you weren't surprised.

Rodriguez: No. Turn it off, turn it on again, okay. If that doesn't work, then I've got to call Apple. And they know about the problem already. It's a relatively well-bounded system.

Hendrie: Were there any particular things that you had problems with that you had to solve when you went through all this compatibility testing, especially with the 200-inch-per-second, high-performance tapes?

Rodriguez: Any particular problems?

Hendrie: That came up.

Rodriguez: No. I mean, actually, the reason for the test went through very nicely. It was everything else. I was sad to say, from out-of-true casters to doors that didn't latch properly, to... everything else that could go wrong. And then of course in the process also machines break, and you got to fix them. No, it was an invaluable experience for me. I learned to use the operating system. I was telling you about this LROS 50 It was the most noise-sensitive machine there ever was. One night-- again, this is the middle of dawn, in the morning. I mean, three o'clock in the morning, right? And there's probably two or three tests going on in this big computer room. So there are probably three or four people in there, and everyone is looking at some problem with the machines. And of course you're sitting on the stool on the floor, and the machines are at least 60 inches high. The machines were 30 by 30, by 60; 30 by 30 could go through any door. So you were sitting down and you're scoping and you're immersed in your problem. And all of the sudden, the room gets quiet. But you're just thinking of yourself. "Something is not working." Check the scope, everything's-- the room is very, very quiet. So a couple of minutes of trying to figure out what's wrong, and you get up, start looking around, right? And all of the sudden another head pops up, a third head pops up, fourth head pops up. We're looking around. Everyone's saying, "What's going on here? The room is quiet." And then we hear this vacuum cleaner. One of the cleaning people had come into the room with a vacuum cleaner and was cleaning the carpet on the raised floor. We all look at this guy, and we know the noise sensitivity of this system. The vacuum cleaner killed the computer. And we all figured out what had happened right at that moment. I mean, the moment we heard the vacuum cleaner, we all look at the guy. We say, "What have you done to us?" And this guy looks at me, looks at the other guy, looks at the third guy. Then all of the sudden he turns around and he runs out of the room. The next

day we get a complaint that we've harassed this guy. We didn't say a word to him! He had killed our night. I mean, you have to restart the system, restart the tests. I mean, we told the world that there was no way anybody else was going to come into that room while we were there, anyway. It was LROS-- inductive-- I still don't know what it stands for. I don't even know how it works. Kind of inductive permanent memory. It wasn't core, but it was some kind of inductive...

Gardner: Read only storage?

Rodriguez: Read only storage. Yeah, yeah. I mean, it was just fantastic.

The next year, apart from being a manager, 1968, was great for my résumé.

Hendrie: You weren't a manager when you were doing this testing?

Rodriguez: No. No, no.

Hendrie: You were just working on the problems. You were just one of the team.

[0:55:00]
Rodriguez: I think I became a staff engineer during that year, and then became a project engineer, which is the title for manager. It was a great year, because in 1968, basically, the level of problems in 360 just went below water level. And everybody who had been so busy fixing problems, all of the sudden the problems became manageable, and I had no project assigned to me in 1968, apart from managing this group, which was really-- I wasn't really very busy with that. That was the year people started to leave IBM, in '68. ISS, I think-- the dirty dozen, right? That was the year they left. And one guy in particular in Boulder left, Carl Carman. He went out to Boston. Another guy from IBM had started a group. I forget what it was called, but it was key to tape -- basically starting to bypass the punch cards.

Hendrie: That's the group that Carl left for?

Rodriguez: Yeah, that's what he went for. At the end of the year, he asked me to come and join them. By the way, I was also working on tape standards during this whole time. So in January of '69, I went to Boston. I liked what they were doing; I accepted the job offer, came back, and IBM turned me around.

Hendrie: They did.

Rodriguez: Yeah. But the interesting thing about it, and it's really a great, great history-- the culture of the moment. A picture of the culture of the moment, at IBM especially. When Carl left, there was some commotion, but not a lot.

Hendrie: Was Carl a manager?

Rodriguez: Manager working for Jesse in the 2420 program. He was electrical manager of the 2420 program. You know Carl?

Hendrie: Yes, I knew of him at Data General.

Rodriguez: Anyway, I came back to Boulder, and they turned me around. All of the sudden, the psychology of the group was something else. By the way, I had had, previously to that I had already been scheduled for a week of management class in Tarrytown, New York, and then I had to go out to a standards meeting down in Florida, straight from that. Which, by the way, I was supposed to fly on a Sunday. At that time they were hijacking planes to Cuba, and I didn't want to go to Cuba. So I took a train down to West Palm Beach, where the meeting was, and that afternoon two planes were hijacked to Havana. I don't know if I would have been in one of them, but maybe. So I basically attended that standards meeting, and then my next trip was to Europe for standards with IBM, where we met with all the IBM standards country managers. We were trying to make 1600 BPI a standard at ISO level. So we had a meeting with all the country managers, standards managers, in France, and then we went to an ISO meeting in Paris, and then flew back. So basically I had come back from Boston, they had turned me around, and I had left right away on what was basically a six-week jaunt. Took some vacation. So, I came back. And on the trip back, on the plane coming back, I said, "Boy, I just probably missed the opportunity of a lifetime. I guess I'll work for IBM the rest of my life." That's what was going through my mind. This is a Saturday night I'm flying back. Sunday night, my third-level manager comes to me and says, "Juan, we got to do something."

Hendrie: Who was your third-level manager?

Rodriguez: John Taio. And he was the first of many people that came to me.
[1:00:00]
I had had this experience of actually looking out at the world. I wasn't a virgin anymore. I knew what it was all about, and people were so anxious to talk to me about going out and doing something. But it was interesting. It was so interesting. We lived in such a sheltered world where everybody thought they had a job for life, and never thought about leaving. But it was the attraction of the unknown, the grass is greener kind of a thing. Just so many people came to talk to me, but of course, my only experience had been to fly and talk to somebody else about it. I actually hadn't talked to somebody else; I had talked to Carl, who I'd known for a long time. And the guy who finally took my job was Joe Leonardi. Did you ever know Joe Leonardi?

Hendrie: The name sounds familiar, but I'm not sure.

Rodriguez: He was another guy. Something tape.

Hendrie: Key to tape?

Rodriguez: Yeah, it was key to tape.

Hendrie: We aren't talking about Cogar. We're talking about a different system, right?

Rodriguez: In Boston, in Massachusetts.

Hendrie: It was in Boston, yeah. Cogar was in New York.

Rodriguez: I don't think it was Cogar.

Hendrie: I just can't remember the name.

Rodriguez: Yeah. And I think it was after that failed that he went to Data General.

Hendrie: So maybe you can continue with the story. So you got back on Sunday night, and you got a call from your third-level manager, and he wanted to do something.

Rodriguez: He wanted to do something. I'm not sure he knew what he wanted to do except something else. He eventually left. And Jesse started to talk to people. I mean, I couldn't have done it without him. He was the senior engineer. He had all the credentials to get out of...

Hendrie: Now what was he doing at this time? What was his position?

Rodriguez: He had been the program manager for the 2420 program.

Hendrie: So he was the program manager of that. And Carl had done the electrical stuff.

Rodriguez: Yeah. And Zol Herger had done the mechanical side.

Hendrie: And you weren't in that program. Were you in that chain?

Rodriguez: I was in the technology group. Basically we supplied all the technology to the 2420 program.

Hendrie: But it was a separate group.

Rodriguez: Yeah, it was under Bill Phillips at the time. We did all this technology, but they did the machine work, we did the technology work. We did servos. We did the read/write; we did the detection systems for the control units. In a sense, a service group, but you're so intimately involved because you don't get to do reading and writing until everything else works. You're always the bottleneck at the end, because you didn't get your time to...

Hendrie: You didn't get even to test your stuff really until...

Rodriguez: No, no. And everybody's saying, "How come?" "Well, it's not working." "Okay." But then it's interesting, because ask yourself a question, right? In both disk and tape, who eventually become the bosses, the top engineers, the top head of companies and stuff? Mechanical engineers, a Servo engineer-- I'm one of the few read/write engineers that ever became super boss.

Hendrie: Can you name someone who wasn't?

Rodriguez: Think about it. Tape or disk.

Hendrie: Wasn't an engineer, you're saying.

Rodriguez: Who wasn't, no. There were never logic or systems engineers. Maybe actually John Squires. He was a microcode guy.

Gardner: But he never ran a company.

Rodriguez: He never ran a company, yeah. Terry Johnson was a Servo engineer.

Hendrie: Jesse's background was?

Rodriguez: Mechanical engineer.

Gardner: Finis Conner, not an engineer at all.

Rodriguez: Yeah, I know, I know. But he took over-- yeah. That was certainly a change in culture. But obviously he took over this group up here, which had been founded by Terry and John.
[1:05:00]
Mechanical guys, Servo guys maybe, and-- what's his name at Seagate?

Gardner: Al Shugart?

Rodriguez: He was a field engineer, right?

Gardner: His degree was in Engineering Physics but he joined IBM as a field engineer.

Rodriguez: Yeah. It was interesting. Well, and the reason I mention it is, as a read/write guy, every problem gets first defined as a read error, or a write error, right? There are very few problems after the system starts to work, and it's the way data is handled, and in the end, it appears as some kind of an error on the console that says, "I couldn't read the record," "I couldn't write the record." So the first guy they blame is the read/write. So you get in there, and what you do is you become the ringmaster, right? But it's either that, or it's a Servo problem. So you become a ringmaster to start saying to people, "Well, I think we should be looking here, here, and here." So you start looking at the world from the center of the universe-- everything that can go wrong. You start getting an idea about the system quite a bit as a read/write guy. The mechanical guys, in the end-- and the servo guys are kind of in the same ballpark-- it's a very unfair world. But it's typically the guys who are responsible for the problems who get to solve them, and when they get to solve them, they're the heroes, and the heroes get promoted!

Hendrie: That's pretty good.

Rodriguez: I told people if they wanted a career, please work on a mainstream product, a mainstream purpose of the business. Because people will come to depend on you to solve the latest crisis when you're mainstream. If you're in a support group, they can only complain about you. There's not enough software, there's not enough IT, there's not enough this, there's not enough paper, it's not on time, the

cleaners are not here, the parking lot is not clean. They can only complain. You can never be a hero. First of all, you're probably never given the means to be a hero, but second of all, what is an IT guy supposed to do except make sure the computer is working all the time? And he's never a hero when he makes it work again. Everybody says, "Finally!" Right? So I think most of us were-- the ones of us that were at the convergence of where problems were focused on eventually became leaders. It was obviously a selection process of sorts, but we became heroes very quickly, because we were in the middle of creating a lot of the problems that we solved.

Hendrie: Can we talk about the back and forth that went on that led up to the founding of Jesse actually leaving and you deciding to go with him, and all of that? How did that all happen?

Rodriguez: Obviously Jesse was the one who organized the company, and we were very much aware that he was seeking funding in the West Coast and the East Coast. In Los Angeles—Ben Wang Who started a couple of the tape companies down in Los Angeles. Anyway, he had worked for IBM. He had access to some money, said he might fund us. But the real connection came through Carl Carman. Carl and Jesse were pretty close. Carl had gone out to Boston
[1:10:00]
to a company, again, that was funded by J.H. Whitney and Dave Dunn. Basically Carl introduced Jesse to Dave Dunn, and to Reid Dennis-- I'm not too sure when Reid Dennis got in. I think J.H. Whitney was the first.

Hendrie: Were the first people.

Rodriguez: The first people at Storage Technology, right.

Hendrie: And Reid must have been still at American Express, probably Fireman's Fund?

Rodriguez: Oh, yes. Yeah, because we got a lot of business from American Express afterwards. Yeah, he must have been funding that. That was 1969, right?

Hendrie: Yes, right. I don't think he started his own venture capital firm till '73 or '74.

Rodriguez: So I was 28 years old.

Hendrie: Really? Okay. Now, is Jesse a lot older.

Rodriguez: Ten years older. Yeah, I'm February 10 and he's February 19. So yeah, he's ten years older. I mean, he was a senior engineer-- well, like I said, I just finished-- I think to the day I had just finished six years of work for IBM when we left. We went to resign-- so you got the funding...

Hendrie: So he had the product idea to go and compete directly, just make a better...

Rodriguez: Plug compatible.

Hendrie: Plug compatible, but better tape drive than IBM was, and lower price.

Rodriguez: Lower price, right. I think 15 percent lower was the objective.

Hendrie: That was the pitch.

Rodriguez: Yeah. And I'll come back to that later, because it was how I decided to do a product. And we had the four engineers. Tom Kavanagh, he had taken over Carl's position.

Hendrie: So he was in charge of electrical.

Rodriguez: Electrical in the 2420 project.

Hendrie: So he was working directly for Jesse.

Rodriguez: For Jesse, yeah. So basically it was Jesse, Tom, Zol Herger...

Hendrie: Now, who was Zol Herger?

Rodriguez: He was a mechanical manager under Jesse on the 2420.

Hendrie: So Jesse was-- he was talking about taking his two senior people, and you, off in the technology group.

Rodriguez: Right, right.

Hendrie: Had he talked to you about doing this? Had the four of you met and talking about this while he's trying to raise money? You haven't resigned yet, of course.

Rodriguez: No, I hadn't resigned. Not the second time, anyway. Yeah, and he had also recruited I think three or four more guys-- a CFO type, a salesman type, and I don't know what else. A manufacturing type. And maybe somebody else. I think there were four guys who at the end got cold feet and didn't join us.

Hendrie: So he had a team.

Rodriguez: He had a team, a whole team. Not a dozen, but I think it was eight. We weren't a dirty dozen anymore. We were probably going to be eight. But the last four guys just got cold feet.

Hendrie: Were they IBM guys also?

Rodriguez: All IBM. I remember talking to one of these guys many years later and they were commiserating on how they should have joined the group and so on and so forth. And I said, "Yeah." But you know, in the back of my mind, I said, "You know, if this guy had joined us, maybe we'd failed."

Hendrie: Maybe he wasn't as good as you could have got.

Rodriguez: Because you talk about Jim McGuire-- he was the VP of sales. He was a fantastic salesman. He is a fantastic salesman. And we wouldn't have gotten him.--
[1:15:00]
he had been working for Telex when they were making tape drives then. So he had a lot of this small company experience. He had a network of people, so on and so forth. Ray Livingston, who just died just a couple of weeks ago, he was our treasurer. We eventually got-- what was his name? The guy from manufacturing from Control Data. So instead of having this homogenous mass from IBM, within two years we had three distinct cultures come together, right? One was Control Data, and that was manufacturing, basically; Telex, and that was basically sales and marketing; and IBM, which was basically development engineering. If we had been one mass, I don't know. It wouldn't have been-- well, it wouldn't have been the company it was, it became. So you never know. I mean, when somebody said that, I said, "Yeah, yeah." But I kept thinking, "This guy..." I mean, this guy was talking to me. I said, "Well, I don't know." Boy, the guy was so political that I thought maybe he would have destroyed the company before it got started. So we quit on August 1st.

Hendrie: Did you have a commitment of money before you quit?

Rodriguez: Yeah, yeah. We had the commitment of money, or we were close to a commitment on money. I forget if we had a commitment of money yet. We had not incorporated yet. There were four of us, and as you can see, I was in a different management chain than they were. Actually, Jesse was the head of the two other guys, and he was reporting to a guy who reported to the lab manager. So we said, "Okay, we'll quit tomorrow morning." Well, tomorrow morning-- Friday morning-- August 1st it turns out to be. There was a meeting of managers in the cafeteria. So I'm sitting in my office, don't have anybody to quit to. I haven't gone to the managers meetings, of course. I wanted to quit to somebody. So finally about 8:30, I called Jesse. "Hey Jesse, I don't have anybody to quit to." He says, "We don't have anybody to quit to either. I think I'll send my secretary," and bring his boss out of the meeting. So I said, "Well, who do I quit to?" He said, "Well, come over here. You can resign to him too." I said, "Okay, fine." Oh, about an hour, two hours later, we were talking to the lab manager, Wayne Winger, whose parting words were, "Jesse, you're taking my job!"

Hendrie: What's that mean?

Rodriguez: I don't know. A lot of bitterness in that. Funny thing is Jesse had this station wagon. Somehow or other he had driven the thing over a boulder and had smashed the gas tank, so it only held about two or three gallons, we were always stopping in a gas station to get gas in that car. I think we incorporated after that, so I kind of assume that basically we got the money after we quit. I wasn't paying a lot of attention to all the...

Hendrie: That wasn't your job.

Rodriguez: No, that wasn't my job. We got the money, and within four weeks, we had taken another 10 people out of IBM. . We had an office above the Aristocrat, which was a hamburger joint on the corner of Broadway, a block north of Pearl. It's a great spot. And six weeks after I quit IBM, I get appendicitis. Never gotten sick a day in IBM, and six weeks later, I had-- we had a health plan. I still have, somewhere-- I haven't found it-- I still have the get well card from everybody in the company that day.

[1:20:16]
END OF TAPE 2

[1:20:26]
Rodriguez: We got a job from the Social Security Administration to basically make some very fast 200 BPI drives. Two hundred BPI was really the first format, there was a 100 BPI format that was very short lived and then there was 200 BPI and I think one of them was five megabytes, you know, on the reel tape it was amazing how many of the original machines were five megabytes long. The first drum, the first tape, the first 5 ¼ disk…

And we had the fastest machine in the world then in terms of linear tapes, linear velocity it's 250 inch per second machine at this time. So basically what the Social Security wanted was to be able to read the 200 bpi tape as fast as you could. This-- they had them in archive and at that moment they were 15 to 20 years old. Okay. And some of the original tape was on a cellulite base and the oxide didn't stick to it very good so every once in a while you had missing oxide on them. But that was you know that was accepted. The real problem was we couldn't read them. <laughs> It was, you know, the technology the media technology had developed so much, right?, that the signal quality had improved so much that we basically had-- I mean it wasn't a big change, change the cap to make them work. But it was-- you know, they weren't working. But it was amazing, it was 1972 so it was those tapes were probably from mid '54, '55 and they had been in vaults and Social Security wanted to read old tapes, I mean, they had them in the vaults. So they had to read them and so that was then.

