IBM Tape History – Session 2: Overview of tape products and product management

Joel Levine, Albert Rizzi, John Teale

Moderated by:
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Introduction

This is session one of five sessions held in Tucson, AZ, regarding IBM's tape storage history. The five sessions are:

1. Tape Media (CHM catalog number: 102737992)
2. Overview of tape products and product management (CHM catalog number: 102737994)
3. 3480 tape drive (CHM catalog number: 102738021)
4. Linear Tape Open (LTO) Consortium (CHM catalog number: 102738023)
5. Recovery of tapes damaged in Challenger disaster (CHM catalog number: 102738025).

See IBM Tape History Session 1: Media for an overview of IBM Tucson,

This session is broadly focused on IBM's development and management of tape products. Within IBM product management has been distinguished from system management; well into the 1990s product development was the responsibility of a Lab Director whose direct reports would include engineering managers for the various products assigned as well as a Product Manager having one or more subordinates responsible for business aspects of the product. Today's session includes a Tucson Lab Director (Teale) and two tape product managers (Levine and Rizzi). Attachment 1 is list of Tucson Lab Directors responsible for tape products.

Interviews

Tom Gardner: Good morning, this is Tom Gardner again on our second day in Tucson discussing history with a number of folks from IBM Tucson laboratories, most of whom worked at IBM Boulder Labs beforehand. We'll start with the three panelists today introducing themselves, starting with our host actually, the retired IBM-er, owner of West Press, and the person who made these facilities available to us, Joel Levine.

Joel Levine: Thank you. Good morning. My life history in a few words or less. I was born in Troy, New York, November 1937, grew up in Albany, except for a couple years during the war we had to move, came back to Albany, graduated from high school there. All through high school I was working in a hardware store and one day this Marine comes in the hardware store for something or other and we got talking and he told me I outta really should join the Marines. And I gave it some thought. Now a week or so later I went down to see him at the Marine recruiting place and he was out at lunch, because it was my lunch hour, too. But there was this Navy recruiter across the hall and down a little bit. So, after four years in the Navy--

<laughter>

Levine: And when I went in the Navy they gave me these aptitude tests and they said, "You outta be in electronics." And I went, "Huh? What?" But those of you who are familiar with being in the service understand how that all works. So, that's what I did. I got out of the Navy in January 1960 and went back to Albany and somebody said, "There's a place down the road in Kingston that's probably hiring guys with

electronics experience." And I said, "Who's that?" "IBM." "Who? What?" So I drove down to Kingston, went in, applied for a job, and they said, "Oh, no, we don't need you." And somebody said, "Go down to Poughkeepsie." You know, somebody was, like, standing there. So, I went across the bridge down the road to Poughkeepsie and they hired me. So, I started work in Poughkeepsie on March 7th, 1960, as an assembler and we were assembling resistors on pluggable units. So I hope everybody knows what those are. And did that for a while and then about that time the 729 tape drive was just taking off and they said, "We need a bunch of people on the assembly line of the 729. You, you and you." So, there I was assembling 729 tape drives on second shift. And I got hired for two dollars and twenty-five cents an hour plus ten percent shift premium. So I was living pretty high. So we started assembling 729s and they were so busy we ended up working twelve-hour days, six days a week. They could not make enough 729 tape drives to save themselves. And that went on and on and on for quite a while. In the middle of that, got married-- last week was our fifty-fifth wedding anniversary. My wife-- I can throw a plug in for my wife here. When I met her she had just started being a kindergarten teacher. She'd gone to Syracuse, graduated, and she retired a couple years ago as Professor at the U of A. She worked her way up through ranks, -- got her doctorate, and ended up as a professor at the U of A and retired a few years ago. Anyway, we worked long hours, building 729s. One day a guy named Bob Riley who worked in the lab-- sweet old Bob-- came in and he-- those of you who know Bob-- I can't imitate him real good. He walked around, "What are you doing? What are you doing?" and all this and that. And he's a bully kind of guy and I don't mind saying that. And I was a wise-ass young kid, so I said, "Who are you? What do you want?" and I gave him a little bit of my lip, which I used to do fairly well. And he came back a couple weeks later and he says, "I want you to come work for me in the lab." And I said, "Why?" What do I know? So, anyway, I ended up working in the lab for Bob Riley for a while and we were working on the 7340 Hypertape, which came in a cartridge about yea thick [17-inches long, 10.2-inches high, 2.2-inches thick][1], two reels mounted in a cartridge. Worked on that for quite a while. And from there, got transferred to Boulder in 1966. We moved to Boulder, worked on head development for quite a few years in Boulder. In 1977, I went to Hursley, England, for a year-- okay, basically the full year 1977-- moved to Hursley in January. It rained-- right after the holidays, it rained every day in Hursley, Not pouring rain, but just light drizzle. But it rained every day in Hursley till about the first of February. Then I look out and there's people walking around the streets, still gray, overcast, wet, and I'm saying, "Oh, look, it's a great day. It's not raining." And I had a different reference point. So I learned a few things there. Came back to Boulder, worked on the Sprat -- the floppy disc drive, came back to Boulder with some of the people and we worked on that for a while till it died, got killed. And then in November of 1978 I was made the Saguaro program manager. An interesting tidbit on how I got that job: Jack Wells and I were both working for Bob Mazza at the time. And Jack was in charge of Saguaro program. He walks up to me and he says, "I'm going to Charlotte. You take over Saguaro." Just like that. Looked at him sort of funny, like, This is an unusual way to learn about a new job. And I said, "Okay." And he walked his way and I just sorta stood there and was thinking about it all and a little while later Bob Mazza comes up to me and he says, "Did Jack tell you that I want you to take over Saguaro?" I said, "Yeah." He said, "Okay, you got it." So, anyway, that's how I got the job. So I worked on the 3480 through announcement and then right after announcement I moved over into manufacturing as the tape products manufacturing manager, saw

[1] Source: IBM archive website, https://www-03.ibm.com/ibm/history/exhibits/storage/storage_7340.html

through first customer ship along with all the other products, went to Jarfalla[2], Sweden and Valencia, Spain-- helping them get set up so that they could make their first customer ships. Did all that and then in January 1988 Glenn Larnerd who was the site manager at the time, asked me to come work for him. Did that. And I was put in on this big secret at the time: "Your job is to figure out how we can get rid of a few thousand people here over the next few months." And so we announced the workforce reduction in June of '78-- you may want to check that date. I think I'm right. June of '78--

Al Rizzi: No. '88.

Levine: '88! Thank you. June of '88, did that through till April of '89 and I retired.

Rizzi: Oh, you got out of that.

Levine: I helped make it happen. And <laughs>-- yes. And, so, I retired in April of '89, started West Press January of '91. In between '89 and '91, just a little side tidbit, Carmen Rosato was on the board of directors for a company here in Tucson called WYKO[3], an optics company. And he said, "Joel, you have to go help them out. Carmen: "They need help." So I say, "I'll do it," but that's not really what was in my heart. I always wanted to own my own business. So I said, "I'll do it for a short time." And I did. And, you know, blah, blah, blah. End of story.

Gardner: Okay, first of all, the dates on the 3480: when you started and when you ended?

Levine: No. Well, I started on the 3480-- here's the announcement-- November 5th, 1980.

Gardner: Okay.

Levine: You can have that.

Gardner: We would very much like that. And you started it on then--

Levine: Through announcement and first customer ship.

Gardner: Which was--?

Levine: First customer ship was in January of '85.

Gardner: That's my understanding also. Your wife's maiden name?

Levine: My wife's maiden name: Kaskel.

Gardner: Okay, and where's her parents from?

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[2] IBM plant site from 1970 until 1994
[3] WYCO was acquired by Veeco Instrument's in 1997 and its Optical Industrial Metrology (OIM) business in Tucson, AZ, was sold to Bruker Corp in 2010. See: Wyko Veeco History

Levine: Poland.

Gardner: Poland.

Levine: I don't know where in Poland.