Today I'm pretty sure you could read a 1600 BPI from back then. Sixteen-hundred BPI really became the first industry interchange standard of any worth. The original NRZI standards never got to work on interchange because you needed to make a perfect mechanical alignment between machines and the different manufacturers had built different incompatible mechanical configurations. And basically again, you know, with 1600 BPI you could have interchange between different brand machines. UNIVAC, Control Data, whoever made the tape machine and IBM. In 1600 BPI by putting clock on every data bit alignment wasn't a problem. And 6250 BPI later on electronically became much more complex, so in fact 1600 BPI became kind of the model for the cheap, for the inexpensive tape drive of the century-- that were built into, I think, in the year 2000.. But it was the easiest format to maintain to really get compatibility. First of all it offered again-- well, you're guaranteeing interchangeability in spite of mechanical differences and it was relatively simple, a relatively simple format.

Hendrie: Can we roll back to the very early days of STC where you talked about where you were. Could you talk a little bit about how the detailed decisions were made about what you were going to build as the first product?

Rodriguez: The first product that we were going to build was going to be a 2420 compatible tape drive. Plug compatible, which means you disconnected the IBM drive and you plugged-in the cable to this drive. And you connected it their control unit, to the IBM control unit. So you had to mimic the IBM drive

totally. As it turns out that wasn't the first drive that we actually delivered because our first customers wanted something else.
[1:25:00]
And what they wanted was a NRZI-compatible tape drive. And we did. Gates Rubber in Denver was the one who first took our drives and then we went to EDS in Dallas. I know I went to work at those places to make machines work. There were a couple of problems. First of all we decided to stay in Boulder because you know I think primarily because we lived there, okay. But second when we looked at the map we said we are two hours from San Francisco, two hours from L.A., two hours from Chicago, two hours from Dallas. You know, we're kind of in the middle of everywhere and in the middle of nowhere and equal distance to everywhere. And you can make New York and even make business the same day if you had to, you couldn't do that from the West Coast. Anyway, we're here. Minneapolis, you know, was also a little closer, you know, they had a lot of machining going on up there and castings. Castings in Minneapolis, I think Machining in L.A., circuits in San Francisco and customers everywhere. So, you know, we stayed here. There was absolutely no entrepreneurial infrastructure here at all, you know, I could say we got our money from New York and we got our lawyers from Boston, Hale and Dorr.

Hendrie: Okay.

Rodriguez: We got our patent lawyers from Philadelphia. And as I was saying I think electronics from the Bay Area, machine shops I think from L.A. and castings from Minneapolis. So, you know, and it served us well many ways. But again we couldn't-- yes, I mean we didn't want to move.

Hendrie: Now besides compatibility what were design objectives?

Rodriguez: Just be compatible I mean you couldn't connect an IBM control unit without being extremely compatible. Our first was a 200 inch per second machine. I mean we knew exactly what we needed to do.

Hendrie: How were you going to meet the cost objective?

Rodriguez: I don't think we had a problem. You know, I mean originally-- I think that the machines had like a 75 percent margin on them.

Hendrie: Oh so you could sell them at 65.

Rodriguez: Oh yeah.

Hendrie: Yeah and you'd still do fine.

Rodriguez: Oh you'd do very fine, you know. They leased for $1000 a month. Cost to manufacture those things was in the $10,000 or $12,000 range, okay. And so you got your money back in less than a year from leasing. If they want to, you know, and they want to lease for three and five years, you know, I mean they were money makers, okay. Our first real problem with that came I think it was in 1971 when IBM announced the 3400 series tapes. What they basically had done, simply speaking, technically was change the interface from being an analog interface for the read channel to having an all digital interface between the drive and the control unit. But from a business standpoint, what they did was cut the price in

half. The lease went to $500 a month. So at that moment we had price pressures, okay. And it was their reaction to us. You know, again, you know, in 1969 if you were to look at our business plan and I don't think I have one. Right. You would have looked at the competition and looked at Potter Instruments, Telex, Memorex, who else was in the tape business. Right? Oh well, you had all the main frame companies right?
[Editors note: Memorex did not enter the tape subsystems business until well after 1971.]

Hendrie: Right.

Rodriguez: They're all building UNIVAC, Bull, well I think they were called something else (CII?), Siemens. I mean everybody was building their own tape drive. Right? And five years later we basically were the only ones left, outside of IBM. But in 1971 they came out with this interface and it was really-- it was really a turning point in a sense in the industry because I still remember the conversations we had, the fights that we had. And I still remember Jim McGuire in spite of being the greatest sales man in the world had very little regard for the engineering, at least at that moment. When we told him, "Well you know IBM announced a product a year before delivery. We really don't know what that interface looks like. We've got to examine it and it's probably going to take us at least 18 months to get the thing-- to make it look like them, you know, we have to be compatible to their control unit. God, we don't know what the control unit looks like." You know, when you attach an IBM channel at least you have, you know, you have the full set of spec's to what to do. Right? Attach an IBM control unit then what? That's the world's best kept secret until it comes out and even then you've got to figure out what it's doing. They don't tell you what it's doing. The manuals don't really give you the engineering detail that you need to design the thing. So we say, "It's probably going to be two years." And Jim says, "We've got to have a machine within a year. Otherwise we lose the game." The basic thing that this machine offered that was very difficult to do, at least conceptually, was that it offered a switch in the control unit. So basically we had a radial connection to the drives which before that had been done with this 2816 switch that I mentioned to you before. that's why it had reed relays because it was switching analog lines. But this new machine, the control unit, had this switch in it and it was all digital. And boy, how are we going to attach these things if we don't know what it is doing? So I suggested that I could build an analog switch inside the control unit using FET switches and we went on with that and were able to respond to them. But instead of being plug compatible at the control unit, which is what everybody talked about being plug compatible, we were plug compatible at the channel. We had, I mean, Jesse had the foresight early on, in late 1969, to have a control unit group come in and design a control unit. We were just about ready to ship the control unit when this whole thing happened. We did actually ship that unit. So we had a control unit in house and all we needed to do was basically add this switch to it to make our drives work with it and we were able to respond within months, not even a year. I mean, you know, it really it was just a question of a little better microcode-- well, hardware and so on. And remember you had a year, right, before their hardware came out, right. You still needed to have their hardware to test compatibility, but the response time, by the time their hardware came in you were basically all in hardware -- your hardware was already designed. We followed the same tactics a couple of times later which made us very successful. I guess the tactic was to respond within a year of their delivery. IBM at the time would announce a year before delivery. And because of the injunctions they had against them by the Justice Department they actually treated us favorably in the sense of first customers. Okay? So they gave us a time advantage in that sense. And we said that if we respond within a year we take over the business and that's really what happened. Why by 1975 had all the OEM's become Storage Tech customers? Because we were the only ones who had a 6250 BPI system in place. We had anticipated a lot of what IBM was going to do and we responded with the system within less than a year of them coming out. I was the program manager for that product, the 6250. I had taken it over when it was just starting to fall apart and basically we were supposed to install at American Express? No, Fireman's Fund.

Hendrie: Ah yes that's where Reed was.

Rodriguez: Yeah, not American Express, Fireman's Fund, right? We were suppose to go against a-- on a test against an IBM system that had been installed six months before. And boy, we had so many problems. They were doing their correction much better than we were doing. We were having the head gaps crumbling on us. We were using Applied Magnetics as our head vendor. And we, you know, the design of the technology was to deposit glass gaps. And, boy, it took us a while to find that problem but basically the glass in the gaps were crumbling and, you know, you can imagine glass, little fine pieces of glass embedding themselves on the tape. And when you start to do shoe shine it was like you were building your own lapping tape. Okay. So I mean the thing went into a degenerative process that just killed you. And it was either that or if you can put the new tapes in there you didn't have that problem but they-- since the gap had crumpled, the metal surrounding the gap lacked the support of the glass and it just kind of smeared and we had no gap left. So this is the situation. On June 1st we had gaps that were crumbling, and we had an error correction system that was nowhere near as good as what IBM had done. And we had built, I think, a 2 by 16 system to ship to Fireman's Fund and basically the two keys to making the thing work weren't working.

Hendrie: Okay it wasn't out to the customer yet, but you're in test and it just is not working.

Rodriguez: In test, yeah**.** I had just become the product manager a couple of months before because of all-- I guess all the issues. Talk about hero's right? And my wife wanted to go to Spain where her parents were, had three children at that moment, one was two and the other was four and the other was ten or nine. And so I was supposed to go out for three weeks. So I compromised I took her out for a week came back for a week went back out to pick them out and came back. But what I had asked the guys to do is this -- I said, "Okay, this is what needs to be done this is what needs to be done in the control unit, so have it all done by the time I get back." By this time AMC had found the solution to the problem with the gaps and basically they had gone to their subsidiary in Korea where they had these Korean women and, I mean can you imagine Korea then and now, Korea women splitting the stone that slivers, what do you call it, shale, no...

Hendrie: Mica?

Rodriguez: Mica into one micron shims. They were cutting natural mica to one micron shims, which is the width of the gap and this-- they needed to break a sheet about this big [gestures: 6-inches by 6-inches]. So they could put it as basically as the spacer between these two pieces of metal and needed two of those, right? We had identified the problem late May. They had come up with a solution and they had basically delivered to us heads by the time I got back from Spain. We had the control that we just rewired to do the error correction and they worked. <laughs> Basically a month later we delivered those machines to Fireman's Fund and we outperformed the IBM tape product.

Hendrie: Oh wow.

Rodriguez: And you know, and then actually very interesting, right, I mean in one sense I don't know if they thought it all out before hand, but they had a great strategy. At this moment everybody that was manufacturing tape drive was trying to do the same thing we were doing.
[1:40:00]
But they weren't on the same schedule we were, right. In September of that year IBM announced a mass

storage system, the 3850, and it was marketed as a tape replacement device. So what they were saying to the world was, "The half-inch tape is dead, come see our replacement." Right? We had no choice. We made tape drives and we had a tape drive working. Everybody else and I mean everybody, everybody else that had a tape drive in development said: why should we keep working on 6250? You know, it's not done. We had done ours and we had already won some accounts. And everybody else stopped working on tape drives. Well in a sense, that's what really made Storage Tech. We, over the next year, remember they announced it a year before delivery, right? Over the next year we went around and around on this issue. Can we afford, you know, do we have to do this? Yes we have to do this. Can we afford to do it? The rumor was that IBM had spent half a billion dollars developing this system.

Hendrie: This disk?

Rodriguez: No, this is tape.

Hendrie: No, the tape? Yeah.

Rodriguez: This is a honeycomb library, okay.

Hendrie: Oh, all right.

Rodriguez: I mean cartridges that held three inch tape they were about three inches in diameter and about maybe, well not three inches, well yeah three inches in diameter maybe three or four inches long cylinder. And they were loaded into drives and they had-- they were emulating a-- what's a disk then? The?

Hendrie: 3330.

Rodriguez: No, the 3330 mod 1. They were emulating a 3330 mod 1 on this thing so they had 100 megabytes in each cartridge and so a cartridge was a disk, right? And it was well-- it turned out to be the beginning of tape libraries in a sense, but it was a system that didn't work very well. I mean it had performance problems because basically you had a control unit that was a bottle neck because in order to read or write something you had to go through the controller, I don't know, basically each byte had to go three times through the control unit to make it work. Did you ever work in one of those?
[Editors note: The IBM 3850 cartridge's capacity was 50 Mbytes so two cartridges represented one 3330 Model 1 disk drive.]

Hendrie: No I did not.

Rodriguez: Control Data tried to do one of those similar ones. We couldn't afford it. But actually during that year I was in all these discussions, right. By the way by this time I had become the V.P. of Disk Engineering. And I was in a discussion when finally one day I heard a customer say, "By the way how do you back this up, q 3850"?. I said, "What do you mean back it up?" You know I mean it's a tape. He said, "No. No. No. No. I got to back this thing up."

At that moment it became clear that back up was still half-inch tape. So I said, "Oh. I guess we don't need to do it." <laughs> And we didn't do it. Now you've got to remember, -- maybe you don't remember, but in '76 we were forecasting that by 1978 we would have more machines returned to us than we would ship.

Hendrie: Oh my goodness.

Rodriguez: That was the forecast for tape.

Hendrie: Really at Storage Tech.

Rodriguez: The internal forecast, right. And then two things happened. First, the 3850, I mean, IBM believed so much that this was going to replace tape that they stopped manufacturing here in Boulder and moved the tape mission to Tucson to do whatever, okay, and they're going got build all tape in Montpellier in France. So by doing that they cut their tape production capacity by, I think, two-thirds. And I mean-- and then the other thing that happened is that the 3350 came out.
[1:45:00]
And of course we didn't know it then, right. But the 3350 was a fixed disk machine. And what nobody ever counted on was the fact that if you had a little single transistor failing in that machine you would not have access to the data. So that every failure became a disaster in that because now you had a disk drive and had SYSRES on that machine you took down the system. And all you needed was a little one transistor in that machine to fail, right? And at a failure rate at that point was about .0.2 failures per month per machine you know. Probability of a machine failure was pretty high. Two out of every ten disk drives in an installation would fail every month.

Hendrie: That was unscheduled interruption.

Rodriguez: Right. And so all of a sudden back up, you know, tape went from being secondary storage, right, to back up because everyone of these disk drives had to be backed up. Okay? And the only other way to back up a disk drive was to put it in another disk drive, and most systems had several disk drives with replica because you know you could...

Hendrie: They had mirror drives?

Rodriguez: Yeah. But backup became the main thing. So two things happened the basic demand for tape went up. IBM's production capability got cut by two-thirds and the rest of the world stopped producing tape drives, right. So this is the image of the world in 1977. There was basically Storage Tech here and IBM in Montpelier, France making the only tape drives in the world. You know at that moment they truly depended on us to ship systems.

Hendrie: That's a pretty fortunate set of circumstances of various sort of global factors coming together..

Rodriguez: Yes but the most important thing at that moment, in a sense, was the fact that we had actually a working machine in the field that had beaten out the IBM competition and it was proven that it did work, okay, before IBM made that announcement and it happened-- that happened-- we happened to have shipped that system nine or ten months after IBM delivered their system. They delivered their first

system on November 1, 1973. And the reason I know that date is because they would not release the format information to the Tape Standards Committee until they delivered the first tape drive. And we at the Tape Standard Committee decided to meet on that day to receive the format from IBM and we did. So they delivered the machines on November first and we delivered machine to a customer in July and now the reason that becomes so very significant is because the next step is basically our introduction into disk. When IBM announced the 3350 we had been building a 3330 model I and a model II. We had SuperDisk in place and we weren't doing well much -- in any list of the disk suppliers we were last on that list.

Hendrie: Why was that?

Rodriguez: We were the last ones to come in or we had to actually start to resell ISS drives and we just didn't have the market share. I don't know if we knew how to sell them. And our SuperDisk that were supposed to be the real sexy alluring disk, you know, because they had 800 megabytes of storage in it wasn't a very reliable machine.

Hendrie: Okay. So just lots of problems.

Rodriguez: We couldn't make-- it was very hard to make them work and it was very hard to keep them in the field. People loved them, the early adopters they wanted that machine so bad and we couldn't deliver enough of them. I mean and again I was the head of this. So the IBM announces the 3350 probably in April. Probably April 1st, 1976. And so we have a year, right, before they deliver our product and Jesse says, "I want our equivalent to be done within a year of their delivery." You know, again, it had become the basis for our success. First when IBM announced its 3400 and the different interface and we said that we'd be there and we were there and basically that kind of killed half of our competition and then the other half got killed when we had delivered 6250 when nobody else had. So and I guess following that same philosophy that we had to deliver in a year. I had a new development manager. I told you I was Vice President of Disk Engineering. And I had a development manager who, when he was told this he said, "We can't do this: the industry does it in 18 months". So I said, "Well, you know, work it out." So the first time he presents, you know. presents it to Jesse, he says "18 months, okay". Jesse says, "Go back to the drawing board give me a schedule for a year." So again he comes back a second time, you probably know who this guy is Mike Riegel, he worked for CDC. He was a good guy. He was a very good guy. He was a great manager. So here we are in October and he's saying again after the April delivery a year and a half. I mean long meeting, long meeting, long meeting, year-and-a-half. In December Jesse's getting mad and he's saying a year. So I said, "Mike go and tell the man a year. I mean you can have anything you want, just do it in a year." This is a year after delivery right. So he comes back, one last presentation in December and he said, "A year-and-a-half." And I said, "Oh, Jesus." So I go to Jess and by this time I'd figured out how to do it in a year.

Hendrie: Okay you'd figured it out.

Rodriguez: I was his boss. I was following every bit of it -- I said, "Jesse I think I can do it in a year. There's only one thing that I ask." He said, "What's that?" I said, "Drop every other development program we have. I want every disk engineer on this project." He said, "Okay". So on January 1st we killed every other project, we told people don't even put it to rest you're not coming back to it, okay? You know, normally people spend months putting things away, right. We're working on this new product and we don't know what it looks like. We don't have one and won't have one until April 1st. I said, "Well you

know I think we can guess. Control units yeah, they already told us quite a bit of what their control unit needs to do as far as the challenge concern and so on and so forth. And you know they did release those facts and as far as the drive is concerned, what are they going to do? I mean, they're going to-- they're probably a 3340 development group, and they are going to pump it up to a fixed disk machine. How would we do it, right, if we had a 3340 to start from?" And we basically started from that and by the time we got their machine on April 1st we basically had done all the mechanical design of the machine. We hadn't gone to hard tools, you know, to castings yet. But we finally looked at their machine we had already, you know, we had figured out how to do everything and when we looked at their machine we saw a couple of things they had done better than we had and we copied those and we figure we had a few things that they hadn't seen that we were doing better than them. And boy, we were doing castings by the end of April. I mean we had it ready to go. We were ready to go full-bore. The circuit designs that were going strong. And we delivered our first product by the end of March of the following year and basically that took us from being last in any list of suppliers to being first after IBM.