Gardner: I might suggest for your grandchildren's sake you ask your wife what town in Poland her parents might have come from, because it may not be in Poland. It may be in the Ukraine.

Levine: Yeah.

Gardner: Which is actually my history. And a problem, which is why I raise these questions in this meeting. And your parents?

Levine: My father died when I was pretty young. I was fourteen-- my father died. And my mother lived till she was in her early 70s. And they were from--? My mother was from Troy, New York.

Levine: My father was born in New Jersey. Trenton, New Jersey. I can't tell you why.

Gardner: So, it was the aptitude test that led you to electronics engineering? You come out of the Navy as a C tech?

Levine: I was an electronic technician.

Gardner: In those days that must have been an interesting program.

Levine: Oh, it-- the Navy was good. I mean, I had this terrible assignment. I was aboard ship for three and a half years. The ship was home-ported in Villefranche, France, which is in between Monte Carlo and Nice, in case you don't know where it is on the coast there. So we had to live in France for three and a half years on the coast. <pantomimes disappointment>

<laughter>

Levine: I was going to re-enlist on that point, because it was good livin' there. You can't argue with that. And I was talking to one of the officers and he was trying to convince me to re-enlist and I said, "Do I stay here aboard ship?" He said, "No, no. Part of the deal, we have to move you." I said, "Thanks anyway, bye." <laughs> That was the end of that.

Gardner: What did your dad do?

Levine: He worked for the local power and light company in Albany.

Gardner: Technician, management?

Levine: He was in the bookkeeping department.

Gardner: Children? Grandchildren?

Levine: I have my daughter and her husband and my grandkids here in Tucson and my son and his family lives out in Dublin, California, works for Ericsson out there-- network folks. He was one of the original people who went to work for Cisco after he graduated from college, worked for Cisco for quite a few years, and Ericsson stole him away however that works out there. And he's okay. He's doing all right.

Gardner: Anything you'd like to share or state about the workforce reduction? That must have been a trying experience.

Levine: It was. Actually, the majority of that work-- Glenn Larnerd did a lot of it. I helped him with it. All the negotiating with folks Back East probably wore out more than one pair of his trousers sitting on the airplane, going back and forth, but it was all new ground. I mean, the company had never done anything like that before. And nobody was quite sure what you could do, what you couldn't do, what you could get away with, what you couldn't get away with. Maybe "get away" is not the right word. What you could do and we just tried ideas out and bounced them off the folks Back East and a lot of it was "No, you can't do that. That's terrible." And you'd say, "Well, what's your choice?" You know, "I mean, you're serious about reducing the company," and so he worked out the package that turned out to be I think a fair package. Especially if you look at it -- it was hard to tell it was fair at the time. If you look at what's going on today, it was a very fair package.

Gardner: Now, a question: I think John probably went through that?

Rizzi: Oh, yeah.

Gardner: How about Al-- were you through it, too?

John Teale: Through which part?

Gardner: The reduction.

Teale: That one.

Gardner: Yeah, that one.

Teale: No.

Gardner: Okay, so maybe we'll give you a chance to talk about reduction, too, when we go into John's-- what was behind it? Why did they have to have the reduction?

Levine: There was a point where they came to-- by the way, it was also at Boca Raton. There were two sites They were running in parallel. Boca only reduced by, I think, sixteen- eighteen hundred people. Somewhere in that range, I think. I may be off a hundred here or there. But in that range. But they were a smaller site to start with and then we went down, I think, twenty-eight- twenty-nine hundred people, and I think it was well-presented to the employees. I think the majority of the employees accepted it, you know.

There's always some that didn't. But I think the majority did. It wasn't-- the announcement day wasn't a good day. Got through that a little bit. And it happened.

Gardner: I was more interested in that question, in the business clauses, in your view, behind the reduction.

Teale: Let me offer some perspective. I joined IBM in '78. And I'll be introduced in a minute. When I joined IBM, IBM was a forty-billion-dollar company. Tucson was about a 1.3 billion dollar business. So, we were a good, solid, five-percent mindshare. The disc and tape were big wigs when I joined the company. And I don't remember-- one of these guys will correct me-- it was either Opel or Akers[4] who had a vision of growing IBM to be a hundred-billion-dollar company rapidly. And the pointy-heads back in New York decide that IBM, in order to accommodate that type of a growth plan, that we needed to build a massive amount of infrastructure. They built Tucson, they built Boca. I think they may have built a couple more. I don't remember when Manassas and Burlington were built exactly. Just kinda helping you remember exactly--

Levine: Right.

Teale: --what it was like. And they had in '78 probably one of the biggest hiring booms in the history of the company. They hired thousands and thousands of kids like me outta college. And, long story short, the hundred-billion-dollar plan didn't happen. And ten years after this massive infrastructure, frankly, the corporate financial picture was not looking very good. We, as good employees, had been taking opinion surveys annually every year of our careers saying, "Do you believe if you do a good job that you'll be employed for life?" Answering "yes" to that year in and year out <pantomimes checking a box>. It was a very difficult decision. I had a friend at the time who was in-- who had a front seat, a fellow named Steve Ward. You probably remember Steve. And I remember him calling me saying that they had made this decision and that it was probably the most painful decision that had ever been made at the corporate level. There are three ways to facilitate a legal reduction in workforce. One is called performance, one is called staff reduction by skill group, and one is called elimination of mission. And after a lot of debate it was concluded that the first-line managers, of which I was one that had to implement this, were not going to do so voluntarily, so we have to force them. So we all got a little piece of paper with the people that were to let go. It was based on the average two times your last appraisal-- blah, blah, blah-- performance formula. We had psychiatrists roaming the hallways. We had security people roaming the hallways. We were concerned about post event incidents. We didn't have anything that bad, but we had a lot of people running out of the building screaming, crying, sobbing. As Joel says, it was a difficult day. And the only reason my perspective-- it dovetails, because I was the first-line guy doing it. And Joel was way up there kinda watching me do it. <laughs>

Gardner: And your perspective then as the overexpansion in general--

Teale: That's my personal--

[4] John Opel CEO from 1981 to 1985 set the expectation that IBM would be a $100 billion company by 1990
A View From Beneath The Dancing Elephant, Greulich, ©2014 , p.57

<overlapping conversation>

Teale: We had put this huge infrastructure in--

Gardner: One at a time. Now, Al Rizzi.

Rizzi: I'll be introduced also later, but I can add just one element to that, I think, is that when they decided the mission, they looked at-- they had a brand new facility, the IBM plant site, which was an asset in itself, but to get manufacturing out-- and they had enough manufacturing capability other places, so they basically moved the manufacturing to other facilities and then they had this big site that they were able to turn over, which they actually did, as you probably all know. So, that was also probably part of why, I think, Tucson got hit so hard. And it was the-- basically, the whole manufacturing mission went away. Development mission pretty much stayed, but cut. And we had, both software and hardware development activity, which continued on, but at a much less resource level.

Levine: We had excessive manufacturing capacity. That was very obvious.

Rizzi: In IBM.

Levine: Right, I mean, the simple fact if you take a 3480 and its footprint, you put two drives where you used to put one. So, now you need half the space to manufacture a 3480 than you did a 729-- or 3420 So, we had excess capacity and that just, over the years-- obviously, you know, what we have in our cellphone-- and used to take a roomful of more space.

Gardner: So it was a combination, then--

Levine: Combination of a lot of things. The financial part that John's talking about was obviously a major factor and what Al mentioned was a very sellable site. Being as new as it was, okay, it's-- I don't want to say anything bad about Endicott, but it's easier to sell Tucson than Endicott.

<laughter>

Levine: Or you couldn't sell San Jose with all the stuff you guys stick in the ground. So, it was a sellable site. That's another major factor in how it was determined, which site it was.

Gardner: So Al mentioned everybody knows about the sale except I don't. So, who did it get sold to?

Teale: Yeah. What we did is we did a seller-financed deal with the University of Arizona. And, basically, our rent equaled their mortgage. The only effect that it had, and I hope I'm not talking too out of school here, was that a half a million dollars a year disappeared from the valley tax base, because the University of Arizona doesn't pay taxes. There were people that came out of the woodwork protesting that and somehow that issue just silently went away. I don't know how. But we also gave them a free high school on the site. So, the site became known today as the Technology Park-- the University of Arizona Technology Park. And there're startups in there. IBM has a piece, Raytheon has a piece. There are a whole bunch of little startups. It's kind of funny now, because you go to what used to be the cafeteria and

you'd see everything from high school students to one star generals visiting Raytheon sitting at adjacent tables. It was actually a lot of fun.

Rizzi: Did we sell Building 10 to 3M?

Teale: The first divestiture was Building 10, which was our immediate manufacturing facility that Ric probably spoke about and Andy-- we sold it to 3M. Later they spun that out, as I mentioned, and that sale had some interesting stories around it. We had something called a utility plant and IBM, the original IBM facility was almost self contained -- it was a city. We had seventeen wells, well water. We had our own recycling. We had a billion gallons of diesel fuel and a pad with jet engines that could keep the thing running twenty-four by seven. We had it next to a railroad spur in case Tuscan got blown away. Tennis courts, recreation facility, twenty-four by seven-- it was like a city with six thousand people in it and it was weird at night. Eerie. One thing of note is that at that time in '78 Tuscan was one of three strategic targets in the United States. Tuscan was circled by ICBM missile launch sites dug into the ground. And there was another one somewhere in Kansas, I think. And there was a third one somewhere.

Gardner: Wichita.

Teale: And those-- all those ICBMs were pointed at Russia. This was Cold War era. So there was concerns about Tuscan in a generic sense, which is why this shiny, beautiful, award-winning site that's kinda bullet-proof, in theory-- you know, Tucson gets blown away we all just kinda go to work and stay there. They had showers, they had everything we needed. <laughs>

<overlapping conversation>

Teale: The cafeteria workers were IBM-ers in those days. The people mowing the grass were IBM-ers. It was just a whole different era. And I don't know. This is kinda fun stuff to talk about.

Gardner: Actually, I think it's great stuff to talk about. I really appreciate your elaborating on it. So I think that pretty much continues. Joel, would you like to put a plug in for West Press? I understand one of the best southwest printing companies?

Levine: No, I'll let-- let's stick with IBM. I'll put a plug in for IBM. I worked there almost thirty full years. I met and worked with a fantastic group of people who continue to put a smile on my face. I thought it was an outstanding company to work for, some fantastic people and there were all good years. Thank you.

Gardner: Okay. So I think to Joel's right, my left, and probably in IBM chronological order, not necessarily physiological-chronological order we have Al Rizzi.

Rizzi: Age-wise, too.

<laughter>

Rizzi: Hello my name is Albert Rizzi. And I was the tape products functional manager at the time of the announcement of 3480. I joined IBM in 1965 after graduating from San Jose State with a bachelor of

science in mechanical engineering. And I continued with IBM until 2002 when I retired, and that was thirty-seven years. When I joined IBM I looked forward because of a lifetime commitment that we had expected. I said, "I think that I will be able to work thirty-seven, thirty-eight years." because, then you think, probably sixty-five is your retirement. Well, I came close. I made it to sixty-four. And so that-- and it was a long career. The 3480 was a one- or two-year timeframe in my career about halfway through the career. Education-wise I also received by going to night school an MBA from the University of Santa Clara while I was still working. I got that in 1973. I'm a California native, born in Gilroy. It was the garlic capital of the world, they say. And grew up-- moved a few places. My dad was a railroad foreman. They call them gandy dancers back east. But, basically, he had a crew that basically kept the railroads' tracks going. They would call them section foremen. But they had a section that they had to take care of. And lived down in Goleta down by Santa Barbara and then we moved to Hollister when I was five or six years old, started-- went through all of my schooling, basically, in Hollister. But a year before I was going to graduate from high school my dad, I think for my benefit, thought that living in Hollister was a real small town-- about three thousand people at the time. High school was-- I don't know-- six hundred people total, all four years. Thought that he should try to get me where there might be some opportunities. And he bid on a job in San Jose, got a job in San Jose. We moved there in the middle of my junior year. Finished high school at Willow Glen. It's where I met my wife. She was-- her name is Kathleen-- at that time "Staples". And met her when she was a senior. I had already graduated. Prior to graduation I had enrolled at San Jose State University. So that would've been-- I had graduated in '56. I would have been going at '56. My dad was from an Italian family and I think that he didn't really encourage me to go to college. It was kinda like it's time to go to work and bring some money into the family. I think that's the way he thought. He'd been working long enough I should help the family. So he didn't really encourage me. And about that time General Electric-- Atomic Power Equipment Division moved into San Jose. And one of my counselors-- I was very good in math, I was good in drafting and that kind of stuff, because you take those type of classes in high school. One of my counselors came to me and says, "GE is hiring and you might want to consider interviewing, going there." And I was planning to become a teacher. That was my-- at that time I said, "Well, I'll become a teacher. because when I was in high school I tutored kids that weren't doing well. And so I thought I had an ability to teach. So, I go to General Electric and I got hired on as a draftsman trainee. General Electric had a great apprentice program Back East in-- is it-- not Endicott. I'm trying to think where-- exactly where General Electric is.

Levine: Schenectady.

Rizzi: Schenectady. Yeah. because they had just moved out from Schenectady. And the people that came were part of the apprentice-- of the apprentice program, the drafting and the design and that kinda stuff. So I got in and became the drafting trainee. And that training actually stood well for all my career. I became a mechanical engineer and over that time I was able to use that training in drafting design throughout the whole process. I can read drawings.

<laughter>

Rizzi: One of the things that you learn. But, anyway, so I said, "Well, I'll take that job." So I did take that job and I worked there for about a year and a half, went through the program and then they were going to go through a layoff. Lockheed had just come into town and Lockheed was going to hire and General

Electric was going to lay off. And General Electric also was pretty good at handling their people, caring about their people. So, what they did is they put together a list of the people they were going to lay off and brought in recruiters from Lockheed, gave them the list, set up the people to interview with them. I wasn't on that list. They wanted to keep me. And I said, "You know, these guys are getting pretty good offers. So I said, "Look, can I talk to these guys?" <laughs> So, I went and talked to them and they-- I guess, they're smart enough people, they said, "This guy's not on the list. Maybe we should hire him?" So, I ended up going to work for Lockheed. And during this time I'm dating my wife and we ended up getting married when I was twenty. I was working at Lockheed.

Gardner: Can I ask which part of Lockheed?

Rizzi: Lockheed Missile and Space Division.

Gardner: There are two Lockheed divisions in the Bay Area--

Rizzi: Yeah, Missiles and Space Division. They were located in Sunnyvale. And I went to work as a designer, draftsman-designer. And can't remember exactly-- I went to work at General Electric in '56 and, finally, it was '57-- late '57, early '58, I went to Lockheed and about three years--

Gardner: One more. This is the Polaris part of Lockheed?

Rizzi: Polaris. I worked on the Polaris missile.

Gardner: That has been described as a startup with nuclear weapons in the Bay Area?