Hendrie: Just because you figured out how to get there faster.

Rodriguez: First to market I guess is what it's called, right?

Hendrie: Yeah.

Rodriguez: And, you know, I mean we had a lot to learn but we went to AAA in Detroit with that machine and they loved it. As it turned out we couldn't build a second one, but that's okay. <Laughs> You know, it's funny-- well, no. No. we just had a big screw up in one of the drawings, you know how these things happen, right. They had the linear motor, right, and it's a very complex product, right. And the, you know, the dimensions were to a tenth of a mil. And when it was originally sent for a prototype I think the most significant dimension was 5. And then six or seven numbers after that right or maybe it was only five I don't know what the mil is.

Hendrie: But a lot of numbers.

Rodriguez: Maybe four, yeah. And unfortunately for one of the two castings the number had come out to be four. It started at five, but somehow went to four, it was off by an inch! So the guy in machine shop calls the engineer and says, "Hey you know, this number? one of them is wrong." The engineer said, "Oh, yeah, yeah it's five." Never got changed! First prototypes worked very well, right, we were going to production. Oh no. Oh Jesus, how could this happen? You know, you've got a part that's an inch short. And it did, right. And I that really set us back. But everything else was working pretty well there. But boy we were learning. We were learning how to build product and-- but I'll tell you by the time October came around, which would have been the six month time frame we had more orders than we could satisfy. Our clean room couldn't satisfy the demand. So in October we said we need a new building and we've got to have it done by April and we did. We started a new building to build I don't know a 20,000 square foot clean room, we were in a 2,000 square foot clean room. We got the building and the clean room functioning by April 1st on a cost plus basis we did it faster than anything. And boy we were humming. We were humming and that was really a fantastic success.

Hendrie: That's great. That's a great story. We need to stop. We've gone through another tape.

Rodriguez: One last thought. There is a couple of minutes? Yeah. Well I tell you, so by this time, you know, I'm the General Manger of the Disk Division. I went from being Head of Engineering to having a new division -- we divisionalizied the company. So here we're thinking about the next generation of product and IBM rumors of IBM-- well IBM had announced, you know, they were coming every three years right. So IBM should have announced the double density 3350 by, should have announced by 1979. Should have been announced and they decided to skip a doubling to go to a quadruple, a 3380. But instead of saying six years, which would have been, you know, time skip of two generations they said five years. And, you know, my simple mind is just every product needs doubling. So I was asking marketing to come up with a, you know, with an argument to support this product. What do we need to do right? And it was count key data architecture, which made duplicating-- we're going to just have it a double-3350, literally, right. So to me there was only one solution: double the number of tracks and everyone looked at me and said, you know, this is the only solution. The tracks had to be identical otherwise you could not manage count key data architecture, which was a variable length record architecture. And you could have variable length records in the same track.

Hendrie: It would have been a nightmare. Yes.

Rodriguez: No, you couldn't do it any other way -- mathematically it could not be done because, you know, if you have a different overhead and a different-- if you had different overhead than what they have or if you have the same overhead per record but you vary the length of the record, you could fit an infinite variations of records in there of different lengths of the track and the only way to fit it was to fit it track identical to the ones you had before. But I asked-- I kept asking marketing for some support, you know, I mean I had Terry Johnson as the program manager for that and I said, "Hey you know why we have to do this, right? I mean if they don't come out with that's their problem, you know." And I kept asking marketing for pricing, for the product. "Oh, we can't figure it out, blah, blah, blah." I said, "I'll tell you how you solve this problem okay?" We had never had to price a machine before in the history of Storage Tech. Okay it was always 15 percent less than IBM, right. So I went to them: " I tell you what, figure out what they would do with this product and we'll charge 15 percent less." <laughs> And they took it as an insult. But then finally I said, "Hey, we're doing this no matter what you guys think." And we did. And actually that machine became extremely successful, captured market share from IBM because, by the way, they were also late with the 3380. I think they were a year and a half late. So instead of a five year cycle it was a six-and-half year cycle and what they missed was that, boy. Those computer rooms were fixed in size and when data storage doubled, I mean, demand doubled you needed re-tool the size of the machines otherwise they wouldn't fit into the same building. And data was growing then at the same rate it's growing now which is probably, what?, 100 percent a year in data storage demand.

[2:02:00]

END OF TAPE 3

Hendrie: When you were still doing the tapes and understand what happened to the other two founders. What roles did they initially play and then what happened to them? How long did they stay? What did they do?

Rodriguez: Yeah. Well, Zol Herger was the mechanical manager. He became first vice-president of engineering and then, when we formed the tape division and the disk division in 1977 he became the general manager heading those two divisions. And I was the vice-president of disk and I'm trying to

remember the name, Don Bunker, who was the vice-president, general manager of tape. And so Zol basically kept on being that up until the end, until the Chapter 11 in 1984.

Hendrie: Okay.

Rodriguez: You know, I left the disk group in late '79, in December, I can go through a lot of reasons of why I did, I mean, very successful but very tired and very confused. I can go on.

Hendrie: Well, we can get to that in the next thing.

Rodriguez: But basically, then I started the optical disk effort, and we'll talk about that later. Tom Kavanagh left Storage Tech in '73. He had been the electrical manager of the group and he went out and started NBI, who was a very successful company here. You know, they were basically legal word processor, right? Failed to make the transition to compete with the personal computer and Word, in the 1985-87 time frame. Very successful company and just made the wrong turn, when the competition told them to make a turn, they went the wrong way. But they were a very successful company here in town and he's done, obviously, did very well and he has had a couple of other startups since. I saw him a week ago, you know?

Hendrie: Okay. You keep in touch.

Rodriguez: Yeah. We keep in touch, yeah. Actually, saw him at Costco the other day.

Hendrie: Who took over the electrical when Tom left?
[2:05:00]

Rodriguez: You know, that's a good question. He must have left in '73, before -- you know, I can't recollect. Ron Vitullo.

Hendrie: All right. That's okay. Maybe you could also tell us, before we get into our next session, just a little bit about your change from doing tape to being involved in the disk. Tell me about that transformation.

Rodriguez: I told you about shipping that product to Firemans Fund in July of 1974? Basically, right around that time I think the disk guys had been asked to move over already to Boulder and they didn't have a manager and I was a manager so I became the head of the disk group.

Hendrie: And dropped your responsibility in tape?

Rodriguez: Yes. I had gone out of tape development and I went into to disk.

Hendrie: Okay. But disks, how did disks start at Storage? Was it through an acquisition?

Rodriguez: We had funded a startup in the Bay area in 1973, I believe. I think it was a year and a half later where I think-- Al Wilson, you talked about before, and John [Kievel] you know, basically, headed that group. A year and a half later, they were not on schedule, the group transferred --about half the guys came and they came without their original leaders. Obviously, the company knew me and so they put me in charge of it.

Hendrie: And they had done the 3330 compatible?

Rodriguez: No, they had done the Superdisk.

Rodriguez: When they came over, they started doing a mod 1 and then a mod 2 but, you know, they were products that were so late to market? The Superdisk was the sexy product. The other ones were trying to catch up with the market. We had actually started to sell ISS disk earlier, maybe at about the same time we acquired the disk group. We had funded the start up. It's a little hazy. But, you know, Terry Johnson was one of those guys that came over with that group, along with some guys, was his name Johnson?

Gardner: Jim Morehouse?

Rodriguez: Jim Morehouse, yeah.

Gardner: Ivan Pejcha?

Rodriguez: He didn't come over. He stayed on as a consultant for awhile.

Gardner: Tony Berti?

Rodriguez: No, the other guy. What was the name of the guy who ran the controller in our group?

Gardner: Nick Assouad [???] ?

Rodriguez: No. His boss.

Gardner: Hancock?

Rodriguez: Yeah, Bob Hancock. Nick also came.

Hendrie: Why don't we wrap up right now and then thank you for the first part of your oral history. There's more to come, clearly.

Rodriguez: Only halfway through. <laughter> Don't get too enthused.

END OF TAPE 4

[0:00:00][1]
Gardner: This is Tom Gardner, and this is the fifth tape of an interview with Juan Rodriguez in Boulder, Colorado. We were talking off mike, Juan, about STK's innovation in subsystems in the late '70s and early '80s, and you'd mentioned something about how that came about. Would you share that with us?

Rodriguez: You know, really, Jesse Aweida was quite visionary in the sense that, you know, he brought in a control unit group in late '69. By that I mean three or four months after we'd started. It was headed by Barry Cunningham, and Eric Rinkjob and Andy Anderson were significant part of that group. And basically Barry left in, I don't know, '72, right after going public, a couple of years later. We had a control unit, and I think, as I mentioned earlier before, that allowed us for the quick response to the IBM 3400 announcement because it allowed us to do our own thing within the subsystem and be able to plug to their channels, which were very, very well defined and very well known, and as a result of the openness within the IBM system those connections never changed. So, that part, you know, that part was very well done, you know. Eric afterwards basically headed a lot of the solid state storage disk efforts and the VSS and basically that whole system side of the company, which eventually led to, you know, the very sophistication of the libraries and stuff. I mean, obviously the library's a mechanical element, but from a systems standpoint it's a very significant storage element. That was part of the success, you know. I think Eric left in mid '80s, too, and he's been involved with several different companies since then.

Gardner: Yeah. We were talking about first the CyberCache and then the Solid State Disk, and then VSS, which turned out to be a precursor to a lot of the stuff that came in the '90s.

Rodriguez: Yeah. I mean, it was, you know, VSS was certainly the base for a lot of the system efforts afterwards. All that system expertise we brought in to build what was essential later on.

Gardner: I have to segue and ask you the question. The public documents say that Jesse Aweida was not in favor of a library. In fact, they had to hide it from him while the work was going on.

Rodriguez: I have no idea; you know, that might be true. The library effort, obviously, was a very big effort. We started the library effort on the optical disk project with Jesse's approval. That was very public. [0:05:00]
The tape guys did come in and kind of sneak the effort to help us put it together, okay. All of our customers for optical disk basically demanded a library, and we built that optical disk cartridge to be handled properly by a library. So, we were all for it. You know, afterwards, we believed that the significant part, especially of the system effort, required of the tape libraries, was developed in optical disk. In fact, a prerequisite to all that development in optical disk and in the libraries was the system knowledge that we had already in house or that we had brought in house under Eric at VSS. And, because, for the optical disk, we basically had to develop what we'd call the drivers today. So, I know we're going to talk about optical disks, you know, but optical disk was basically four efforts, the drive, the media, the control unit and the system software for the attachment. And as I mentioned to you, we were working, architecting and planning more than anything else at that moment the library, and we were making sure that whatever we would do, it would be compatible with the library system.

[1] Time stamp, h:mm:ss, from beginning of Tape 5, found on DVD 2.

Gardner: That's a great introduction to optical. I guess you made the strategic decision to get in and then acquired the Exxon Star technology. Talk about how STK decided to get into that space and then get into it.

Rodriguez: Well, you know, partly I'm a little bit to blame for not believing in magnetic technology. I should have listened to Al Hoagland, whose basic argument for why it would never stop growing was that it had never stopped. You know, at the time I couldn't buy the argument, but later on, I have accepted that argument. It's totally, totally true. The trend line obviously, has kept ongoing. And as a matter of fact, as we all well know, the trend line basically doubled the rate in logarithmic terms in the 1990s, right? So, we went from doubling every three years to doubling every 18 months.

Gardner: Would you share with us your opinion of what caused the need in 1990? We all know about the need, but there are a lot of different opinions. I'm curious as to yours.

Rodriguez: Well, again, you know, if anybody was predicting an end of disk, it was at 300 million bits per square inch, okay. And I would say that that was probably what was being said in 1980, or maybe a couple of years before that, and I forget what densities we were working at at the time. The optical disk promised 600 million bits per square inch for its first product, and so I said, "Okay. You know, this is where the storage keeps on moving, right?" But it was really, I still remember doing a forecast around the 1980 timeframe of when solid state memory would meet magnetic disk. And it seemed pretty far then, but obviously, we've gone past it now. I remember distinctly that it would be in 2005.
[10:00]
And the only way magnetic disk could keep its edge on solid state memory was to go up the same rate as solid state memory, you know. So, you know, I mean, people might argue about all the engineering and scientific efforts that went into doing that, but I think it's all immaterial. I mean, the need was for the business to keep going, and it needed to double the rate of advancement. Now, there was a business need too for the improving technologies, as we well have known since then, I mean, proven since then, obviously. You know, the people keep talking today about how data storage needs double every year in the world. Well, that has been the case as far as I can remember. And 1980s probably as good a time as any to forecast. So, was there a need to double every 18 months? Well, you know, yes. You know, actually, the demand was doubling every 12 months, so I mean, there were all those reasons. And if you all remember how big those disk drives were back then, you know, it's difficult to-- I mean, the layman finds it difficult, to say, "Well, who needs all that?" You know, and the answer is, if you've ever seen a room full of disk drives, and by a room I mean a room the size of a football field where you can just about see the horizon bending, like Ford used to have up in Michigan. I don't know what they have right now. And this room is stacked with hundreds, thousands of disk drives. And you say, "The need for storage is going to double next year." You say, "Well, I need two rooms this size." And the year after that, double again. You'll say, "Well, there's no question they need much, much higher density." And actually the technology wasn't quite keeping up with the demand. So, we've gone a long way since then, and still it is amazing how much the industry has grown. And it could have done a little better with a little less competition, but I think the opportunity for the gold at the end of the rainbow always just lured everyone into it, right. I mean, as a result of that, you know, I guess, I mean, I don't have to tell the disk guys that there were just hundreds and hundreds of companies started in the early '80s to do disks, you know. And obviously, what do we have today, three?

Gardner: It's six going to five.

Rodriguez: Well, it's always X going to X-1. <Laughing>

Gardner: That does have a limit as opposed to areal density.

Rodriguez: Yeah, that limit is 1. <Laughing> But it's amazing that, you know, obviously the need for competition, but it's just amazing what these engineers have done in the meantime. And the business, how it's grown and has just become ubiquitous everywhere, that little disk drive. Of course, now it's being gnawed at by all this nonerasable memory, but that's okay. We won't talk about that.

Gardner: So, the impetus for optical, then, in the early '80s was the specter of magnetics running into a limit and optical being able to handle it.

Rodriguez: Yeah. Definitely. Definitely. You know, I had started looking into it late '79. I was still running the disk operations. But I was really becoming disillusioned with being a general manager over an operation. And the reason for it, you know, I felt always, as an engineering manager, that I had total control over what I was doing, and by control, I don't mean that I could tell where everything was going, but I could where everything was and why, you know. And to me, that was control. Okay? With a manufacturing operation, it was mayhem, I mean, you know, looking at it backwards, we had, I would say, maybe beyond semiconductor technology, we probably had the highest technology being manufactured in the world, from a mechanical standpoint, certainly, you know.
[0:15:00]
And yet, the processes were so crude. And probably the worst process we had was quality, you know, where we talked about testing-- I'm sorry-- inspecting the quality as opposed to building it. And it is such a huge difference. I'll tell a quick story on how bad quality was, or the quality concept, it wasn't the people, they tried, obviously. I used to go into the clean room very often. After a day's work I could relax by putting on the bunny suit and going inside a clean room and just kind of watch the activity. It was also interesting to know that everybody knew who I was because in spite of the fact that you're covered head to foot in a white suit and your face is covered, people can tell who you are by the way you walk, or the way you talk-- well, certainly the way you talk. But anyway, it was amazing to me how they could tell anybody in the room from 50 yards away by just looking at their back. Anyway, here I was, I was in the clean room, and I was watching somebody do an operation. We were testing something, and I was very curious to see how it was getting done. And in the background I'm hearing this shout, "Quality! Quality! Quality!" After a while, you know, you start saying, "Wow, what a great spot. Everybody says quality." Right? And so they just kept on working. Just this shout keeps coming back: "Quality! Quality! Quality! Quality!" All voices. And so I finally ask what's going on. The answer was horrific. We used to build a disk pack with 8 disks, and they had little cylinder aluminum spacers in between and eight bolts to hold the pack together. And the way you tighten that disk pack is the same way you tighten a wheel on a car, you know, you start with a hand tighten and then you work with tool a little bit tighter, and then you do every other nut and then all the even and then all the odds. And then at the end, you torque to spec. The reason they were calling "Quality!", they were basically calling the quality inspector to come in to test the torque on that nut at the end. For every nut tightened, there a quality inspector had to come over and confirm with the same tool the operator had used that it was being torqued to the right torque. So, I said, "Why?" Doesn't the guy that's torquing the thing know what he's got to do? Isn't he responsible for what he's doing? "Yes, but, quality has to put their stamp on it." Oh, geez. And, you know, I think we all understand what putting the wheel on the car is, right? So I think that's a fairly easy example for everybody to understand. But everything was like that. Everything was like that. I mean, I'm sorry. Another example of quality, you know, used to run these units through the manufacturing line and then go into system test and just test for 24 hours, 48 hours. I forget how long we had to test these disk drives.

But we did. Actually, I can even go back to tape drives, right? Same thing, right? They would go out in the field and now we had our own field engineers to install the product. And they would come back with records like, "We have missing cards, we have cards in the wrong socket, wrong level, you know, a power supply that was mis-wired."
<Pause>
So, the same thing happened with tape drives. And you know, we had the control units, the tape control units, the disk control units. And you had this problem day and night.
[0:20:00]
So, I said, you know, "We test the system, we ship it out. The field engineers received it, and there's no way that machine could have gone through system test. No way. No way." No way, right? So I asked my guys, right, I says, "Tell me why this is happening." Right? Quality. After all this effort, in the dock, before the machine shipped, under the worst environmental conditions because docks were not air conditioned, let's say, right, there would be a quality person that would take out every card in that unit to make sure it was at the right level, you know, basically take the machine apart and put it back together again, without the covers. Then it was sent somewhere else where they put the covers on. Who knows what happened there? and there's where you had the lowest skill level in the company in the worst environment-—Their final fit was with hammers and stuff. And I thought, “This is crazy. This is crazy! We're going to put covers on at the beginning of the line.” Manufacturing Engineering said, "The covers are going to get scratched." I said, "Hey, we're putting them on. You guys figure out how not to scratch it." But when that machine leaves the system floor, it's being packed by the system engineers and it's ready to go. I mean, they also have to put some shipping blocks in the gates and they had to do a lot of things. It was not simple to go from the system floor to a truck and end up in one piece. But, you know, it could be done under the operator's control. I mean, these guys, these poor guys, you know, we were blaming them for not testing the machine properly, and it was obvious. I mean, a missing card, a cross-wired power supply, I mean, things that they couldn't possibly have tested-- so, I mean, they were very glad to do it. And they had known all along this is what's going on. And unfortunately, that was the problem. Right? So, I said, "We'll do it this way." The world went up in arms. We're just going to do it this way. Okay? And if we scratch them, we-- well, if we scratch them, they go out that way. <Laughing> I mean, it was just, I mean, that's another example. But there are just so many examples like that. When I started optical disk, one of the things that I said I was going to do was I wasn't going to have any quality inspectors in my line. Well, who needs one? God, you should have seen the uproar.
<Pause>
So, you know, '82, '83, when finally my ideas came to the surface and people say, "No quality, no quality," I was pretty independent. We had moved to Longmont to that building in the corner of Hover Road and the Diagonal. There was a 450-thousand-square-foot building with another hundred thousand in warehouse. I mean, it had been built for tape, but at the time we were probably occupying about, we got to occupy maybe 200 thousand square feet. We were getting ready to manufacture optical disks there. But I was sufficiently far away from the headquarters building and all that that, you know, I wasn't bothered by the politics of the process. I reported to the president of the company, the CEO, to Jesse, and I really didn't care what anybody else said. And, I mean, I had a great position. I was politically all powerful. Nobody got in my way. Or if they did, it didn't matter. I ignored them. But, basically, it was a point in time where Demming was becoming the thing, and the zero defect was in effect. And it was so, you know, as it turns out, after I looked at it, that we were doing and what he was proposing were basically the same thing. People misunderstood zero defect saying, "Well, we've got to build with zero defects, and if we're building things with zero defects, then therefore we don't need any people to find them."
[0:25:00]
<Laughing> And I knew, again, from this basic principle that says, "Hey, you know, you can never test enough." There's always problems and your objective is basically not to repeat them. To solve the

problems in general, not specifically, I mean, to solve them once and forever as opposed to every day. And your objective was just to get rid of the processes or improve the process that basically get rid of defects as you build into the machine. And it was a learning process. And you needed quality engineers as opposed to quality inspectors. You needed people to define processes, to make sure that people -- Demming and I were on the same wavelength there. He was talking, obviously, from a lot more experience than I was. And I was designing a manufacturing process based on my horrible experience in disk, and experience with me as a general manager, absolutely no idea why things happened, not to the level of detail that I liked to hear, liked to know. And things, it was kind of like magic, whereas in engineering, again, you know-- so, this was the process that was being engineered. And with that I felt very comfortable. And in fact, we carried through quite a bit of it until the whole effort got shut down. But I learned a lot. Afterwards, at Exabyte, we implemented all of that. And of course, by then, maybe people were starting to come my way, if you will, from the Demming side. But anyway. So, back to where we started in optical. Yeah, we had actually, in the fall of 1979, I actually went to visit Phillips in the Netherlands to see if we could get a relationship going, a technology relationship going. And everything was going very well, but their price, their price for the relationship was one third of the company. <Laughing> And we said “no”. It was just ridiculous, the whole thing, a third of the company! A company that was, I think, just about ready to break if we had just broken through the billion-dollar mark, right, and they wanted this for the technology. So, you know, we started knowing the value of what we were doing. It actually helped me get more money for it. <Laughing> And eventually, we bought the assets of, what was the name of that company again?

Gardner: Exxon Enterprise’s Star.

Rodriguez: Yeah. Yeah, Star. And we got a couple of people, and it helped. I mean, I think we brought the intellectual property as much as anything else. We also had bought some furniture, and actually some outdoor furniture I still have in my house--great furniture. Bought all the assets, and we brought in the people That purchase brought a lot of intellectual property into the group. I'm not sure how much their efforts really had helped; their experience, had helped us. I think everything helped. I mean, what I remember about recruiting, right, you know, I have been recruiting into the Boulder area ever since we started STC, you know, forever. Right? I mean, for 40 years, well, geez, it was 40 years ago on August 1st that we started Storage Tech. Yeah. And I'd been recruiting into this area. And I scoured the country. In 1980, I scoured the country for optical engineers, and there wasn't such a thing. Back then and probably the same thing now, you know, if you wanted mass production optics, you went to Japan. [0:30:00]
If you wanted quality optics, you went to Germany. And the United States was actually very, very strong in small quantity, space, NASA sort of stuff, you know, satellite. Ball Aerospace here in town had actually quite a few people working on optics. You know, afterwards they did the Hubble Telescope. Of course, it had a screwed up lens, but I'm not sure who screwed it up. But, you know, the Hubble is the effort from Ball Aerospace. And so, there was some talent here. But I had to go ahead and instead of hiring engineers, of which there were very, very few, I went and hired scientists and brought them from RCA labs, you know, brought them from, you know, we recruited a good bunch of scientists, very few engineers, some. I went to Rochester, New York, to get a few of those. I went everywhere looking for them. Boy, the talent was just not there en mass. I mean, you're thinking of saying, "I'm going to get a servo engineer, a read/write engineer." I mean, you know the good ones are few and far between. But everybody knows who they are. You know, optical, we didn't know where they were. I mean, there was-- anyway. So, we got the effort going, and we knew what we had to do. We had to design the drive. We had to design a media. We had to design a control unit for it. And we had to design the system software we needed to attach to the system through our own operating system, if you will. And we had this write-once media. We had a couple of great marketing guys.

Gardner: Can you name them?

Rodriguez: Yes, John McIntosh. He was so good. You know, I was reading the brochure you handed back about optical disks, and it's interesting, but all these applications that are becoming just-- well, are the norm of today, right, the printing of the checks, you know, the space, you know, all the photographs from space, all this stuff we predicted with the advent of this 4-gigabyte disk. This is when tape was at 200 megabytes and, well, what was the 3350, 8350, right? I mean, the 8650, the double density 3350 disk drive was 1.2 gigabytes, you know. And we had a 4-gigabyte disk, replaceable, and its functionality was very, very similar to tape. But it was physically write-once. We actually, one of the reasons we were like tape is because tape, from a system standpoint, is a write-once device, and files can only be extended and so on and so forth. And with the optical, obviously, we basically had to take what all of us in magnetic recording thought as a weakness, the non-erasability, we played to the advantage, and we basically came up with this concept of the fact that now you could have total traceability, that it could serve as a legal document, concepts that are still being pushed today by optical. We had, really, a great program. Towards the end of the project, I had 480 people working on it. At that moment, we were about a year and a half late. The most interesting thing about that whole thing is that if I look back at why we were late, one of the reasons we were late is that the architecture of the microcode was not done properly. It was a layered system where basically it assumed that you had the casters on first and then the skins and then the-- I mean, you could not debug a layer in parallel with any other layer. It was layered as opposed to vertical. So, you know, we couldn't get to servo until we had the cartridge loading fixed. We couldn't get to read-write until we had the servo fixed. It was just-- and when you say fix, right, you mean fixed to a very high level of reliability. And while I had 480 people on the project, the most disturbing thing was we only had two microcode guys who could run the program. And I said, "God, you know, we can't run these guys 24/7." I could run a 24/7 operation with that many people, but my bottleneck was these two guys, you know, who knew everything, if you will, you know, the chief microcoders. And, you know, it was so frustrating. We had an optical disk effort. We actually went into a partnership with Kodak. They had a drum disk they had, which was basically, if you can imagine, two concentric annuli, aluminum rings, a large one, let's say, 14 inches, and a small one, let's say, whatever, 3 or 4 inches, and a membrane stretched taut between the two. And so, basically, they could produce the optical media on a web and have a continuous manufacturing process for do that. And then a very sophisticated but simple operation to stretch taut, like a drum between the two disks, between the two annuli. So, that was a very interesting project. In the end, I forget technically why it didn't work, but where we parted ways, it did teach me a great lesson about contracts, though. You know, I've always been known to be relatively impatient, especially about these bureaucratic things.

END OF TAPE 5

Gardner: Interview of Juan Rodriguez July 15, 2009.

Rodriguez: So, this is probably 1982, and we want to get in a relationship with RCA-- I mean, no, I'm sorry.

Gardner: Kodak?

Rodriguez: Kodak. Kodak, RCA, Kodak, 3M. So, you know, obviously, Kodak being what it is and what it was more so then-- it was a very large corporation, and they had, you know, they had their army of lawyers that needed to get paid. So, they worked long and hard on a contract. And I was very impatient

on this because we really couldn't get to first base without a contract, according to them. I would do it on a handshake. And so it took, like, eight or nine months to get a contract drawn. And so I signed it and we went on with things. Interesting thing is that when we broke up about a year, year and a half or two years later, whenever it was, we parted friends, you know. And the reason for it was that that contract was just beautiful. It basically defined what would happen when you broke apart. What I learned from that lesson was that, you know, contracts, they really don't define success. They can't define success, but they can certainly define breaking up. And so, I really look at contracts very differently since that experience. Again, I look more for what happens when we don't get along, as opposed to, you know, things that define success. It's interesting, you know, when you finally get to jump over to the fence where now you're looking at success, you know, greed takes over. And you know, so you have to try to, initially, try to bound the excesses of greed in a contract, but boy, at that moment, you're defining success. And like I say, a contract is very difficult to define. In this technology effort, where even if you know exactly where you want to go, in the end, exactly doesn't mean exactly, you know. Exactly is kind of broadly defined as being first a market, let's say, with a product that becomes successful. You know, almost anything else is irrelevant. I think my ability to lead projects to success is more based on the fact that I was able to compromise the reality of the design process with the need that eventually was being demanded by the product. And there were things that, you know, were extremely important. Like, let's say for the STC8650, say, hey, let's have double number of tracks, you know. And it was the only way to define it. Everything else was immaterial almost. Cost was, yeah, reliability, yeah, all those things, yeah, yeah, yeah. But anyway, so, in the end, you end up with something that you couldn't have possibly envisioned to the detail that you need to have. But broadly speaking, it's exactly what you wanted, you know. And your mind changes a little bit with experience, with time, with knowledge, with all these things and, you know, with reality. But we had, unfortunately, Chapter 11 hit. And you talk about bad timing, right? I mean, you know, a little mistake cost us, I think, the optical disk effort. I'll tell you what that was. You know, we had a manufacturing process with that has some extremely obnoxious elements for manufacturing in it.

Gardner: This is manufacturing the optical disk?

Rodriguez: Manufacturing the optical disk specifically, yeah. It's kind of like a semiconductor process, you know. It's a lot of nasty stuff. I had a corner office and with nice glass window, and it was only about four or five foot off of the outside soil, and I had a big rock brought in, because if I heard that alarm, I was going to throw the rock through the window and jump out. <Laughing> I wasn't going to take any chances. We had all kinds of safety whatevers in place just to make sure we didn't harm anybody. But to make this short story too long, when we finally went to manufacturing, we obviously needed the EPA permits for exhaust fans, for exhaust out of the building. And we missed one. So we couldn't get on with some of the construction until we got this one. We finally got it. Three months it took us to get that permit. Probably the difference between the program going on or not because when Chapter 11 hit in Halloween 1984--great day--we were six weeks away and half a million dollars from finishing a 40 million dollar clean room. What was missing were basically the drywall walls. And because we had this monster machine that we called the Bertha. It was a 90-foot-long machine. So it had to be installed. We had to take a wall out of the building to bring it in, and basically we had to build a clean room right around this. This was basically a five-stage continuous process deposition machine. And, you know, and this was the heart of the system. And again, you know, you couldn't finish, you couldn't do anything until it was installed. So, when the bankers came through the building about four weeks later, we had stopped construction because in Chapter 11, they had just stopped all the cash into the clean room--into the division. I went from having 100 thousand dollar signature authority to having no authority to sign any checks-- nothing. And, you know, this army of bankers comes in. If you can imagine, I forget how big that clean room was going to be, maybe a 50-thousand-square-foot clean room, and with drywalls all over

the floor, drywall dust all over the place. By the time the bankers went out the door, their shoes and their dark pants were just full of white dust. And, to them, this was the beginning of something, this was going to take forever to finish -- of course, we were also burning about one and a half million dollars a month, but, or maybe it was two million. But at the time, we had two to three hundred million dollars worth of backlog for this product. I mean, people were extremely enthusiastic about it--the idea of a 4-gigabyte volume was, you know, where so far they had 200 megabytes--was just, I mean, anybody that was in data storage wanted this thing because of its capabilities, from the government to the oil companies, exploration companies to everybody. And if it had stayed, if it had remained, it would have changed the face of the world as we know it. By the way, in parallel with this operation, we went to visit Sony quite a bit. They were developing what we know as the CD now. I think the CD came out right around the same time, that 1984, '85 timeframe. I think it was '84 or '85. I mean, I don't know the exact date because I was visiting their operations fairly often and, you know, I had looked at their machines for mastering CDs and all this and met their scientists and stuff, and we were very interested in what each other was doing, and I'm not sure helping much, but certainly, you know, we gave each other the vision to do things. And so, you know, I mean, I don't know why we would not be where DVD or Blu-ray is today, on a 14-inch disk. That was kind of big, it was kind of clumsy. But finally, you know, when Chapter 11 hit, as I mentioned, I don't think anybody was enamored with the expense we were going through, the fact that we were late, the fact that the clean room wasn't finished. Like I said, boy, that one exhaust out of the building, if that facility had looked like a clean room when those bankers came through with people in bunny suits inside making believe they were working, we'd probably still have a program, but off by a few weeks in what was measured to be, we had spent about 120 million dollars on it.

Gardner: I'm surprised there was no attempt to spin it out.

Rodriguez: There was an attempt -- there were several attempts. I was flying all over the place. But unfortunately, you talk about bad contracts, right. We had an R&D partnership funding, a 40 million dollar partnership funding the effort. And unfortunately, in the contract with the partnership-- well, first of all, we're the general manager of the partnership. We're general partner. I was the president of the general partner. And there was no, what's the word, there was no way to change the contracts. Nothing, you know, most contracts have some kind of an arbitration process to change things, you know, because obviously, we couldn't change the thing willy-nilly, but the partnership had a contract that couldn't be changed, and without those changes, it couldn't be sold. I mean, from a practical standpoint couldn't be sold because of the economics of the relationship.

Gardner: Not even given the Chapter 11 bankruptcy opportunity to rewrite contracts?

Rodriguez: No. No. For some reason or other, there wasn't a-- you see, the general partner was totally conflicted. It was owned by Storage Tek, but its responsibility was to defend the rights of the limited partners.

<cell phone buzzing>. This is the one that I have to take. Just a second.

Gardner: Cleaning the cassette, something we never do in disk drives. Still cleaning the cassette.

Rodriguez: It's probably doing it intentionally. It's probably going forward and backwards, you know, kind of making sure the...

Gardner: Still cleaning the cassette. That's interesting.

Rodriguez: I wonder, that's the first time <inaudible>.

Gardner: That's the first one. This is the longest break we've ever had. Usually we just go continuously. So, we did something.

Rodriguez: Well, there's something. You know, it reminds me of some of the issues. There's something, I think, in the hard coat, in the _____ of this system that reacts with some of the environment, you know, chemicals in the environment, and you know, reminds me so much of some of the disk problems we had with those solid lubricants.

Gardner: I have a product for these guys, a product. There's no way-- it's not a business product, though. This has a memory card in it?

Rodriguez: Yeah.

Gardner: Instead of the cassette?

Rodriguez: Yeah.

Gardner: You can take a terabyte disk drive, put a memory card plug on it, and so all of a sudden, you have a, you know, instead of a gigabyte memory card, you have a terabyte memory card. Because, man, look at all the junk I've got here. You know, why am I recording to tape today when, you know, I could plug a terabyte disk drive into this memory slot and, you know, and now the terabyte would be, what, 4 gigabytes an hour, 250 hours?

Rodriguez: Yeah, you know, my advanced <inaudible> was strictly with _____, you know. We basically had a solid state video cam.

Gardner: Yeah. That's, I think the solid state video and the disk drive industry were debating that. But that's the last market for the 1.8-inch disk drives is the video cams.

Rodriguez: What's the capacity on those things these days?

Gardner: The hard drives?

Rodriguez: The 1.8, yeah.

Gardner: 250, 150 gigs, 150 gigs. But the problem is that's way too much-- I mean, that's a lot of time. The question is, how much time do you need, is enough? And, you know, if you had, like, a 40-gig solid state, you know, that's 8 hours. How many people record 8 hours before they unload? So, I think, you know, you don't need anything much more than 20 or 40 gigs on a consumer video cam. So I think, you

know, it's like the iPod. You don't need 100 gigs on an iPod; 4 gigs is enough. So, the solid state guys would kill them.

Rodriguez: Yeah. Blu-ray is 25 gigabytes for 2 hours, right?

Gardner: Now, if you went to high-D, that'd be 12 gigs an hour, right?

Rodriguez: Yeah.

Gardner: If a conventional, it's 4 gigs an hour. But even high definition, so 12 gigs an hour, a terabyte, you know, that's 8 gigs per-- that's 80 hours per terabyte.

Rodriguez: Yeah, I know..

Gardner: And then you don't have to change cartridges, you don't have to do cleaning cassette. And look at all the junk we shipped here to ship a...

Rodriguez: Is that a new camera?

Gardner: No. It's a fairly old camera. It's a DVD cam, but it's a high quality camera.