Rizzi: Is that right? Well, I worked on that. And I worked in what they all check-out systems. And that, basically, monitored the system prior to shooting it in the air. You know, out of the sub's tubes. But, anyway, I worked on that and I got to the top of my rank in about two years as far as pay. And I had an electrical engineering manager-- I guess you might call him a mentor, his name was Gail Lewis, as I remember. And he said, "You know, you have to go to college. You got the capability. You should just go to college." Well, San Jose State was right there in town. So, I said, "Well, maybe I should do that." So I took one night-- one year of night classes, see whether I could still pass classes, and then I enrolled-- you know, quit my job. My wife was working at Ames at that time. Ames Research is right adjacent there. And then later she worked at Lockheed herself. She was a math aid-- mathematician-type stuff. So then I went off for four years, going to school at San Jose State. So it's from '61 to '65 I went. During that time I also worked about seventy-five percent full time while I was going to college. I worked at something called Explosive Technology[5], which made the destruct system for the Apollo Missiles. You know, the spacecraft, the ones that would blow it up if they had to self-destruct it. So I worked there, basically, for four years and I was-- graduated and they wanted me to stay full time with them then. I was always a little bit afraid of explosives and they were moving up to Fairfield -- close to Sacramento by actually where you actually lived at one time. I can't remember the name of that town. But, anyway, I also interviewed with

[5] Explosive Technology Inc. Fairfield, CA, was acquired OEA, Inc in 1971 [source: which was in turn acquired by Autoliv, Inc [NYSE:ALV] in 2000.

IBM and General Electric and decided that IBM was probably the best one to go for. A lot of people always thought of IBM as an electrical engineering company. But I realized that it was a significant mechanical engineering challenges to work with. So, I joined IBM in ’65 as a design engineer. And, basically, back in those days, you know, we didn’t have computers you could draw on, etcetera. You know, you drew with a -- I guess we had those mechanical arms and such. So, I worked on board as a design engineer and I was doing tape cartridges. And I remember the very first-- it was a cartridge for an image projector and then also we had an analog CRT as part of the education systems. We shipped that product. It was a 1512 image projector and then the 1506 tape product. I learned IBM system at that time, because back then we did what they call an ABC Test -- an A test, a B test, and a C test. The A test was basically a verification test, equivalent to EVTs.

Gardner: For what it’s worth, my recollection is it was Digital Equipment Corp that actually drove the language change in the industry from ABC -- system ABC tests to EVT, DVT and-- DEC. It was the selling of all OEM’s to DEC.

Rizzi: We wouldn’t know.

<overlapping conversation>

Rizzi: We wouldn’t care at that time. <laughs>

Gardner: It’s sort of interesting. Lots of changes of language.

Rizzi: I recollect nothing that says it was that. I think what happened is we had A test, B test and C test and the A test was, basically, just kind of the conceptual-- we’d build-- engineering, we’d build about two or three engineering models, put it in, see whether it was working all right. And if it was, we would then advance the product to the next stage and between A test and B test, we would do major changes of the mechanics or the electronics. And then at that time you would get in manufacturing kind of a pilot line-type activity going, where they were involved with building the-- we would start releasing drawings to them, they would start building product to your specifications. So, it was kind of the B test was at that time kind of a pilot line validation I would say. And then if you got through that test that was really the announced test capability. We usually announced after a B test, not after an A test. And then they would go into a production run that was the C test. And that was your ship replication test. You couldn’t ship unless you got through that test, but you already announced the product. Over time, which is aside from my private experience-- over time IBM shortened the cycle. because that type of cycle’s long, and so we were trying to shorten the cycle. So, as part of shortening the cycle, you have to be-- basically, you get into your announce and verification, your DVTs. And, so, we basically changed the length of time and the type of testing we were doing through that process. And I can’t remember really whether that was-- I know that-- because-- I’ll follow on with my discussion. So I was working on the 1500 system. We did that-- a couple projects, got to understand the A test, B test, and my responsibility, as I a gathered more responsibility in that job, was take both these products through that test and get them to qualify. Then I was moved on from there to Winchester. Winchester was already as a program-- you know, these programs get put into place, you establish how many resources, you need your schedule-- maybe I can recruit people. You don’t just come in with a full staff. So you recruit people. And I got recruited by Dick

Mulvany, who was probably one of the key conceptual guys along with-- he worked for Haughton at the time, but Mulvany was one of the key thinker-type guys that we had in those timeframes. So, I went to work for Mulvany. And my job at that time was to design-- I designed head-arm assembly. You know, the four head-arms, the carrier structure where it attached. And that's why I know A test and B test were different, because what we shipped, the whole way we attached was different than A test. I also designed the load mechanism, because that was an HDA that you had to couple to a voice coil motor and I was responsible for that mechanics. And the first design we had, which was actually one that was based on what Dick Mulvany had to have, -- if you recall on Winchester module you had to open a door. Well, the first model, the A test model we pulled the door sideways. It was a flat front and we pulled the door sideways as we went in. Well, that thing was causing problems -- basically, you had forces going this way <indicates sideways with hands> when you were trying to move things forward and at the same time you had to couple the voice coil actuator out to the back of the carriage. So, between A test-- that just didn't work well. So I re-designed that and went-- said, "Look, we're going forward. Everything should be part of a motion forward." So, we designed a cam system that basically controlled all the timing to this thing; that, basically, when this was going forward, part of the motion forward was we were pulling the door down. So the door, instead of going sideways, became a door going down. It had a curvature to it so that we could close it. And then you had the coupling mechanism. The big challenge of those type of things was actually getting your carriage attached to the back of a carriage and holding a gap so that you weren't touching with your voice coil to the motor. So I worked on that -- Mulvany was a great man. I don't know if any of you guys knew Mulvany, right? But he wasn't a real good manager, because he was more of a theorist and he had ideas. He just always had ideas. But you have to cut off ideas sometimes and move forward with what's going to work, not keep improving things. But, Chris Coolures was working for Haughton. Haughton was really the program manager. Chris was the engineering manager. Chris brought in Jim Gilmore as the manager and structured two managers-- first-line managers under him. And I was one of them. So I became a first-line manager working on Winchester as the-- responsible for, basically, all the mechanics, besides the HDA. The HDA was then put under Shel Ellis. And so Shel had the HDA. Now I had already-- I had responsibility for the carriage and the ways in that part of the system, and we had some real good engineers that were working-- you remember Tom Patel? Tom Patel did the design of the voice coil motor and that kinda stuff and did all the dynamic analysis. So, I became a first-line manager. Shel also took over as-- he took the HDA, I took the rest of the drive. We then got that product through and shipped and we got that out in pretty good time. We got that out in 1973 we announced it in May and we shipped it the same year [November 1973]. As you're going through product development you're looking at-- I guess you call it roadmap now. I don't know that we call it roadmaps back then. But you'd look at where we would go from here. What's the next thing? And part of it was people wanted to keep their jobs! <laughs> You know, they wanted to keep working, but they also-- they're looking at it, you know, from the product point of view: Where do you go? So, we had work going on and what could we do for the next generation? And that turned out to be Madrid, which was the fixed HDA. And part of the way you looked at cost per megabyte and that kinda stuff-- and there was performance elements that you had to worry about. But part of the way you get the cost per megabyte down was stack more discs, get the overhead that you have to put into product to support more capacity. And so we went from a Winchester-- I think we had thirty megabytes on Winchester and I forget what we even put on Madrid-- those type of numbers--

Gardner: Actually, there were two data modules, right? A 35 megabyte and a 70 megabyte.

Rizzi: I'm talking about Madrid.

Gardner: Oh, Madrid?

Rizzi: Madrid, the 3350. We basically took the same base casting-- I can't remember if we used the same voice coil motor or not. No, we would have had to put a different magnetic structure in there and we stacked it with -- I think it was eight arms high. And we fixed both of the inner bases.

Gardner: Yes, it was 317.5 megabytes in the IBM full track CKD format.

Rizzi: Right, that's the number. You took that-- what did you call that? Memorex 3650, right?

Gardner: You betcha.