Rodriguez: No. No. Yeah. Yeah. I mean, it's, well, it's the momentum. It's always the infrastructure that people have on tapes, right? I mean, and then, of course, you know, you're going to have to keep it somewhere. I don't know if you guys plan to put that in the disk drive or put it somewhere. Anyway, you know...

Gardner: Maybe I should just throw this tape out or finish it.

Rodriguez: Is it still going?

Gardner: Still cleaning, yeah.

Rodriguez: I wonder if there's something else wrong with it.

Gardner: <Laughing>

Rodriguez: <Inaudible> I would put a new tape on.

Gardner: Okay. Let me see if I can stop it without <inaudible> <pause> It is now recording. I have to say, for historical purposes, when I first tried to record, it went into a cleaning mode and spent the next 5 minutes cleaning itself. I don't ever recall a disk drive doing that, but we used to have brushes in disk drives, didn't we?

Rodriguez: Well, you used to do the, what do you call it, that St. Vitus dance on the disk?

Gardner: They still do it.

Rodriguez: They still do it, huh? Sweep it?

Gardner: Yeah, the lubricant. So to keep the lubricant from building up, most disk drives, after sitting around for a while, will do a...

Rodriguez: Will pool, huh?

Gardner: I had never heard it called a St. Vitus dance, but that's more or less-- it's very proprietary. Every company has their own.

Rodriguez: Their own dance. Right.

Gardner: Their own dance.

Rodriguez: Mambo, samba.

Gardner: And they all consider it a trade secret.

Rodriguez: Yeah, right. Yeah. That reminds me of a story. Let me see, I'm probably not violating any confidentiality after 30 years. Ah, I won't tell it.

Gardner: There's no confidentiality after 30 years.

Rodriguez: Well, we had the supplier of disks, right. And when we first went into the disk business, we said, "Hey, you know, what's this lubrication stuff?" So we went to the suppliers, and we asked them, and they all said, "Shh, confidential, can't tell you about it. So I said, "Okay. Let's start our own program to see what lubrication is all about." So, we went and studied and this and that, experimented, built some machines that, you know, that would spray the right amount on the disk, and we could control them. Then we basically came up with a method of measuring how much lubrication there was on the disk and so on. And we really, in a year, we really got pretty far. And by about this time, we were starting to, you know, build some prototype quantities, and this one manufacturer, you know, God, yeah, we had this plastic cover on the HDA, right, and basically you spun that HDA for a while, and you could see the rings, the lubrication rings on the outside. So, we were saying, "Boy, these guys don't know how to apply lubricant on the disk, how to apply lubrication." And we said, "Well, you got to show us what you got." "No. Shh, no, no, confidential; you can't see it." We said, "Okay. If you don't show us, we just won't buy any more from you." Right? They said, "Okay. You can come and see it." Well, what they had is they would place the disk on a spindle, they spun it and somebody with two rags would dip into the oil bath and would wipe the disk". Well, how do you control that?" "Oh, we spin the disk. As it turns out, that wasn't the real-- I mean, that was part of the problem-- but the real problem was that their oxide would not absorb the lubricant, right. But, you know, I mean, so, to me, when somebody tells me that,

“confidentiality”, it's because part of the issue is that they're embarrassed to show you what they have. <laughing> Or it's so basic, you know, that it's just the pure art of marketing. Anyway, I'm sorry.

Gardner: Not at all. Stepping back a little bit on the optical.

Rodriguez: Yeah.

Gardner: You talked about the discussion with Phillips. Now, several years later, Phillips and Sony came out with the CD-ROM, but was your discussion with them about a worm product, which you ultimately came out with, or was it with the CD-ROM?

Rodriguez: No, no. It was about the product that we were seeking to do, yeah. They thought they had enough technology. But, you know, they really, again, it was about intellectual property, and I think getting the stakes on Star was really more about intellectual property than anything else, because I mean, it sounded like, you know, everybody had filed on anything, everything. And we needed to have a solid base of technology from which to develop our product. We didn't think technology was worth it then. You know, it was, if you remember, back in 1980, patent law wasn't as strong as it is today. Right? It really became much stronger a few years later here in the United States. And I think it was in that timeframe, in the early '80s, where the Eleventh Court of Appeals was, I think-- I think I'm saying that the right way-- was formed, which basically became the patent jurisdiction court for the United States. And instead of going, you know, people used to go to the different jurisdictions, you know, to get differing declarations of validity, and so on, and so forth, And finally the Courts said, "Stop this. We've got where one court will decide." And from then on, you know, patents became much more solid. Before that, it seemed like, you know, you could go to a different court and get a different opinion, a contrary opinion, and, you know, suits went on forever. With this one court interpreting the law, we got consistency and patents became much more important.

Gardner: Yeah, it's the circuit.

Rodriguez: It's the Eleventh.

Gardner: No, it's not the Eleventh, but it's the Federal, it's a special appeals level. You still fight out of district, but then all the appeals go to one place, and that gives you a consistency.

Rodriguez: Yeah, yeah. And I think it's the Eleventh Court of Appeals. But anyway, I am not a lawyer.

Gardner: Neither am I. You mentioned that microcode was an obstacle in the middle of a program, and I find that surprising. Can you care to elaborate?

Rodriguez: You know, again, it just seems like the microcode structure was built on a layer by layer. Like putting together a building and, you know, starting with the first floor. You can't find out what the eleventh floor looks like until you've built the tenth floor. So, and what was happening there is that, I think, I blame it on the microcode structure, architecture, where maybe we should have been able to debug things in parallel. But in fact, I think what happened is that we really didn't build enough debug stations to be able to try out the different systems before, independently of the rest of the system. Now, the other issue is this, right, you talk about maybe disk drives, they're layered the same way, but, you

know, you always start from a solid base of code from the previous machine. And you have your testers and everything in place, which are pretty solid, right. And by the way, we were talking-- and I think to understand this problem, and I think why optical has never really been successful in this data storage business--well, probably several reasons. I think we were on the way to solving that problem by saying we have under control all the resources that it takes for a storage device to work in a system, which was the system software, the media, the drive, the controller, all under one command. You know, the disk drive, the optical disk drives that came after that, you know, nobody had under their control all four elements of that. And therefore, they really couldn't make the right compromises nor come out of it quickly enough to make it happen. Now, assuming that that had been the case, then the question was: How come they never really quite succeeded? And I think the basic answer is this: You know, when we looked at the optical technology, we said, "Boy, this can do so much more than magnetics at this time. You know, we can forecast." Well, like Terastore in the late '90s, kind of did the same thing, right. And, say, well, you know, we can do much better than magnetic can, or we can help magnetics do better, right? And so you say, "Why is that?" Well, you know, we Optical don't have to be in contact. Of course, Terastore was different. But we don't have to be in contact. Boy, that solves the biggest problem we have in disk, which is we don't crash. And, you know, technically, once you've solved all the problems of making sure that you don't have head disk interference with the optical, which could happen, but basically those problems were solvable, then you basically have the very immense distance of a millimeter between the head and the media, and you've solved that problem. And you have a spot that can be made small, and you have optics and all this. So. But when I look at the basic three technologies that make a disk drive, a tape drive, an optical disk, anything that works in this recording industry, you need a head, you need media, and you need servo. You know, if you look at the issues with the head, they're very different, magnetic and the optical. You know, but in the end, they kind of turn out to be very similar. I mean, for independent technologies, it just seems like head problems get solved, you know. I mean, nothing, not a big deal. Media problems, you know, if we're going to record at about the same density, the objects are about the same size, whether magnetic or optical, when you're done in that microscale, the issues of depositing free of irregularities is about the same. When you have an irregularity, and, you know, whether it's a piece of dust or a piece of material that hasn't quite dissolved properly or a splatter or whatever, you know, the geometries of the defect for the same density probably require the same order of magnitude solution. So, you say, well, okay, media problems are very, very similar. And then, optical kept promising higher densities. And when you say higher densities, you say, "What does that mean?" It's all about servo, you know. I mean, linear is the recording technology. The track density is all about servo. And so you have a head, which is about the same order of magnitude issue as far as development effort and manufacturing effort. You have the media, which again is about the same order of magnitude, difficulty and effort, okay. And but then you have one technology where optical is saying, "We've got to push it ten times what the magnetic guys are doing." And they run into all the problems that you have when you're trying to basically break through the state of the art by a significant amount. And I think it is the servo that has, in the end, kept the-- oh, by the way, the media, if you're trying to do the ten times the density, it's got to be ten times better, too. Okay. So you say wow. And then you say the head, well, you know-- and, of course, you don't have the scale of production and experience that you have in magnetic disk. So you're trying to do all things better in an industry that doesn't have the order of magnitude of production and experience, the capability that magnetics have. So, somebody comes out with a disk that says, "Oh, boy, this is going to be ten times better, right." By the way, ten times is only five years, okay. So, you know, so by the time the product gets there and is two or three years late, you've cut the distance in half. Then you've got to get into manufacturing, and you've got to produce it at cost. And boy, the economies of scale for costs are not there. And so, by the time you get anywhere near close to producing a product that has got the cost and the reliability and the availability requirements of the industry, you're probably right on top of magnetics, okay, with that five year lead all of a sudden has vanished, and you have a product that doesn't have the advantage. I mean, you know, these guys up in

Longmont (In-Phase) here that are trying to do this holographic recording, you know. They can't even beat tape, okay. I mean, the performance, I mean, the great advantage of holographic is it's parallel massive transfer rate, right? Yeah, yes. But you've got to engineer it, you know. And again, you know, in the end, you think about it, right, the servo issues, they are so humongous, you know. I mean everything looks great until you figure out that you've got to servo within a couple of micro radians, whatever that is, you know. And you say, ah, geez.

Gardner: Usually the servo has to be within ten, fifteen percent of whatever your pitch is, whatever your pitch is, your servo takes ten percent of the <inaudible>.

Rodriguez: Yeah, yeah, yeah. It's got to be ten times better. Yeah, everything has to be-- and again, anybody that promises more has got to do more. And if they're doing more than whatever the disk industry's doing, they're asking to break state of the art. I mean, if you're behind it, you can say, "Oh yeah, yeah, all we have to do is what they did, maybe a little different." Right? When you're trying to break the state of the art, you're really going into worlds unknown. Right? You never know what's going to hurt you the next time. I mean, you know everything that's hurt you before, and you try to anticipate that, but then you know something else is going to come up and bite you in the wrong place, you know.

Gardner: I think the term is the unknown “unknown” sketch.

Rodriguez: The unknown “unknown”, right. And you say, "How can I build that from a planning standpoint?" What happened to us in optical disk we should have been able to plan around it. And we wouldn't have been so late. And we were spending so much money and everything, you know. And because the architecture looked wonderful once the machine was debugged. But it wasn't, you know, the architecture wasn't designed, the architecture of the product wasn't designed to debug the product. Again, you know, you can't believe how frustrating, once you realize that how frustrating it is to say, everybody keeps asking the question, "You have 400 people, why can't you work three shifts a day seven days a week?" And the answer was, "Well, there's really only two guys." <Laughing> And they can't work that way, you know. Oh, how bad, how bad. But, in the end, you know, when they went to close-- well, go ahead. You have a question.

Gardner: No. I was going to say, was the controller and the disk drive electronics integrated into one microprocessor? Was that part of the reason?

Rodriguez: No. No. No. We still had a control unit and we still had a drive. You know, I mean, what you see in this picture-- I don't know if...

Gardner: Yes. I'd like to-- give me a second. I'll try to zoom in. There we go. And that's you. The hair's a little darker.

Rodriguez: The hair's a little darker, and the guy on your right is, I think it was the head of data processing at NCAR. We had delivered this first product. We're both holding an optical disk cartridge. And as you can see, in the background, there's a Craig computer operating back then. You know, then, NCAR at least had the biggest data storage requirement in the world then. I don't know if that has been exceeded, but you know, weather is always a generator of large amounts of data. I asked...

Gardner: You can put it down now.

Rodriguez: Yeah. I asked NCAR one time, "So what are you going to do with this four-times speed processor that you're getting, you know, from so many gigaflops to four times that?" And they said, "Oh, well, just half our grid." <Laughing> You know, and obviously, they all believed that, you know, the smaller the samples space they have, the more accurate their forecasts are going to be. And it's probably true.

Gardner: NCAR is an acronym for...

Rodriguez: The National Center for Atmospheric Research. It's here in Boulder. It's a subsidiary of the --UCAR--University Center for Atmospheric Researcher, a corporation that is basically funded by the government and universities to research weather.

Gardner: Okay. We're running at the end of the tape, so give me a chance to switch tape.

END OF TAPE 6

[0:00:00][2]
Gardner: In 1982, there was a major disk drive problem, so big that it reached the financial papers. Can you share with us what some of the underlying problems were that caused the recall?

Rodriguez: Yeah. Well, several things occurred, and the culmination was this report. First of all, I believe the 3380 came out that year.

Gardner: It actually shipped late in ’81. It was delayed a year. It was supposed to ship in early ’81.

Rodriguez: Yes, so finally IBM had a machine, which was double the capacity of the 8650. The customers had been forced to sign five-year contracts on the equipment, and they’re only out was “quality problems” <laughing>. That was a big driving force, and I won’t minimize that because in this world of technology, people with a need can live with a few problems, okay. But tomorrow if they can find a better product, all of a sudden those problems are insurmountable. So they want to get rid of that. So I think that’s the trigger for it. Okay, having said that, the company— there was such a high demand for disk drives for this 8650. But the company decided to quadruple— three or four times production in ’81, decided to go through that. And why was this? Again, IBM made a big mistake in not having a double density 3350 product in three years as opposed to designing a five-year cycle for a quadruple and so on. I mean, eventually obviously it proved out but for all the wrong reasons. By the time it did come out, six years— on the six-year cycle as opposed to the five-year cycle, the demand for disk drives was going through the roof. Storage Tek had looked at this and made the decision to increase production by significant amounts, spend $100 million in increasing production facilities and in the process realized that their yield on HDAs had to improve. So they demanded that Dysan, who was the disk supplier, improve the error rate on the disk. Well, when they did that, they did that by minimizing the amount of silicon in the disk, which was the problem— which is little bits of sand that you put in to act as kind of crash stops to the head. And so it increased the HDA failure rate. But I mean the big mistake in many, many ways

[2] Time stamp, h:mm:ss, from beginning of DVD 3 containing Sessions 7, 8, and 9

was really this tripling of production capacity,— would hit in the fourth year of production when product life cycles are never more than five years. I mean, that was silly. It was good to take advantage of the demand, but it was wrong. It was wrong. So it stretched all the engineering capabilities. By the way, I had already been out for two or three years. I would have not made that decision. I was in optical.
[0:05:00]
It strained all the technical capabilities and made a mistake. There was an additional thing, which I kind of blame Dysan all along for it, which was the eventual solution to the problem. Dysan was finally the preferred and probably only disk supplier that we had for the 8650 and for the 8350. Originally, they had their own lubricant. And they said it was identical to IBM's. And when you looked at spectrographic analysis and all that, it looked very similar. But we said hey, if it's similar, why not use what they're using? It wasn't proprietary. Dysan says, well, their stuff costs $3,000 a quart, and ours costs $1,000 a quart. Yeah, but you're only putting two or three pennies in there, if that much, per disk. Dysan goes, "yeah, yeah", but— I think in the end it was arrogance, engineering arrogance that they could do things better than the other guy. Well, as it turned out— and we didn't discover this until that year of '82, there were two significant problems with that stuff that we used instead of IBM. The first one was that this temperature profile was different than the IBM. So basically, it got more liquidy with higher temperatures. So the stuff wanted to pool at the outside of the disk more than the IBM stuff. But the thing that was really the problem probably— I mean, and again, you don't know if it is, but it probably is. You know how you hydrogenate oil to make margarine? Do you know about this issue?

Gardner: No. This is a new one to me.

Rodriguez: Yeah. Basically, you supersaturate oil and all of a sudden you have margarine, right?

Gardner: Turns solid by hydrogen, I think.

Rodriguez: Turns solid, right. Well, the same thing happened with the stuff with halogen. Halogen fire extinguishing systems in every computer room, they work by when the go off they basically exhaust the oxygen supply in the room and turn off fires. Well, the Storage Tek field engineer discovered a pattern in a computer room where there been an accidental discharge of a halogen fire extinguishing unit with a spray pattern. And every disk drive within that spray pattern had crashed within three or four months of that accident.

Gardner: Now, that's an observant field engineer. I hope he got a big award from the company.

Rodriguez: Well, so we went, and I still had a materials lab were reporting to me. And we went and looked at the problems and sure enough, the lubricant and the halogen gas were in the same chemical family. And the halogen gas basically super halogenated this lubricant and turned it into a solid. Well, it was a liquid lubricant turned into a margarine-like substance in both cases, by the way, in both the IBM lubricant and the Dysan lubricant. But the IBM lubricant went back to its original state within 24 hours and ours remained that way. Again, it's one of the cases where you tell hey Dysan, "change it!. Otherwise, we're not taking one more disk". The day that happened, everything that was built from then on was as reliable as IBM. And that was a time where the IBM HDA life was measured about 400 months mean time between failure, and our stuff went under 100. And if you want to know one of the reasons for the Chapter 11, on that big building that we were occupying in optical disk,
[0:10:00]
in 1985 when I left it— on February 1st I resigned from Storage Tech. There were about 10,000 machines

on the floor basically as tile on the floor. And they had all been stripped of their HDAs. If there were any good HDAs in those, they had been stripped to ship to the field for them. But again, so basically you have a technical problem, which made your HDAs less reliable, and that was the problem. You have IBM comes out with a 3380, and the customers want that product so bad. But they need room in their computer rooms for them <laughing>, so they have to get rid of the STC drive. And the reliability that was acceptable the day before became unacceptable the day that machine came out. So they started basically sending machines back because of the quality, lack of quality. And that's the world we live in. I mean, the machines weren't working up to spec, quality spec. And the difference, what 400 machine months to failure means is that if you have a room with 400 machines, you have one failure per month, and one machine is failing every month. One HDA is failing every month. You're replacing one HDA every month. And if you're operating on 100, it means four machines are failing every month. And the difference is so dramatic to an operator, and especially to your big customers. Your big customers had several hundred machines on the floor, and they were the ones who would experience your problems more often because the same failure rate means there were more failures every month with more machines.

Gardner: At Memorex, we use the IBM metric of unscheduled incident, UIs.

Rodriguez: Yes, yes.

Gardner: And I forget the numbers, but I think it was something like .1 UI or—

Rodriguez: Yeah, .1 UI was for the— yeah. Well, at the time we were trying to beat— there was this house out there that published the failure rate.

Gardner: Reliability Plus.

Rodriguez: Reliability Plus, right.

Gardner: I remember them well.

Rodriguez: Yeah, I know. And we all learned how to manage those numbers a little bit. So .1 UI meant one failure for every 10 machines a month, right?

Gardner: Right. That was our goal at Memorex.

Rodriguez: Right, right, but those failures could be mostly electronic, could be fixed by a field engineer on site within an hour or two. They weren't nice, but they weren't too bad. And again, if you had a room with 400 machines, a .1 failure rate meant you have 40 failures every month. So in order to cover that account, you needed to cover that account 24/7. So you had field engineers in the account all the time.

Gardner: The big customers demanded an on-site field engineer and on-site stocking of spares.

Rodriguez: Yeah, and they paid for it. <laughing> So when you're leasing the machines that were part of it, part of the lease. Otherwise, you paid the monthly maintenance fee. And it seems horrible that a room

with 400 machines would have 40 failures every month, but that's the way it was. By the way, disk drives were .1. Tape drives were .4. Printers were at 1.5 to 2. So basically every printer in that account had to have about 1.5 to 2 failures a month. And we all believe that in printers; they were always breaking. Tape drives were less reliable. And in the end, I think by the time we left they were pushing to a .05 for disk drives. And I'm sure they're better right now. In the end, somebody calculated that if there were no hardware failures, the UI at the time, for a disk drive, would probably be about .02, .03. And they're all basically software or fimware problems. I don't know whether they are today or if Reliability Plus is in the system at all.
[0:15:00]

Gardner: They're gone.

Rodriguez: Well, basically the problem got solved with basically paralleling disk drives.

Gardner: Sure. There's an interesting paper. I'll send you a copy, if you're interested, that Google published. They studied 50,000 failed drives, because they probably have a million running. The bottom line is the annual failure rate is very, very dependent on batch and model. Some models are better than others, and a good model is maybe a half a percent per year or better, lower.

Rodriguez: Failure rate?

Gardner: Yes, half a percent per year.

Rodriguez: So failure a year in every 200 machines?

Gardner: Something like that, and that's a good one or a good batch of a particular model, and the worse one's run about 10 percent. And then they're very variable. And even the same vendor, his generation one will be good, and is next generation 25 percent higher capacity, -- bad. It's really very variable — they're all, of course, a million hours MTBF. But the failure rates <laughing> are not.

Rodriguez: Yeah, well I guess Hewlett Packard was notorious for inventing ways to improve UI, I mean to failure rate, MTBF, right. They had the methodology. They had a great methodology. Somehow or other, it always favored their machines.

Gardner: Does that come to the end of Storage Tech?

Rodriguez: Yeah, pretty much.

Gardner: Now we are about to embark upon your real entrepreneurial journey.

Rodriguez: Well, one more thing, the thing that saved Storage Tech is unbelievable, right. I mean, the company went into Chapter 11, Halloween 1984, and Ryal Poppa came in, in January. Two weeks later, I knew I couldn't work for the man, so I resigned and so on. What saved Storage Tech was somewhere in that timeframe it was discovered— the business was about leasing machines and selling machines. And basically you leased as many as you needed. You wanted as many machines on lease, because

they gave you a recurring income. But in order to make revenue, you had to sell machines. And so it was a combination of those two things. So over a period of two years that Storage had been selling these machines, they were normally sold to leasing companies, the same companies that would basically take a contract on a machine. And they would basically get about half the revenue from the machine. The other half of revenue would go to the company cash flow really. Revenue is the wrong word to use. Half the cash of the lease of the monthly lease would go to the leasing company. The other half would go to Storage Tech for maintenance and whatever. So what they discovered at that moment was that none of the machines that had been sold to leasing companies for the past two years had transferred title, UCC code. Somebody had forgot to sign or wasn't paying attention to the basically turning over of the title to the leasing company. So all of a sudden, all that cash flow came into Storage Tech. I mean, the leasing companies were up in arms about this, and all this, silly mistake, silly mistake, silly mistake. But it supplied Storage Tech with cash for the next two years. In the end, the leasing companies got their machines back, and I don't know how they got their money back. The power of the Chapter 11 court was amazing.

Gardner: That's an enormous cash flow improvement.

Rodriguez: Oh, humungous, right.

Gardner: Now, that's not generally known. I've not seen that in the discussion, but I haven't read the bankruptcy papers about coming out of bankruptcy.

Rodriguez: Yes we were all very naïve about the benefits of Chapter 11. But in fact, this town, and I mean Denver Metropolitan, Colorado, as a result of this Storage Tech bankruptcy, became very well-versed in bankruptcy. And I think several law firms are still making their nationwide business out of Denver as a result of that experience. And the number of lawyers, you can imagine. I mean, the company was in Chapter 11 for I don't know how long, two or three years. And it was able to basically finance their operations. I wish they have financed my optical disks. I mean, that was only a couple of million a month. <laughing>

Gardner: So the changing cash flow allowed them to bring the library, fix the disk drive problems and bring the 8380 out.

Rodriguez: They were out of disks within a couple of years. That was another mistake that was made. As I mentioned, I left the disk in late fall, November of '79. At that moment, I had two distinct programs going, the 3370 and the 3380, our versions of the 3370, 3380, again, working under the philosophy that we needed to be delivering product a year after IBM delivered theirs. So in order for that to happen, you had to have the product ready, the product ready, functioning, but possibly not compatible, most likely not compatible when the IBM drive came out. And basically you spent the next year making the products compatible. And the products were to be compatible by making sure the control unit made them compatible. So that was the philosophy that I was working under. Well, the new regime that took over said that's not going to work; we don't have the resources to make this thing happen. So we're going to scratch this whole thing, and we're going to wait for them to come in. In the meantime, of course, the quadrupling of the production took all the resources or a significant number of resources and basically abandoned. By the way, I had also started the semiconductor operation at Storage Tech, both to supply what was then the computer development effort that we had, mainframe development effort that we had in place and also to supply thin film heads.

Gardner: Okay, we've pretty much, I think, covered Storage Technology. Anything you'd like to add?

Rodriguez: Yeah. No, I think many things that— there's not enough time or enough tape cartridges.

Gardner: We are running low on cartridges. So you now, I think, describe yourself actually as a serial entrepreneur.

Rodriguez: Right.

Gardner: And your next truly entrepreneurial step is Exabyte.

Rodriguez: Yeah. I resigned from Storage Tech on February 1st, 1985 and I said I would go into some consulting. And sure enough, I got a lot of consulting activity and a lot about optics. I mean, I knew a lot of things and a lot of people, and everybody wanted to have a little piece of my mind here. I was reading some of this company in the Bay Area, XEBEC or something. I mean, I was doing well financially with consulting.

Gardner: That's Jim Toreson of XEBEC?

Rodriguez: Yes.

Gardner: XEBEC is the company that was early on in SCSI and did the IBM PC/XT controller. Jim Toreson is famous in Silicon Valley.

Rodriguez: There was another company there, and I don't know. I forget the names. I was looking through my papers the other day. Actually, it might be in here. I still have some of those contracts. Anyway, I mean, very quickly I grew tired of consulting for two reasons. The first one was traveling, I mean, just traveling too much. But the second one was even more important. I realized very quickly that as a consultant you advise, and whether they take it or not, it's beyond your control. Of course, I've always— being a general manager of a division where in the end when you say, "Let's do it;" people do it, as opposed to you go to consult somebody, and you say, "Let's do it;" and they say, oh, maybe. <laughing> It wasn't quite my bag. Anyway, within six weeks of quitting, the two guys from Storage — that's Harry Hinz and Kelly Beavers, came to me and came up with this idea for an 8-millimeter based product. They had been working at Storage Tech, Harry in particular, trying to prove this technology. And the product had been rejected as not in the company's main line of business, which was the business of building this tape drive that would sell from $20-50,000, right?. They came to me and this cartridge and it had 1 gigabyte. They said this thing can hold a gigabyte. Helical scan had a very bad reputation among us in those days. There was actually a product built in the '70s, this TeraBit from Ampex, TeraBit memory that was actually installed at the National Center for Atmospheric Research. . But it was really a lab product. I mean, it had an oscilloscope in it. It was really a very elementary, from an engineering standpoint, a very elementary machine. But it held a terabit of a t storage. And so I looked at it, and I scoped it again. Coming from the read write area, I said well, I should be able— and I spent hours in my basement on top of my green pool table; I had everything laid out in front. I spent hours watching those signals, watching signal quality. And pretty much, I was convinced that it was good. And then <laughing> I started doing some calculations, and I told the guys, you guys are sandbagging me.! This thing should be able to do easily 2 gigabytes, okay.! They said, yeah, we know, but we didn't think

everybody would believe that it could a gigabyte. I said, well, we can do two. And so I went to David Dunn, who had I had done Iomega with and actually who was the original investor in Storage Tech. So it's a guy that I've known for 15 years, more or less, not that close, but close enough. But I had actually recommended that he invest in Iomega— I knew the Iomega guys from IBM, and they had come to me for help in getting their company funded. So I had been involved in that, and I became part of their board of directors when they were founded, the two Daves, Dave Norton and Dave Bailey. And so I had known, again, David Dunn for quite awhile. I had talked to the people here in town, and they told me, hey, yeah, they liked it. I knew the people. And so I went down to see David Dunn in Fort Worth, Idanta Partners, Fort Worth, and presented to him what we were planning to do. And he says, well, we'll give you an answer in two weeks. I came back to Boulder, and I asked the guys how long before we get funded. And they said it was going to take at least three months. And one was Carl Carman; the other one was John Hill. So again, people I'd known for a long time, John Hill had been VP of Sales for North America for Storage Tech. And Carl, as I mentioned before, I knew him from IBM days, so I'd known him for 20 years.
[0:30:00]
And they gave me this very negative response. So Dave Dunn came back two weeks later and says, "Yes, we'll fund this! And we did. We basically— I said, okay, I need a trip to Japan to just make sure that I can get the relationships, because as, I had mentioned before, in optical I had met quite a few people at Sony. And I was thinking Sony would supply us with the device. And I made enough enquiries; I knew enough people in Japan. They said, yeah, this is feasible; they will supply us with the mechanism, "they" meaning somebody in Japan will. And we can make it work as a data storage device. I had absolutely no doubt about that. So I went to Japan, and we had a business plan. Well, it was a very elementary business plan. Actually, I think it's one of the reasons we got into trouble later.

Gardner: The museum would love to get a copy of that business plan, by the way, a copy of the Storage Tech business plan too, the original one.

Rodriguez: I don't think I have that, but I may be able to get that business plan, yeah. You got to realize, that summer of '85 I went to Japan. The Yen was trading at 256 yen per dollar. So when you look at our cost estimates, they were quite a bit lower than what they came out to be.

Gardner: By a factor of 2 you think?

Rodriguez: By a factor of 2, yeah, obviously.

Gardner: And this is sort of a departure from you as a general manager, because at Storage Tech as an engineer and a general manager, you did everything. You did your own media in optical. How did you arrive at were you going to buy the deck?

Rodriguez: Well, first of all, after my experiences as a consultant, I mean, thinking about it is I need a real job. So I said I've been a general manager of a half a billion dollars a year division. I'm a senior vice president of a billion dollar corporation, which was probably equivalent to about $4 or $5 billion these days. And the only way I'm going to get a job in an equivalent thing is somewhere else than in Colorado, or I can start a company. <laughing> And obviously, you really become accustomed to a lot of the infrastructure of a large corporation. But I decided I was going to save money, and I didn't want to hire a secretary, or as we have these days, an executive assistant. We incorporated the company actually on June 5th, 1985. That's in the book. That's in your story. And two or three weeks later, I had a call from

the VC saying, “oh, you know, that presentation? Why don’t make a Xerox of it? You make a copy of it and FedEx it to me.” I was going to argue a little bit. But,I said,” Okay, fine, fine.” Well, we didn’t have a copy machine. So I knew where one was. It was a Safeway, $0.10 a copy. I can make a copy. But I had never FedExed a package before. And by the way, we had a fax machine but only to communicate with Japan. Nobody had a fax machine in those days, so I couldn’t fax a document in those days. Obviously, there was no e-mail or anything like that. So the quick way to get something done is to FedEx it, right? But I had never done a FedEx before. So basically I spent about three hours doing a simple task: “copy and FedEx it.” And I said, “self, this doesn’t work. I got better things to do!.” So I called my old secretary <laughing> who had left STC before I did actually. I mean, a lot of people had left. I said, “Cindy, could you come over tomorrow? She said, “Yeah, yeah, what I am doing is boring”. She was really very, very good.

Gardner: It’s awfully lonely, I’m told, in a start-up when you have four walls, not a lot of furniture, not a lot of people, which is where you were in June of ’85.

Rodriguez: Yeah, actually by this time, we were pretty well on our way of having recruited most of our engineering team, so much so that Storage Tech got a little pissed at us and sent us a “Cease and Desist” letter. And well, it’s a long story, but we finally came to an agreement where I wouldn’t hire any more people out of engineering. But we kept hiring people out of Storage Tech, and whoever an engineer wanted to come work for us, he first transferred into manufacturing and then came to work for us. <laughing> Again, it’s amazing how people just do whatever they want, right?. But so we got started, and actually we got some people out of marketing and some people out of manufacturing and some people out of engineering. So then basically by the end of the year, there were 11 of us in the company. And at that moment, actually it happened over a period of several months, but basically, by the end of December we had just— the investors and us did not trust each other. And I mean, I can go into some detail, but basically they decided to close us. We were ahead of schedule! We believed we were under budget. And they closed us! Well, I’ve thought about the issue, because the cause wasn’t necessarily obvious then. And I eventually believed that the main reason for our lack of trust, both sides on the other, was because we really hadn’t written a business plan and defined our business model. And basically, we shared a board with Iomega. I mean, everyone on the Exabyte board at that moment in December of 1985 was on the board of Iomega, including myself.
[0:38:39]

END OF TAPE 7

[0:39:00][3]
Gardner: Tape number 8, the Juan Rodriguez interview, July 15, 2009, Juan.

Rodriguez: Well, I eventually came to the conclusion that the distrust came out of the lack of communication about the fact that we believed we were an OEM company, and they believed we were going to be a shrink-wrapped company like Iomega. And of course, our plans didn’t make any sense to them. And their criticisms implied to us that they wanted to take us over. I mean, after all, the board was <laughing> totally Iomega! And they were a public company, and we were not. And so there was distrust. They were doing everything possible to make sure that Iomega could take us over, because they believed that we were just totally wrong about what we were doing. I mean, how could we possibly

[3] Time stamp, h:mm:ss, from beginning of DVD 3 containing Sessions 7, 8, and 9.

do what Iomega was doing if we were basically operating under an OEM agreement? So I got fired. So their last visit was on Christmas Eve 1985. It was a Tuesday. By the time they left, they knew that we wouldn't have an agreement. Basically, they wanted an agreement from the individuals that they would stay around so the technology could be sold. They understood the technology could not be sold without the individuals. Everyone refused! So this is Tuesday afternoon. I got a call; we were having an emergency board meeting Thursday morning, which is the day after Christmas, by telephone, at which time I got fired. I had given everybody the rest of the week off until Monday. And on Monday, they came in and basically fired the rest of the people. But as they fired an individual, they gave the individual the opportunity to stay on as a consultant. I think they wanted to make sure they had this thing wrapped up before year end so from an accounting standpoint they had closed the books, if you will. And everyone refused to join except my secretary. And I said," Cindy, well, I tell you what. Why don't you just stay and tell me what's going on? "She accepted. In the meantime, I'm trying to get VCs around here to come in, and by the way, Idanta had offered me a package that said we'll sell to whomever at $0.50 on the dollar what we have. And we basically had $0.50 on the dollar of the original investment left, so it seemed like a great deal. And I actually brought the local guys on board on what was happening during the month of December and had discussed it at the Christmas parties and stuff. So it wasn't a surprise to anybody. But when you get fired the day after Christmas, everybody is skiing, and there are no cell phones at the time. It's impossible to get anybody who is skiing on the slope. So I was frantic trying to get a hold of people, leaving messages. I mean, impossible, impossible. So the day after they got fired, on Tuesday, we got together and I said, "hey guys, we're going to get a month allowance here. I know everybody needs money here. Why don't you guys start looking for jobs, but please, please don't accept any jobs until a month from now. I'll have the money by then". Of course, I didn't know whether I'd have the money by then. But I said, "if I don't have it by then, you guys can do whatever you want." And basically, we got funded three weeks later by new VCs. And, in a sense, the rest of it is history. But having been fired and thrown away by one of the most successful venture capitalists in the country, David Dunn had done obviously Storage Tech, had done Iomega, had done Prime Computer and probably multiple others. We looked like lepers by the venture community that year, and we were bridged by Hill and Carman. They were two different VCs then. I mean, I like to say that we had 44 presentations that year, and the way we got even was that only three of them invested, and they got one hundred times return on their money out of that investment. That's how we got even. This is where the nickel story comes out of—what's his name?

Gardner: Gardner Hendrie?

Rodriguez: Yeah, Gardner Hendrie, yeah.

Gardner: You definitely have to tell that story.