Rizzi: So I was responsible for mechanical-- Bob Friesen took over as the engineering manager. I think he was a program manager, because I think Haughton moved on to something else at that time. And Chris Coolures went over to do the [3800] printer. We were having troubles getting our big printer out. They moved both-- Chris went over there and he pulls Jim Gilmore out, takes him with him. That leaves some opening for people like me. So, I basically went to work for Bob Friesen who had the responsibility for the whole Madrid, which would be the servo and the electronics, etcetera. And I had the mechanical, the whole mechanical design under me. One of the key engineers I had was Jim Lucke worked for me at that time. You guys probably know Jim. I think he's still around. I see his name; it's still in IBM still. He may or may not be retired. Tom Patel and a few other guys, but then-- so we got that product, the 3350, out in 1975. And I'm trying to remember what Bob did. I proposed then the follow-on product to that was the 3370-3375. And we were aiming at the mid systems, not the high-end system. We did a fixed block version and I remembered flying and being in Hursley, in fact, talking with people that-- it was Piccolo was going to be done back in that same timeframe. And the-- we ended up-- so I proposed this particular approach. And I had worked with Tom Patel and others and some of the recording channel guys [Jack Schwartz], -- because when you develop a program, you have to understand what commitments can be made by the technologists and the engineering-type people, you know, that are putting that product together. But I proposed the 3370-3375. It got accepted. One was the 3370 was the fixed block version. The 3375 was the count-key-data version. The fixed block was, I think, direct attach right to the-- I can't remember what system we announced -- in those days we announced systems and peripherals at the same time. You know, we didn't come out later and develop-- but we often announced the peripherals as part of a big system announcement. And so there was a-- the fixed block devices were being done in Germany. I think it may have been at Böblingen.

Gardner: Could it be the System 38 was the first attachment of the fixed block 3370?

Rizzi: I think System 38 was, along with the product, was out of Böblingen. I can't remember, to be honest.
[Editor's note: The 3370 was announced on January 30, 1979 for attachment to IBM's 4331 and 4341

processors and the IBM System/38 midrange computer.[6] The 3375 was announced June 11, 1980, for attachment to IBM's midrange and mainframe computers.[7]]

Gardner: There's rumor in the industry that the System 38, being fixed block, was the only FS system to make it to market, which IBM was doing in the mid-70s and then cancelled about that time. Any comment?

Rizzi: I can't validate that kind of rumor. I don't know. You get involved with work in your space and pushing it. So, we did the 3370-3375. And Carmen Rosato had just gotten back from a Sloan program at MIT. Became the product manager. So, he had the business planning and more than one product. I can't remember-- he would have had the 3380 at that time. So, he had products. And we actually put out the thin film head that was being developed for the 3380 before they could get it out -- and the 3380 was in development for a while, before we ever even did this one. So I then worked on that product and Carmen recommended me for the Sloan program. And I was selected. I thought I was going to go to MIT where he had been. I figured IBM would send me away. They sent me to Stanford, which was great for me.

Gardner: Full disclosure. In June of 1980 you and I met as I was an outgoing Sloan Fellow and you were an incoming Sloan Fellow.

Rizzi: <laughs> I suspect you're right. I can't remember that I had met you, but--

Gardner: I'm pretty sure we did.

Rizzi: Yeah, we had that joint meeting where they introduced all of us and there was and IBM-er that I knew who was in that class. He was a lawyer, right?

Gardner: Marshall Phelps--

Rizzi: Marshall Phelps.

Gardner: --who probably collected all the royalty money that Ric was talking about yesterday -- Marshall went on to become the person that IBM sent off the program to collect royalties for all its patents beginning around, I think, 1990. About ten years after Sloan.

Rizzi: So, I worked on that project-- 70-75. And prior to that from an education point of view when I got out of school I wanted to immediately go to an MBA program, Santa Clara. And Donaldson, who's on that career thing-- you know, career-- what do you call it? Brochure I have there-- was my manager. He says, "No, you have to work for a while. I have to make sure that you're okay." So, they didn't want to, basically, commit to spend money. So, I said, "Well, I'll take the I--" See, IBM back then had a superior education-- internal education. So, I took the equivalent master's degree in electrical stuff. I took logic, I took programming. I took all these things that they offer. Ken Ouchi even taught. Remember Ken? I remember

[6] Source: IBM archive website
[7] Source: IBM announcement letter

taking a class from Ken Ouchi and, so, for that year I took a whole-- I took every class I could. Then I went on for the MBA. But, also, during this timeframe IBM would periodically select people they thought had some growth capability and send them off to really good educational opportunities. So, I went to Sands Point for about three weeks. That was in New York on Long Island in the [Guggenheim] mansion; sitting right up on a hill looking both ways out over to New York. Spent about three weeks there and one of the guys that I was a peer with at that time became the head of research. Can't remember his name right now, but he ultimately became top guy as a young man. He was a pretty young guy. Evidently, he was very, very good. And there was a number of others. I remember that they moved quickly. When you get into development programs, development will eat your time. I mean, if you got in and get committed to a product-- I mean, Joel was four or five years of his career was getting that product out, fighting every day with those kind of problems. And we-- so I got the opportunity to go to some of these classes. I went to one where I remember one of the guys that was in that class-- it was the CE. So, this was a class that was people from all different locations -- what's that place? I think it was in Tarrytown, NY. I remember rooming with this one guy. He was a CE. Big guy. I'd never wake up at night. I could not sleep he snored so loud; it was unbelievable. I remember this guy very well. I don't remember his name, but I remember that. So I had opportunities for a lot of education, that stuff, which helps you in-- basically, in your basic management. because those type of classes, what they're trying to do is they role-play you. You know, they do things that kinda see what kind of manager you're going to be and they try to give you training for that. So, I got selected to the Sloan program, went to Stanford for a year, met some of the best friends you'll ever have through that process. Because the Sloan program, as you recall, is basically, at that time, I think we had forty-three people. You have a room and the professors come to you at least for every class for the first quarter. Then after that you start taking the MBA classes and you get some of both. So, but you get to know people that-- really, really skilled people. One of my peers was John Brown. He became chairman of BP. He's the one that got moved out when he somehow came out, you know. We all knew, but I don't know why somebody comes out when everybody knows something. But he was a good friend and I know guys from-- as you know, from all places. That was the best experience I had at IBM. Prior to going to the Sloan program I ran a task force. I was actually asked by Jack Harker who you know well. Jack had gone somewhere and saw a production line. I mean, I guess he had a vision. He says, "We should be able to just, off of a production line, get HDAs and tailor them to different specifications," different capacities, different things like that. He had this vision-- because he told me what this vision was when he asked me to run this task force. We put a bunch of people from the technology groups, recording channel and from all of the areas and went through what can we do? And we were trying to say that we could do something like what Jack wanted. Well, out of that came the Sawmill program, which was the 9340 series.[8] Jim Makiyama who worked for me on the 3775, he was the servo engineering manager as I recall. He then took over that-- Makiyama came in and took over that program and got it shipped prior to leaving the company. He left the company not too long after that I think. So, you know, so I worked on that Sawmill from that perspective. I didn't really work on it as driving it. Then after the Sloan program, Carmen Rosato, who you may not have heard yesterday, but Carmen is common with Andy Gaudet, who I told you about coming down here, he actually was brought down here by Carmen also-- what? 1980, I

[8] Sawmill is believed to have shipped as an RPQ in 1990. It was announced in September 1991 as a part of the 9570 Disk Array Subsystem and October 1991 as the 9345 DASD for attachment to m ES/9000. See http://chmhdd.wikifoundry.com/page/IBM+Sawmill

think. I came down in ’81 after graduating the Sloan program and there was a job that Carmen wanted me to take that he had kept open for about six months. So I forget who he had in there. I think it was Bill Nelson. They moved Bill to something else. They left the job open for about six months. It was the product manager of the storage subsystems. And, so, I came to Tucson as that product manager in 1981 and Billy Joe Mooney, who we probably haven’t talked about here, but he was the program manager. He was one of these wild men. Did you know Billy? Billy Joe was really one of the great guys that I think most people really liked and they would just put their heart out working for him. Anyway, he had a product, the 3880 was our controller for the DASD. And it was actually developed in San Jose. But they were doing the cache controllers. They put cache in front of it and they would stage data from the DASD so then you had quicker access times. And there was two models. One was a Mod 11 and one was a Mod 13. We called them Ironwood and Sheriff at the time. Ironwood and Sheriff. I don’t know why. It must have been Billy Joe Mooney from here-- he wore his boots in all the time. And Mike Hartung, who was one of our-- one of the key contributors of IBM Tucson at that time-- was kind of the architectural brains of what we were doing back in those days in the cache controller area. I think he became one of the first STSM [Senior Technical Staff Member].