Rodriguez: Well, again, we had made presentation to everybody that year except to IVP. And IVP didn't want to see us because they were invested in another tape drive company down in Los Angeles. I forget their name. The guys that did the quarter inch cartridge down there.
[0:45:00]
And they had gotten rid of that investment or they had sold it or whatever, and now they felt they didn't have any conflict of interest. And Reed Dennis came and basically we went to present to Reed Dennis. He liked what we were doing. Reed, boy, within a week he had his whole team flying out in his airplane to Boulder. It landed at Boulder airport, which is a general aviation airport, and came to visit us. We were only two blocks away from there at the time. We were in Sterling Drive, which is a good place to be. And they liked us and basically proposed to lead the effort. And we closed on a $4.3 million round like at

around December 1st. What's the name of their venture fund, Hendrie's venture fund, Sigma Partners? Basically, we had a potential investor come in and say that they would not invest at $0.60. We had been asking for $0.70 or $0.80 or whatever. It doesn't matter. We finally had come to an agreement of $0.60 a share. And these guys would not invest at $0.60 a share, they wanted $0.55 a share, and we told them that they could keep their money— and Burt Jamison. Anyway, it's not a really big story. What it shows is that in any one of these deals you need someone who is well-known in the industry. After Reed decided to invest, everybody wanted to invest. And things happened. Actually it was a great month. December of 1986 was a great month, because we got our money. I hired my VP of sales, Jim Greenup, who was fantastic. Our first ASIC came back, and it worked!. So I mean, everything started to click then, I mean, especially after having such a horrible year where you're spending your time just trying to convince people. And, as you know, there's an article here that talks about whether somebody needs 2 gigabytes or not, right?.

Gardner: Right.

Rodriguez: And that was a year where we had to argue. Half the people we met didn't believe that 2 gigabytes was needed. And the other half didn't believe it could be done. Of course, the guys who were skeptical about our ability to do it well were our potential customers. But boy, they wanted that product so bad! I'll explain why. And the guys who didn't think it was needed were the investors. They said, "well, I know you're going to do something ten times better, but who needs a gas tank that's ten times bigger?" And my answer to them, by the way, was: "this is not like a gas tank that's ten times bigger. This is like an engine that eats a tenth of the gas!" Actually, both analogies were pretty bad. The fact was that the reason why there was such a tremendous demand for this product was because in the industry at the time, the industry had gotten together and defined a tape drive which would have been 200 megabytes in a five and a quarter inch form factor at full high with a SCSI interface. It was supposed to come out in late 1985. We were starting in June of 1985, and our argument, our proposition was that it would be ten times bigger, and we would take the top end of the market — but otherwise, at the form factor level and at the interface level, we would be compatible with that product. So all you had to do is slip them out and put us in.
[0:50:00]
Well, much to our advantage, and by the way, there were probably half a dozen companies pursuing that product. And slowly but surely, they fell back to where at the end there were two companies just working on the problem. One was LMSI out of Colorado Springs. Laser Magnetics Storage, they were basically Phillips owned. It was actually a joint venture by Phillips, Control Data, Univac; Burroughs may have been in there. And when everybody says, okay, we'll put all these projects into one effort. There was a start-up in California that was also trying to do it. And so this is supposed to be delivered in 1985, late December, first product. When we finally started to deliver our first customer ship, which was really an evaluation beta unit, in the Spring of '87, that product still had not shown up. And by this time, all these planners who were counting on having a five and a quarter inch form factor tape drive didn't have one. So we had an industry with holes waiting for a tape drive to be stuck in so they could do their thing. And the tape drive wasn't there. There wasn't a five and a quarter inch form factor tape drive that could fill that hole. So we went to test at Univac. It may have been Unisys by the time. They had a server group in Orange County. And they started testing. And this is where maybe having a lot of experience with tape drives really came into being. One of the problems with tape drives has been— was and probably will always be is that the first primary access data storage product, it started in a bad way in the early 1950's. And basically, the original device drivers, if you will, were really part of the operating system back then. So it wasn't that you had this different software. It was all part of the same thing. So as the systems grew in performance and in complexity, and tape drives grew in performance and complexity, the software driving tape drives just inherited the last generation's issues and problems. So by the time 1987

comes around, there was one command that these tape drives had to respond to in order to perform with all the software. And that command was “read backwards.” And, I’ll tell you why, because you have to go back to the first tape drive to understand why that command was so needed. By the way, this high-tech drive had been defined without “read backwards.” So those machines were not capable of reading backwards. And so when your first customer, which is Univac, I mean big customer, tells you, “you got to read backwards”, you say, we can’t. Well, what happened was this; they started testing this product against their tape drive software, and the thing kept saying, “not capable.” Why? Well, it’s got this “read backward” command. So, we say, “get rid of it; you know we can’t read backwards.” “You’ve known this all along, right?” This is part of your spec. <laughing> They kept saying— so they spent a few days trying to get rid of all these “read backward” commands. And we’re going to test again, and within minutes it would fail again for the same thing. Oh, another one, oh, okay, spend a few more days getting rid of it. Well finally, after about a couple of months of them trying to run their backup programs against this little drive, they said, “we can’t guarantee there’s isn’t going to be a “read backward” command.” And that is one that we can’t get rid of”. And so we said, “okay, we’ll look into it”. What we came up with what was basically memory gymnastics within the tape drive we asked, do you care what the performance of this feature is? They answer, “No, we don’t care what the performance is when you do that”. We say, “okay, what we’re going to do is: we have memory. So when you give us a “read backwards” command, we’ll go and read that record in the forward direction and then twist it around in memory, because the data has to be delivered backwards too. But this is going to be sucking performance. <laughing> This is going to be slow!. They say, “We don’t care. It doesn’t happen that often, right? And what it was. Again, going back to the first data drive in 1953,and you have to remember, there was no memory in those days. I mean, a tube was a bit. And so in order for the system to know that you had a tape at load point, which is the beginning of tape, which was the mechanical—there was that little reflective sticker that reflected and says we are at the beginning of tape, physical beginning of tape. What they said was a command, “read backwards,” and this is exception, the tape drive responded, “we’re at load point”. Load point, that was the response. So it wasn’t that they were reading backwards, but they didn’t have a backspace command; they had a “read backward” command. I mean, backspace we could do any day, because you have to do a backspace. But you couldn’t do a read backwards. So we did all that stuff so we could do read backwards, but read backwards would never be done, even though this very advanced tape drive could do it. But we just had to report that we were capable of doing it, and be able to do it. And so we said yes to Univac, and LMSI, the only competition we had, which was being supported by Univac, by CDC, by Burroughs, by everybody, they said “we can’t do it”. And they gave up the program. At that point, we had all these holes ready to be filled by our tape drive, which again, needed some work to become the fine machine it became. Boy, it was the early days of SCSI, and there wasn’t this interface. It was much better defined in disk than it was in tape. Disk had its own set of commands. But we had screwed up a couple of them according to specs. But eventually we made it. Again, this issue, when people want something bad, they come over to your side and help you do it, right. The moment they can get it from somebody else— it is a very fickle set of customers. But also at this time, networks started to come into being, and the 2 gigabyte answer, which was a real problem, because 2 gigabytes at the time, it just seems like it was so much. And we finally got some data that year that said the previous year the average DEC system had 1.5 gigabytes of storage. That justified it! But the thing that really made us grow and where a lot of the VARS really made a lot of money, if you will, was that they finally had a network— and to back up, the networks, which I assume you know, was the aggregate of many different disks. We had what they wanted and what they needed; unattended backup was really the main story. And the demand just grew through the roof. When we finally got IBM as a customer, we had arrived. And we did that in early 1989. But basically, we really didn’t ship very much product until the fourth quarter of 1987. In 1987 we had $3 million in revenue. In 1988 we had like $31 million. In 1989, the tear IBM came in, we had $89 million in revenue. I remember that number. That’s the year we went public.

Gardner: In 1991, you had $234 million.

Rodriguez: Yeah, $170 in 1990.

Gardner: You were the third fastest growing company in America.

Rodriguez: That's right. It was really unbelievable, and we had, in 1987, again we had this relationship with Japan. And in 1987, we signed a deal with Kubota Corporation of Japan. And in that time frame, they were investing in several computer companies, computer technology companies in the United States. We were one of those investments. Part of that relationship said that they would build part of our product, and we had signed that agreement in July of 1987.

Gardner: I don't think you ever answered my question.

Rodriguez: Yeah, which is?

Gardner: For a guy who grew up in a company that did everything, IBM first and then Storage Tech and making your own optical media, you went off to Sony to buy the deck. And then you went to Kubota, took the deck and build the product. This is a very different strategy. How did you get there? It was just needs of the business, somebody pushing you that way? It's a radical change from your prior experiences.

Rodriguez: To outsource, right. I don't know.

Gardner: Just got smart?

Rodriguez: I don't know it was that smart. We went to Japan— first of all, Storage Tech had a relationship in Japan. And I had been to Japan probably starting in 1980. I had made several visits. I mean, I think the hot thing at the time was semiconductor memory. And they were building it, and of course, in 1980 even though I had an optical disc effort to run, it was a part-time job. <laughing> You go from a division that's got a 1,000 people to one that's got 10, you got plenty of time. So I was kind of the pretty boy and went out in a lot of the cultural business relations. I was very interested in Japan, the technologies and optical disks and semiconductor. And so we had people in Japan. I had people I liked in Japan. And when we started Exabyte, I had a dear friend of mine, Sandy Platter, who was a brilliant mechanical engineer, a little controversial otherwise but brilliant. And basically, I asked for his advice about this mechanical monster, this rotary head. That looked like it was kind of hard. I mean, they were operating at ten times the track density of normal tape drives. And they had this alternate azimuth technology. And I asked Sandy, can this be done? <laughing> I mean, I'm looking at a product that is being done. And the product we were looking at was actually a professional deck. It wasn't a consumer deck. It was a professional deck. And I basically said, advice? Yeah, this is amazing, but I wouldn't try to build it. He says, you'll probably have to get it done in Japan. I mean, there were no alternatives. I mean, you had tolerances in this product which were half what we were requiring in disk at the time, half a tenth and micron tolerance. And there's just no way we can do this. I mean, the drums had to be done in temperature controlled rooms. The surfaces, oh, there was so much technology into that. And the rotary head technology, it was basically Japan's, basically out of the VCR beta max kind of experience. And of course, we were using an 8 millimeter technology product. That was all Japan; the media was

made in Japan. So I don't think I thought about it very long and hard. It had to be done in Japan. I had the contacts. I had the people to basically make sure that I had the right contacts,— and the Yen was very cheap too. So I mean, it just all played. We rode down the Yen to 120. Unfortunately, it's in the 90s today. So anyway, I don't think there were any options for us. It was either Japan or not at all, I think, at that moment.

Gardner: Anything you'd like to share with us about the road show and taking it public?

Rodriguez: No. That part is all glamour. Well, no, no, there is one last piece. We did a road show, and from an investment standpoint, we basically scheduled our last presentations to be in New York. And we had done the West Coast. We had done Boston. We had done Paris, London and Geneva Switzerland. Goldman Sachs and Montgomery Securities took us public, all very glamorous really. That's not an arduous process. It's obviously exhausting but not arduous. And actually what happened is on— that last day was a Thursday, and I forget the day, but it was October. I think we went public on October 19th. Is that the date on that brochure? And I think that was a Wednesday.

Gardner: It says October 19th.

Rodriguez: Yeah. You don't forget certain days. That was a Wednesday. But I'll tell you what led up to it. So, the previous Thursday, we were in New York giving our last presentations. And we had gotten word that Bush, the president then, was coming into town and that they would lock down the town at 3:00 in the afternoon to let the motorcade come through. And we had a plane out of La Guardia, and we had to make La Guardia before then. So on that day, we were going so hot that they were telling us well, we'll probably go out at $14, $13, $14. The brochure said $10, but the pricing would be done at the last day. So I had to give a talk in Monterey, CA, the next day. There was some conference going on in Monterey, and I was supposed to give a talk sometime during the day. So I took a flight out to San Francisco that night, probably got into San Francisco around midnight, I think, and drove a car down to Monterey. And woke up the next morning, and we were attending the conference, and I called my CFO around 11:00 that morning. And he says, the market is crashing. So we're talking. It is his lunch time; we're talking. And he says, I don't know. I mean, I'll give you some funny numbers, like okay, the market is down 80. And 80 was like 800 today. I mean, I think the market was about 1,000. So it was down like 80. And then as we talked, he says the market is down 120; the market is down 150. Oh, Jesus, I forget how far down it went that day. That was Black Friday. And so the weekend goes by. By the way, all this time we're waiting for a final blessing from the SEC.
[1:10:00]
We had registered and everything. We had our third quarter results. We had done very well and so on and so forth. Again, we were in on our way to an $89 million from a $30 million year. And anybody who was in the industry was our customer by that moment, including IBM. And so on Monday, the markets were still in great turmoil. And I was talking to the Goldman Sachs people, and they were saying, hey look, we can't price this thing. If we had the SEC come thru we could, now we can't price on this thing. The markets are very turbulent. So the next day, Tuesday, market is settling down. There's talk about possibly pricing the next day. And you cannot price at the end of the market, at the end of whatever, 2:00 or 3:00 in New York, 3:30. So all day we waited. I think the SEC's release came in either late that day or the following day. But so we're worrying about this thing all day Tuesday, and I was supposed to pick up my daughter at the high school at 6:00 PM. So I'm on my way to the high school to pick her up, when I hear on the radio that there's an earthquake in San Francisco. I said, "Holy shit. What else is going to happen to us?" <laughing> Of course, I really felt ashamed about myself, because I had two sons at Stanford. <laughing> And I said, "Oh God, what's happening to them?" And, I don't know, all of you who

were involved with that, I guess that the telephone company in California shut down all incoming calls into California so they could talk between themselves, I guess.

Gardner: Actually, as it turns out, I was on the road from New York City to Stamford, Connecticut when that earthquake occurred. I got to my motel, picked up the phone, and on the second call got through to my wife.

Rodriguez: Oh really?

Gardner: Yeah, personal line went thru.

Rodriguez: Well, between the kids being in school and so on, we really didn't find out until about 3:00 in the morning that they were okay. So the next morning, I called Goldman Sachs, and they say" well, it looks like the markets are quieted down. We should be able to price at the end of the day. But first"— first what? "You got to do some due diligence to see whether any of your suppliers are still in business" <laughing>, the ones in California, circuits, — what's the name of that company building boards for us in San Jose there? Anyway, and we couldn't get through. We couldn't get through. And well, finally, we were able to get a hold of one of our salesmen who got— I guess it was relatively easy to do it inside California but impossible to get through outside and again, no e-mail, right? I mean, the telephone was the only way. And so I was talking to the Goldman Sachs guy in New York. And I says, I guess we're not going to price today. And he says, "why not?" I says, well the thing in California. That's when he told me about the due diligence, he says. But you know, Montgomery probably can't function with all this telephone stuff. So the guy says, "so what?" <laughing> I guess they didn't care whether Montgomery would have their fair share of the deal. But in fact, I asked the guys at Montgomery, and they said they actually did have cell phones. They may have weighted a couple of tons a piece at the time, okay, but they did all their transactions on their cell phone that day, and they were able to get the deal done that day. And we priced at $10, not at $13 or $14.

Gardner: So Black Friday cost you $3 a share?

Rodriguez: Yeah, times 3, times $3 million, so $9 million. The price of the stock went up afterwards, and in a sense, that's really what everybody cared about.

Gardner: That's correct.

Rodriguez: I mean, we had cash in the bank. We did not need the money.

Gardner: So explosive growth at Exabyte, and then you left. Care to talk about that?

Rodriguez: Yeah. By the time 1990 came around, I was tired. I mean, that's the only way I can really define what I had. We had had this whole optical disk, the Chapter 11 thing, the getting fired by the VC, going through the problems of the start-up, all that travel and everything. And I was just mentally tired. Probably shouldn't have done it, but I did. We had hired Peter Behrendt a couple of years before, and his ultimate objective was to be the CEO of a company. So I said, all right; this is a good time. So he and I kind of agreed that Spring when it would happen. And so we picked basically first of July for it to happen. And Reed made the announcement about distributing the stock before hand and all that. Reed Dennis

distributed his stock; IVP distributed their stock that month. They did it in one fell swoop, and I still remember Reed being extremely proud of the fact that that was the biggest distribution done by a venture capital firm up to that point, and it was about $80 million. Probably those numbers are kind of small compared to what's happening today. But that was the biggest distribution they had ever done then.

[1:17:00]
END OF TAPE 8

[1:17:21][4]
Rodriguez: So I stepped down. Three months later I'm bored. I'm getting all kinds of different offers to do something, and as it turns out, and I would advise anyone who's in that position not to accept anything for a year. Because I really got too busy doing too many things. And all of a sudden well you say, "Well, I can take a look a parallel approach to look at things." And then all of a sudden they all hit at once and through a series of circumstances, I get offered a job at the university, by the engineering dean to bring business education into the engineering curriculum and I accepted that job and it was great. I mean it's always great to be able to give back to the profession what I thought I lacked. There was a criticism I have about Cty College that we had a four-and-a-half year program with 144 credits and no electives. Things changed since then but basically I said, "Boy, I wish I had a business education of sorts." Anything, anything, anything at all. One semester would have been 1,000 times better than what I had. And the basic reason it was very simple: an engineer lives in a business environment. I mean he cannot practice the profession outside of a business environment, otherwise he might be a scientist but not an engineer. An engineer is about putting things together for the betterment of society and normally that implies money and I wish I had had a business education. I think I could have done some things better if that had happened. But by this time I had been schooled in many of these things by both practice and some theory. And I loved that challenge.

But at the same time, these guys who started Datasonix came to me. This is going to be-- there's a little cartridge here. This is 19 by 92,the size of a postage stamp and we were going to put one gigabyte on it. Again, it was a Sony product. It was a Dictaphone kind of product. And what it had is a very interesting technology, basically this is a non-tracking technology. How do you do that? Well, simple, relatively simple to understand. But basically one of the biggest problems with tape, probably one of the biggest problems with disk too, but one of the biggest problems with tape is that you have track follow. And the hard thing about tape that is not in disk is that the media is flexible. And not only flexible in orthogonal to the surface, but also with the surface. It moves in every direction with temperature and humidity and stuff. And therefore predicting the position of a track is nearly impossible. And then you've got several of them in parallel and they could be moving with respect to each other. So these guys were basically packetizing the format, where it will say, "Hey look we have packets. I can read a packet either at this revolution or the next revolution and later on I'll assemble it." That's kind of what they did in a very primitive sort of way. It was an audio product so they didn't care about a lot of data reliability things because audio is not really that way. But they had a concept here that was great. And, in fact, we designed the product to attach to a laptop and be basically field backup. And delivered t in time where you had 10 megabytes, 20 megabytes of memory. And a disk drive was, I don't know what it was, 100 megabytes maybe, or maybe it was less, I forget. A gigabyte backup was fantastic, right?. In fact, we were so impressed by the performance of this technology we basically, again, took a Sony mechanism and put our own electronics around it and were able to get a gigabyte out of it. And we had a very impressive start -- we built and shipped about 12,000 machines eventually before shutting down the company.

[4] Time stamp from beginning of DVD 3 containing Sessions 7, 8, and 9.

Gardner: When was this now?

Rodriguez: They shut it down in 1996. But basically in 1994 our costs were high. Sony charged us too much, well beyond what they had promised they would charge us. And then, to make matters worse, the yen went from 110 down to 79 and our costs were exceeding our sales retail price and so the company kind of collapsed around that issue and it could never get back going again. But the technology was very impressive, right?. And we basically decided to go ahead and start Ecrix using that packet technology and start from scratch on a design that would make it a very effective data storage device and it worked wonderfully, right. I mean it was just this-- we knew what we had to do. We knew all of the basic problems with this product type from a technical standpoint. We knew all of the problems with tape drives in general. And we were able to achieve fantastic reliability in a product. Again, once you got rid of this issue that the platform, the tape platform, the media was-- we didn't care what happened to the shape of a track after we wrote it, okay.

Gardner: You said we a couple of times, same folks at Datasonix and Ecrix?

Rodriguez: Well, Kelly Beavers was the common. And we brought some guys, obviously from Datasonix, but some guys from StorageTek. But some guys from StorageTek, I mean we were able to recruit widely but we knew what we needed, we knew what we wanted. We got it done. It was a fantastic product. And all of the time, though, we're really competing the number of OEMs is going down. We're competing with the four millimeter technology which was low cost technology. We're competing with expensive technology.
[1:25:00]
We're competing with Quantum and their tape. And then right around the time we started ours, we had two other starters one backed by Jesse Aweida and the other one backed by Bill Bierwalters, up in Longmont. So all of a sudden three pioneers of the industry have a start up around the same market basically pushing product. Now, we basically killed each other off from the market. But we all came out with products that on their own would have satisfied the market tremendously. So we came out with our products. We, again, had Japanese relationships for manufacturing and media supply. And we got into trouble. We were a victim of the bubble bursting too. Our financiers, our investors had their own set of problems. One of our major investors was basically into the telephone infrastructure business and of course that crashed along with everything else. And so I think that the board at the time felt that the best solution for us to sell it to somebody and Exabyte turned out to be that somebody. So there we were, in November of 2001 we were acquired, we were merged into Exabyte. And we basically in some ways saved the company, in some other ways it was a company that was in a difficult position to be saved. And they had had their share of problems, declining revenues for several years were basically out of cash with a lot of encumbrances. And we tried to make the best of it and spent four years trying to save it. Two months after I joined-I joined it as a CTO, non-executive, nothing. I didn't want anything to do with running the place- and two months later the board asked me to become an interim-CEO. If there's any lesson to be learned from something like that, you say, "Well, it looks if we got rid of a third of the company we would probably be in good shape." Well, when you're in a shrinking mode forecasting shrinkage is almost as bad as you having to forecast growth. When you're forecasting growth, you're never good enough and you're making all kinds of money because you're always working people very efficiently, supplies, everybody is working to their best because they're working beyond their capabilities. So they're very, very efficient. When you're shrinking it's the same thing in reverse. You're never working at the efficiency level. You're never declining. You're never shrinking fast enough. So instead of a third, I should have cut it in half.

Gardner: Growth covers a lot of mistakes and shrinkage exposes them.

Rodriguez: Exposes, totally exposes them. Yes. And well the argument for not cutting it in half was, "Boy, we don't want to break anything." But we, I mean otherwise, we wouldn't do it. And actually somebody thought we might break this or that, which would really be bad.

Gardner: What you had at Exabyte you were the dominant eight millimeter, the only eight millimeter, I think, by this time.

Rodriguez: By this time. Well, Sony was producing their own format. They had gotten into a fight with Exabyte in the 1993 timeframe and decided to do their own. So they became a competitor. So they ate into each other's market.

Gardner: Exabyte had added four millimeters by then?

Rodriguez: No, no, no. Sony added eight millimeters.

Gardner: Okay. So Exabyte didn't have four millimeter. Did Exabyte have an LTO?

Rodriguez: No. Exabyte tried to get into the four millimeter game by acquiring a company in late 1990 but it didn't work out.?.

Gardner: So you inherited an eight millimeter and the VXA, right?

Rodriguez: Yes.

Gardner: Ecrix bought VXA and Exabyte was basically an eight millimeter company at that time?

Rodriguez: Yes. And with libraries. Exabyte had libraries.

Gardner: Okay.

Rodriguez: You know I had brought out the first library in 1989. And I thought of it as a supplement to the tape. I mean I wasn't in the interested in the business as I much as I interested in showing the market that we had a high performance tape drive that could work in the library. And the libraries became a major part of the business much like the media itself became a major part of the business. And I mean one thing that our libraries did is they consumed a lot of media. And the media was very profitable. So by this time the problem is that Exabyte had come out with a tape drive in the year 2000 that shouldn't have come out at that moment. It should have been fixed before it came out. It should have been more reliable. It was so unreliable that it wasn't really working well in its own libraries. So it was unreliable. And they went from shipping, I forget what, like 10,000 drives a quarter to 1,000 drives a quarter.

Gardner: Because the market had moved to LTO?

Rodriguez: No, they dug their own grave. The product reliability just killed the product.

Gardner: But isn't this the time period when linear tape is getting a rebirth?

Rodriguez: Yes, well what happens is Quantum buys out that tape line out of DEC.

Gardner: That's DLT and SDLT.

Rodriguez: The DLT, right, S-PED [ph?] they renamed it and found themselves with a goose that laid a golden egg in a sense. Got rid of the disk business and just stuck to tape at a moment time where Exabyte was just failing miserable to deliver on plans. You know when I left Exabyte as a CEO in 1990 we had a three year plan to come out with a high density, high performance tape drive along, the Mammoth One, and it didn't come out until 1996 and it came out with problems. And basically that foothold allowed the DLT product to come in. And then what happened with DLT was Quantum didn't really have the …

Gardner: Depth?

Rodriguez: No, it was really more of a business, tape business culture that tape customers, OEMs wanted. They were extremely arrogant in their relationship with the OEMs. So I believe that as a result of that is where LTO came about, right.

LTO was a reaction to the Quantum arrogance, business relationship arrogance. It had to do with royalties on the media, royalties on this, royalties on that. They didn't want to share any of the revenue. If you looked at the Quantum results right, most of their profits came out of media and very, very profitable and the OEMs wanted part of that and they weren't getting it and they decided to do their own, right.

Gardner: And Exabyte's Mammoth wasn't there.

Rodriguez: When I left Exabyte we had a 10 times advantage over everybody I mean it was just very unfair. By the time these guys came on board they had basically closed the gap down to nothing. And not only that they came out with some pretty good product, pretty reliable product. Again, the only real problem with DLT was its banishment, I mean it's business dealings in a way. They basically paved their way to their own destruction by not complying somewhat. I mean you don't have to go all the way but you certainly have to treat your customers with some respect, right? Not that they're nice guys either.

Gardner: OEMs you've got to treat better than you treat your grandmother.

Rodriguez: Yes, it's just business, right. And everybody's got to win, right. And then you make the mistake, you say, "Well, this company versus IBM," well it's not IBM. Yes, it's IBM, but in IBM there's a few individuals within the corporation that you're dealing who have to do their job and have to look like heroes at the end of the day to their company. And that means that you've got to treat them well. And if you start screwing up or screwing around with those guys, what are they going to do? Survival of the individual is a key to all of these relationships. And the individual basically had to survive by more or less getting their own company to go along with them. And if somebody up on top or in the CFO or someone

is saying, “Look at all of the profit these guys are making, how come we can’t get a piece of that business?” All of a sudden this guy looks bad. IBM brought their tape expertise into it. They were able to do wonderful things and they’re doing wonderful things. StorageTech was able to keep up with them and they own their own formats and so on and so forth. But then the sale to Sun has crippled we know by what was StorageTech. From what I understand their business is half what it was when they were sold to Sun about three of four years ago.

Gardner: That’s my understanding too. The Ecrix technology, the packetizing wasn’t able to help Exabyte reestablish itself in the marketplace? I know there was a second generation.

Rodriguez: Yes, second and third generation. The encumbrances of the old Exabyte just killed it. They were constantly lacking cash. They had to repair product. Every one of those Mammoth II machines shipped in the first year came back for repair at least once. They could not stand the rigor of it. We spent more money every month repairing those machines than we were building the new ones. So it was one of those horrendous mistakes to have shipped our product. They would have been much better not shipping a new product and then killing the old product. I mean that was the other thing they did, they killed it. The arrogance, boy, talk about hubris. Gosh. Basically, on day one, they stopped production on one machine and started the other. Well the Mammoth I worked. The Mammoth II didn’t work. Again, they go from shipping 10,000 machines a quarter, to shipping a thousand, why? I mean if you look at the shipping thing, they keep shipping for about four or five months while everybody starts to find out whether or not this thing works. And then all of a sudden everybody realizes it doesn’t work. And just demand just dropped, just like a stone. I mean you’ve never seen a product drop shipments. And the OEM suspended deliveries. They had a couple of nice products before they started shipping this thing, and they said, “No more, you’ve got to take the new one.” I mean what kind of …

Gardner: As an engineer, the packet concept of XVA…

Rodriguez: Fantastic.

Gardner: XVA is still shipping in Tandberg. But it hasn’t come on…

Rodriguez: The company wasn’t able to afford the development of the next generation product and you’ve got to do that right?

Gardner: But the other people haven’t adopted that technology which intrinsically seems the direction one would go because of the advantages you’ve given, but it sort of hasn’t gone that way. Care to speculate on that?

Rodriguez: Well, now you mention that I don’t know where this thing ever went. Exabyte, Ecrix, had a couple of patents on some of that stuff. And in order to make the latest DDS drives work -- that IP was implemented in the four millimeter one. And as I left two or three years ago we were in the middle of a court, we sued over IP and the countersuing was over some silly stuff. You say, “Well, you know you’re doing this.” And they said, “No, we’re not but you’re doing this.” A couple of things they countersued us on we weren’t even manufacturing any more. So anyway I don’t know where that went. That would have been fantastic. The interesting thing was that we almost won in 2001 because Sony said that they were not going to do four millimeters any more. And within a few months HP and what’s the name of the other

company that said they weren't going to do it any more. So we felt great, right, but it sounds like the pressure for the next generation product was so great that finally, they came back and said, "Okay, we're going to have a next generation DAT product but it's not going to be four millimeters, it's going to be eight millimeters." And that's where they started to fool around with some of these concepts -- they weren't quite packetizing yet. The problem with going to a packetizing machine was that all of their controller and stuff was about a sequential data stream. Whereas the packetizing scheme basically works on the principle that the data is coming in asynchronously in parallel. So I get a packet, I get a packet, I get a packet, I get a packet. I get a packet and I put in a slot. I get another packet and I put it in its own slot. I get the packet back it's kind of like the way the Internet works pretty much, where they can come in any sequence they want. Last first, middle one last, first one in the middle, I mean they can come in any sequence. And they all have an individual address. You stick them in memory and they come back. And you put some powerful error correction around that at the packet level. And again, it doesn't really matter. It doesn't really matter when you get the packet. Your only limitation is how much buffer memory you put between the first and the last. And, again, if you put enough error correction in there, you don't even have to have most of the packets. It really is an interesting process. It's an interesting machine because in the end there were about 11 combinations of packets which kind of made a log jam. But when you get a log jam, you only have to fix one of them. And the log jam releases. So it was fantastic. You know, when we first put that system in place, we only had the ability to correct two bytes. And which gives us a fairly good reliability rate of 10 to the minus 20. So we put the first prototypes in place. We were getting an undetectable error every minute. What's wrong? What's wrong? Pretty soon we figured out that that was actually with the error correction system that we had we were actually being able to fool the error correction system that often because we were really-- when you have an asynchronous you don't track as you well know, you get read errors, right. And when you have a system that's not tracking, you can say half of the time it's tracking the other half it's not tracking. And when it's not tracking, like any other read system it's making errors. So your raw error rate coming back from the tape is humongous. So when you finally figure out what your raw error rate is and what your error correction capabilities are, yes, you should get an undetectable error about once a minute.

Gardner: I'll remember that one.

Rodriguez: Yes, remember that one. And so we said, okay, if we had two bytes-- actually it's not that they're undetectable by the way. We were too careful for that. But we had backing up this whole thing we had a CRC around the whole thing and nothing got beyond that. But all of a sudden you had an uncorrectable error, right. So we added two bytes, so we had four bytes of error correction to the system and that got-- the funny thing was it was-- I mean this is why it's so interesting, right, because you start looking at the errors, -- I think it's a 128-byte record. And we were getting five bytes, the most likely error to have was a five-byte error in 128, which met all of the error correction criteria. Those five different bytes together in that whole record gathered around the error detection system. We said, "How can that be?" We had a system that could detect and correct two bytes. But we were getting three-byte errors or four-byte errors. We were getting five and six-byte errors, so how can that be? And it was really all a game of probability right. That basically you could detect most of the three and four bytes errors and there were too few seven or eight and nine, 10-byte errors. So there was just a sweet spot in the five, six range where the things were just …

Gardner: But you solved that

Rodriguez: Yes, we added two bytes and we went to a theoretical error rate of 10 to the minus 29 which …

Gardner: You're one of the few executives who's been successful and experienced all of the storage technologies, optical and magnetic disk and magnetic tape, optical disk. Would you like to spend the next few minutes sharing with us what you've learned or what you've learned to avoid?

Rodriguez: I think from an engineering standpoint, being able to manage a program in real time taking into account all of the issues that come up, dealing with them, being able to deal with them, not just in an engineering sense but in a business sense.
[1:50:00]
And as I mentioned before, defining a product so well that in the end it may not physically look exactly what you want it to look like but it accomplishes everything that you're trying to achieve, right. And basically, instead of trying to engineer, and bulldoze your way through problems, have the ability to be able to move around those problems, right. Don't let problems get in the way, right, if necessary, avoid them. And then you make people say, hey-- one of the problems that you have in engineering projects that somebody's always in trouble, right? And then you get all of these guys that come to you and say, "Oh God the end of the world is coming because he's not doing his job, right!" I say, "Worry about your thing. Your turn is going to come. Please leave him alone, okay, I'll worry about them, you worry about your own. Right!" And then I think the other thing that's also very helpful is I think if you take the position that most of the people that we have are very intelligent people dedicated to making things, work, right!. And you have these people that are constantly fighting. at odds with each other, getting in trouble. And you say how can two intelligent reasonable people have so much conflict between them? You bring them into your office, and by the time they get out, they're smiling, you've solved all of their problems and everything and you're being treated like a genius, right. All you've done is getting them to talk to each other. And being reasonable people, intelligent people, I think they come to some pretty good understandings and they kind of walk away understanding what the other guy was saying, which is probably 90 percent of the problem, they didn't really understand what they're saying. I mean they don't really understand what the other person means. How do they say this when it's all wrong? And the answer to that question is, because you're not really understanding what they're saying,, "Bullshit." And what you really should say is "But you really don't understand what I'm saying." So when you bring them in the room and they come in ready to fight and they leave holding hands, again, you haven't done anything except force them to talk, I guess, with adult supervision. And then when you have real problems, you know, people come together and they don't try to hide the problems. And again, you've got to have the ability to understand what it is that you're trying to achieve and how to solve the problem that you're facing and it's an every day issue. I think it's one of the issues why the computer mainframe people can't really do peripherals. Theirs is such a structured process to get things done. And their end product is almost like exactly what they designed. And here where you're dealing with these products that kind of marry the physical world to the computer world, to this IO, this one zero world, binary world you've got to hold hands with Mother Nature, right. And in the end make sure it's all microcode or firmware. You have to face those lines of few quirks that nobody could have anticipated, right if it was a work around.

Gardner: Okay. Any thoughts about being an entrepreneur, having done that serially?

Rodriguez: It's a good life. When I moved to Boulder in 1966 with IBM, I said, "This is my first move of many." Because IBM stood for "I'm Being Moved", right. And it's interesting the fact that I left IBM, allowed me to stay in this one town all of my life. And very, very stable and so on and so forth. And people ask, "Knowing about all of the problems and everything that face you every day doesn't that get you down?" I say, "No." After going through what I've gone through and knowing all of the problems that you're constantly facing, I don't think I could take a lesser job knowing that there's always something

wrong, while what I'm doing is all okay. So my ignorance of the whole thing would just drive me crazy. So I'd rather know all of the issues that are facing me and what my prospects of living another day is rather than being fat, dumb and happy not knowing about that stuff.

Gardner: Getting a paycheck.

Rodriguez: Yes, getting a paycheck every Friday, knowing that that comes every Friday come hell or high water. Knowing one of the other positions, I know yes, come hell or high water or jail.

Gardner: You've had your high water and you've probably had your hell, but I know you haven't had any jail. And maybe that's a good place to end with.

Rodriguez: Yes.

Gardner: Thank you very much from the Computer Museum for all of the time you've given us. I'm down to about to 10 seconds left on the tape. So thank you again, I really appreciate it.

Rodriguez: Okay. Thanks.

END OF INTERVIEW