Gaudet: Mike was one of the first STSM fellows[9] from Tucson.

Rizzi: First fellow?

Gaudet: Yes.

Rizzi: Yeah. He was key to what we were able to do back from the technology point of view. ‘Course it takes a lot of engineers to basically do what the architects say you want to do.

Rizzi: All right. So he was working for Billy Joe. Really, in some way you might call it a kludge of a product manager responsibility. I was responsible for the 3880 Mod 11-13, the cache controllers, from a business point of view. There’s no way I was responsible from a technical point of view. Billy Joe Mooney was the guy that drove things. Joel, you know, he was a program manager. He knew and his team knew what he wanted and his commitments, it was what you get. I also had the performance analysis group for all of the products, they included tape and such. And I had a software group headed by Gary Marks from Sonoita. And his wife worked in product testing. You can’t remember either. But anyway, we had responsibility for the software for the printers we were doing and also we had a product called HSM, hierarchical storage manager, which was under Al Johnson at that time. And so that was in this group. And I also had the mass store, the 3850, product-engineering requirements. That was Clint Gaylord; he worked for me and he came from Boulder with a product. Again, it didn’t take any of my time to manage that, because Clint was another one of these capable people-- person that just knew what had to get done. And there were always some type of problems in the field with any of our products. And so you had a product engineering staff that supported that. So I had that and, of course, we had the storage subsystem planning responsibility. Jim McMillan, who you initially had shown on-- Jim McMillan was the client manager for that. Sounds like he’s still in town--

[9] Michael H. Hartung, IBM Fellow in 2002

Teale: He never called me back. He's in town and I got word to him.

Rizzi: But I don't think he worked on the tape product -- but he was on the 3880, planning manager.

Teale: He was on the 3840 also.

Gaudet: Yeah, he was on the 3480.

Rizzi: Not during that time -- he wasn't on it during the time I worked on it. Because now Dick Vogel I think you guys were saying-- Andy Hopper was actually the planning manager for the 3480 during that time. And I think Jim Colosimo either came in and worked for him or replaced him. I just can't remember.

Teale: There was a guy named Herb Day.

Rizzi: Herb Day worked in the Hopper organization during that time. So there was a number of what you might call people or real business planning people and it was part of the management team. Colosimo and Hopper were managers. But I can't remember whether Colosimo was there at the time of the announcement.

Levine: Did Jim Colosimo work for Bob Shaff? Bob Shaff ran the demo center, whatever is the proper wording there.

Rizzi: No, I'm pretty sure he didn't.

Levine: No.

Rizzi: I hope this is the right kind of history you're looking for. So I had the responsibility for this set of people. And one of the groups was also I had real small evaluation group we called it optical disk technology. So I had a group of guys that were evaluating what can we do at optical disk? It was clear that IBM wasn't going to be able to invest in one more technology, where you own the technology. And the industry was ahead of us in optical disk technology at that time. So what we did was we assigned a Ph.D. and I had him as a manager[10] and he had about four or five people working for him. And basically, we were evaluating the different technologies. And I did some business trips with him. We went to Phillips. We went to Sony and Matsushita and there may have been others that we evaluated. We ended up ultimately doing some work out of that with Matsushita that 3363 product. But that's in the future. So I had a technology group on the optical disk that was working for me. And also I had a manager and a team working on a follow on tape library for the mass store based on the 3480 tape cartridge technology. so we had a group that was actually physically doing design and such at that time. And also we put a together a taskforce also that Hartung actually ran. It was my taskforce but Hartung was the guy that was kind of the key guy to kind of help drive it. And we basically established what we wanted to do with follow on to Ironwood and Sheriff; and that was the Models 21 and 23. It was the next generation that we announced anyway. Because it was apparent that you could do a lot with cache in the front end inside of

[10] Later on identified as Jim Dennison

controllers with DASD as a back store. And people with foresight probably looked at it with a tape at the back store. But that was the role of that group as far as substance. Then I think there was some management turmoil that happened during this timeframe that they had-- just a little bit of background and history of the IBM and not necessarily my story, per se, but background in IBM is, I think, Rosato came to Tucson as the lab director. And somewhere I saw that Jack Wells. Jack Wells was working for him. So I guess Dauber was the first lab director. Then Carmen Rosato came in. I don't know what happened to Dauber. He may have moved to somewhere else. I'm not sure anything about that story. But Carmen then brought Andy down. He brought me down. He brought Bill Nelson down and I'm sure he brought others that I can't tell you. And he probably made a lot of money for the real estate agent that he would introduce us to because when you come into town you're going to buy a house. And he introduced us to this one guy, I can't remember his name anymore. And so Carmen was the manager. Bob Mazza at that time was a product manager for the tape, the recording. Joel, I think, would have worked for Bob Mazza at that time. And then Carmen got promoted to general manager of the whole facility. And Bob Mazza got promoted as the lab director. And they brought in a person we can't remember the last name of but Joel worked for him. His name was Nick Mitrofanoff. He was a Russian. He came out of Rochester, and he went back to Rochester, I'd assume at some point. But there was probably some conflicts within the management style. And during those time frames we were having weekly meetings with the management from San Jose. The president would come down and Gerry Harries and others would come down to find out what we're doing. Anyway, so they decided to change the management at the product management level. They didn't change anything below that management. So I was brought over and asked to get through the test. I had a reasonably good history of getting products through the process because the process is not just the development DVT test. It's also the business aspect of getting people to accept what you're doing and being able to get the cost structures in place, et cetera, to support the business plans. Anyway, so I was brought over as 3480 manager. And I brought with me the optical disk technology group So I was brought in as manager of 3480. It actually at that time would be called tape products product manager. I brought over the manager who I can't remember his name who was developing the library. So we had the library responsibility going. And it wasn't this big thing, although, they may have ended up going to that at some point. But so we had that. I had the optical desk technology. And at that time Andy Hopper from the planning point of view then reported to me. So let's see-- and Jim Dennison was the person I was talking about that was the Ph.D. that was doing the optical technology. And by the time he had contacts all over in Japan and in Phillips and other places. Now, the thing about what I call the management turmoil in my mind I would think that in some way it might look like what's management turmoil because that management that he was reporting to changed three times, maybe four times through the development of the product.

Levine: He went through one of you guys.

Rizzi: Exactly and I kind of wrote up what I might say. You know, Joel withstood all of us. Maybe it was Joel that was causing the problem. Nobody could handle you, Joel. But anyway so typical structure back in those days and it's probably different now and he can chime in if he likes. The typical structure was the lab director with a product manager reporting to him. We had functional managers reporting to the lab director that all came together to be able to bring a product out from a development engineering point of view. So the product manager typically would have the development manager working for him which, in

this case, Joel was the development program manager for the 3480 who worked for a number of product managers prior to getting the product out. And then you'd have functional managers who had the technology like Andy Gaudet and also lab support. Then Wayne Winger was the last core-- now, Wayne was a key guy through a lot of the tape. And somewhere in the Tucson world I only knew him as the functional manager handling basically the rest of the lab type stuff.

Gardner: When you say functional manager you mean things like product test? Or things like technology?

Rizzi: No, the functional manager in our case was more like technology. Like Andy Gaudet had the technology people working for him. And the functional manager would support more than one product. I mean you might have multiple products that the technology people were supporting.

Gardner: So you might have say a recording channel department under a functional manager who supported all of the development programs.

Rizzi: And often it was personality driven, too. Sometimes a manager wanted this guy working for him and so that happened. And so Mazza] was the lab director during the development and it was actually at the time as I recall that I became the product manager. And then both Rosato and Mazza moved on. And the lab director became Jay Hasson. So I then reported to Jay Hasson. You [Gaudet] reported to Jay Hasson. Phillips remembers reporting to Jay Hasson although at that time Andy had all of the technology included in the media. So I don't think Bill had the media full responsibility at that time; at some point he did but we just changed things around. And as I already said Wayne was the lab support. And that was-- I suspect we had the last part would have included the UL approvals…

Levine: The model shops.

Rizzi: The model shops. So it would be areas that you needed to support a product that wasn't necessarily folded under the product manager because products get cancelled and you don't want to have to do undue your support structure. I went on after that to-- I had this optical disk-- actually, I went over and I was in manufacturing for a while too. We were having troubles with the 3370. They had moved the manufacturing 3370 through 3375 down to Tucson in this interim period while I had gone. And we were starting to have both production and field problems. And they had a group which is not normal of product engineering support working in the manufacturing at the time. And so I was asked to go over and manage that group and that included the 3310. The 3310 was being built there too as I recall. And then the 3370, 3375. So I worked on that for about a year. I think I worked for Harwood.

Levine: Carl.

Rizzi: Carl Harwood. And so I learned a lot-- the management of manufacturing their techniques are different than management of development. And then from there I came back and I did a product called a 3360 optical disk product. The PS2 was in development and we wanted to put a high capacity back store to the PS2. And we worked with Matsushita. They had phase change technology. It was WORM, write once read many type. So it was basically a permanent archival type media at least in our lines how we

sold it. It was designed as a standalone box and with an attachment card for a PC using our software. When I put that together, we had about six guys. I had to build a team. And so we did the software file support for it. We drove all of the evaluation and product test and DVT with this team. I got a little corner down there at the old site that IBM first came in here at down at the airport. I had the best operation that you could have. I had the whole staff within a 100 feet or I'm not sure how many square feet we had but we had labs and everything there. And we working with the Japanese on their-- they were doing the technology. We were basically integrating their technology into the products. And so I had to work with the PS2 guys because we were going to direct the PS2. It was a five-and-a-quarter technology. And that technology we put right into the box where-- and it was attached. We had to have an attachment card back in those days. But it was done as a file right into the PS2 box. In the case of the PCs which we had what I forget the numbers that we had there but three or four XTs and things like that, ATs and XTs, and so on. There was about three or four products that we had to attach. I remember that we couldn't attach the PC Junior which I had one. It was the only PC I had. It was the PC junior back in those days. And so we developed that product. We got it done in about-- and I had to staff the whole thing up from scratch. And you get people that don't want to work with other people or other people don't want them working for them. Bill Burke worked for me. You know Bill Burke don't you?

Levine: I knew the name.

Rizzi: But he did the software. They built the software. But anyway so we did that product and I think we got that on '87. Now, that's the timeframe you're going through the lab reduction, right? So we got that product out. And then we were proposing a library based on Matsushita's phase change technology which is rewritable at that time. And I wasn't able to get that accepted. It was a force inside IBM that wanted MO and not phase change. So that didn't happen. About that time Abuzayyad had gone over to Rolm. IBM had bought Rolm because they thought they had to have the ability to have terminals and everybody-- through the phone system. That was the way you were going to expand computing so they could get up there. Now, that never panned out for IBM but that's what their vision was. If you were on via the phone you could get into everybody's house and help drive computing system. Rolm had a thing called-- what do you call that? Voicemail. Phone mail. Rolm's thing was called phone mail. And they had a Priam disk drive in it for people who remember Priam. And it was a fourteen-inch disk, one or two platters. I can't remember exactly. It wasn't a real high capacity. But basically what they did is they stored voice on via digital on to the platter. And they had the software that talked to the-- well, they had sold a lot of that into the field. Then the field started seeing problems with the disk drives. And the salespeople wouldn't sell it. They actually stopped selling it. And Abuzayyad now had this. And we had other products besides phone mail. So Abuzayyad was looking to [Dale Pilgram]. He was a lab director of San Jose back then, the big tall guy. Abuzayyad went to him. He used to work for Abuzayyad when Abuzayyad was in GPD.

Teale: Bill Nelson?.

Rizzi: No.

Teale: Oh, you're thinking of the guy that used to sing or something?

Rizzi: No. He's up in Arnold right now. He lives in Blue Lake Springs. But anyway, his name will pop. But Abuzayyad had gone to him. He said, "I need somebody to work the phone." And he didn't want to give him anybody because I think they were doing the 3990 in those days. But they knew that I basically had just come out of a similar area. And so he came down there and he says, "I'd like you to take this job with Abuzayyad. They've got a problem with disk drives. They need somebody who understands disk drives and get that problem solved." So I took it because that was the time that they were doing the layoffs. I moved up there in '89 back to San Jose. Actually, I took that job in '88 and I was working the problem trying to understand what was going on, meeting with customers, et cetera. And I'm getting ready to move and I wanted the signed sheet from Abuzayyad. And he calls me here in Tucson. I was going back and forth. And he calls me and says, "I can't tell you why I don't want you to move yet." And, of course, that triggers bells. I said, can't tell me why. And why I can't sign the chit that says you can go ahead and buy a house, et cetera. Well, it turned out that Siemens was buying them Rolm and it was secret. They couldn't tell anybody. And he couldn't. So that finally happens. And he said, "I still want you to come." I said, well, I don't want to come up here and be a Siemens employee. He said, "Well, we'll make it so you can go back when you want." I said, okay, that might work. I said I need it in writing. I'd like that in writing. And Abuzayyad looked at me and he said, "You don't trust me?" I trust you, I just want it in writing. <laughs> Well, fortunately, I had in writing. I became a Siemens employee for about a couple of years. And at that time there was a lot of the people who were Rolm people they felt they were IBM-ers but they couldn't go to IBM because Siemens just bought them for market space. They wanted the market space for their products that they were developing over there. And so I was able to come back to San Jose and Jim Lucke was actually the manager I'd come back in under. This guy's name just popped. Dale Pilgram. And as an aside on this Rolm problem was-- you guys probably all understand that disk drives make errors.

Teale: Oh yeah.

Rizzi: But they can be are recoverable…

Teale: Job security to tape.

Rizzi: Well, that too. But there's recovery techniques like retry, just retry it and maybe it will read it the second time. Well, it turned out that these phone mail guys they knew how to write software that could write it to the product and they put no error recovery into the product. So this Priam disk drive was just making normal errors and the phone mail would collapse. It wouldn't read it. That's why sometimes I thought people got their messages later because they went to read it, it was making an error. Remember, how you were supposed to be notified you had a phone mail message. Well, you'd get this a week later all of a sudden there's a phone mail message from a week before. I think what happens is the system finally read it, again, you know, tried it. But anyway I basically just got the software guys to write in the error recovery. I got that into the field and it basically stopped that problem that was the Priam drives. But the key to that was that it was going to stop them from selling the next generation. They had another generation based on the three-and-a-half-inch product. So we basically were able to then utilize and put that same software stuff on the next generation and that allowed them to move forward. And I worked at that time, I put a little group together to work on the voice response systems. And we were working on voice response. And I told the product at that time I worked for a lady product manager at Rolm who

worked for Abuzayyad. I said, I think my job is done here. I'm ready to go back. So that's when I was able to trigger my right in my letter.

Gardner: So about the Priam drive working on the Rolm system, is it your opinion the Priam drive was basically just exhibiting a normal soft error rate.

Rizzi: From what I could tell. Yeah.

Gardner: And Rolm software…

Rizzi: There was some crashes and such too. But the biggest part of the problem was the software not recovering from soft errors.

Gardner: From soft errors that should be recoverable with normal error recovery procedures.

Rizzi: Right.

Gardner: Not an uncommon story in the eighties in the PC world.

Rizzi: Yeah, because that was basically a PC-based system that they had. Anyway, yeah, that was true. I then go back to IBM. Fortunately, I have this letter that allows me to go back. So my tenure with IBM is like up to this point and then from this point on. But I have continuity of service from year one to the end. It was like you got this and you got this because it was like a one-and-a-half to two-year stint. So I got this and this but the continuity for me pension went all the way through because I made sure of that when I went over there. So when I came back I got a job as the engineering manager for OEM. OEM to IBM was quite a little different connotation but it was kind of consistent with the industry basically. It was basically we were taking our products, selling them to companies who would rebrand them. So they were selling them as their product and so we did that. And we had tape products that were on other companies that we were just marching through.

Gardner: So is this all OEM products? Or just storage OEM?

Rizzi: Storage OEM. I worked for a guy named Larry Eisham who actually was the kind of responsibility from the marketing point of view to make that happen. But we had an engineering group that supported the products with the customers. This was 1991 timeframe. I can't remember exactly what year it was. It was around '91. I think the Berlin Wall falls in that timeframe. The Russian Soviet Union is breaking up. Russia's product management was at the bureaucracy or whatever they call it level and they would tell someone you buy this from Bulgaria. Bulgaria is making disk drives. They're the disk drive people. Right there in Russia you've got the scientists because they're real smart people. They were studied and they knew everything we were doing from the study book. But they didn't understand business because it was a top down structured thing. You buy it from them. They told the Bulgarian guys you sell it to them. Here's your money buy it from them. When the Soviet Union fell they also said to the companies oh you buy them from whoever you want. So when I went over to Russia as an IBM representative for storage on part of this OEM job to see what kind of business we could do with them and somebody had set this up. And what they didn't understand was the business model. They might have understood it technically that it

was revenue minus cost is profit at the generic level. But they had no cost structures. The guys who were manufacturing the Memorex drive copying Memorex drive over in Bulgaria didn't know about cost. They just did it. They just built it. There was a cost to these guys. And their structure for the support structure maintenance they didn't know who the-- these guys who were shipping it didn't know who the customers were. They didn't have a support structure from a customer engineering point of view that reported back. They knew nothing about this. It was like tell us again what profit is type of stuff. So I went over there and they took us through the lab. They showed us their super computer they were developing and they went over and they showed me, "And this is our disk drive." What it was the 3350 design that I had done but a copy of the Memorex copy of ours. So they had gotten a hold in Bulgaria-- they got a hold of a Memorex copy of the IBM 3350 and I was the engineering manager of that. I knew every little thing. And I looked at it, that was an error. They just copied our error type of stuff. So that was their disk drive. Now, this is about '91. We did the 3350 in '75. They're 16 years behind on a technology curve basis. They're using a 3350. It might have been double density because I didn't ask them that question. It may have been a double density. But you know we had gone-- at that time I think we were already into RAID with probably five-and-a-quarter RAID products. But at least we had learned five-and-a-quarter technologies at that time. So they were way, way behind us on the curve.

Gardner: What time was this?

Rizzi: The '91 timeframe.

Gardner: I think you were still doing ten-and-a-half inch.

Rizzi: No, we did five-and-a-quarter back then.

Gardner: I think the 3390 was the mainframe product. Sawmill was that time.

Rizzi: Sawmill was five-and-a-quarter wasn't it?

Gardner: Yes, and Sawmill was that timeframe.

Rizzi: Yeah, but that was nine-- we did Sawmill and it shipped about '90 I think.

Gardner: IBM had smaller disk drives but the still primary thrust in San Jose, I believe, was 3390 class ten-and-a-half-inch big disk drives.

Rizzi: You may be right because you probably have bit more history of that. But I don't recall it being that way.

Gardner: By the way, Sawmill is generally recognized as the first MR head disk drive.[11]

Rizzi: Is that right? Don't know. I think it was.

[11] See http://chmhdd.wikifoundry.com/page/IBM+Sawmill

Levine: I think it was.

Gardner: It made the Computer History Museum's list of most significant disk drives for both the first MR head and first negative air pressure bearing.

Rizzi: Yes, it was MR head. But it was five-and-a-quarter inch drive

Gardner: Yes.

Rizzi: I mean we had to find it back in 1980. So it was probably shipped in '86, '87, I guess. So it was probably shipping. There were probably double density ones and such that were being done. But anyway the thing is it was an aside and it was kind of like I was pointing out that your Memorex one was a copy and I saw that same thing over there. We did negotiate with the Russians to provide them-- they wanted to get some of the new technology. So I think as I recall and I don't know that it ever came to fruition but we basically had an agreement that they would do I think it was a 3480. I think we were doing 3490s back then in that time. And Valencia was our manufacturing site for a while anyway and I think they were doing 3480s. And what we decided so that they could have a built in Russia thing is we would sell them a product came out of Valencia. We tested, do all of the regular things and then tear it down through one stage, at least, I don't know. I forget exactly what we did. But they were going to disassemble part of it, ship that. They'd reassemble it and then do a file test on it. And so they were going to get the 3480 technology through that process from us instead of from Bulgaria or somebody.

Gardner: At least one term of the art that I've heard used is knockdown kit where you knock it down, ship it into a country and then reassemble it as a first way of doing it. But I don't know what it was called at IBM.

Rizzi: Yeah, we didn't have a name for it at that time. But that was basically the structure. Then after that I was asked to-- I think the next thing I did after that was a weird one. You want me to get finished?

Gardner: It's getting long.

Rizzi: Okay. Well, I was trying to give you my total history. It's long.

Gardner: Sure.

Rizzi: I then did a job I was asked to do by the management which was to kill this program. So I went in and I started evaluating the program. I said this program doesn't need to be killed. It's just that we got some redundancy of the program with another work going on in Austin. And I get this call, it was right around Christmas, I get this call from one of the-- I don't know if it was Bertram or it was Paul Low at that time. But it was one of the presidents says, "I want your team disbanded by January 1." This is over Christmas. I thought about it and I worried. I was severely worried. I now understand what you might have gone through or especially what you went through is you really worry about how the impact is on people. So I came back to him and said I can't do that. I'm not going to do that. I said, I have the ability to work with the Austin guys and move half the team at least. And the other half we'll try to get packages to. They wanted to cut it off by year end so they didn't show this money being spent. So I did that little job. And

then we had done a product, I can't remember the name of it, we actually were shipping it but it was a product that was over cost. It was one of our DASD products and they needed repackaging. So I was asked to redefine the packaging for this product; it became the Shark. I forget what the product before Shark was.[12] It was a product that was based on the same technology but it was a different packaging. It was just overly costly, over expensive, impossible to service. So I put together a team and we redefined it in the packaging on Shark. And then I was asked to manage the package. So Ric Davis he was even like a functional manager. We had restructured the labs back in those days at that time. and Ric Davis, I forget who he would have reported to, who the lab director was at that time. It might have been Myers.

Gardner: Shark was a tape product?

Rizzi: No, Shark was an array product. They called it the ESS, Enterprise Storage Server. It was announced somewhere around July 1999.[13]

Teale: It was a competitor to EMC which, by the way, just got bought by Dell Monday.

Rizzi: So the Shark system was heavily microcode oriented. It was basically a controller front end that really the key parts of it but it was a mechanical system, a dual power system raid. It had a monstrous power spike. At that time, I was given the responsibility as a functional manager for all of the package. And we had power packaging, power packaging compliance for a number of products but the Shark was one of them. And that was actually the last product I did before I retired in 2002. And that's maybe a lot of what I did. You wanted to know where my parents were from and all of that stuff?

Gardner: Sure.

Rizzi: It's only eleven o'clock. My mother was born in Hawaii after her parents had moved as indentured workers from Spain. There was big problems in Spain. Dole Pineapple was in Hawaii and needed workers. they brought people over to Hawaii. My grandparents came from Spain, my grandfather and grandmother. My mother was born in Spain.

Gardner: Do you know where?

Rizzi: I mean born in Hawaii, basically on Maui. As soon as that six years was up I think it was a six-year requirement they moved to California. So that's how that side of the family got to California. My grandfather immigrated from Italy, from northern Italy up by very, very close to Switzerland in the northern part. My grandmother had been adopted by the Rizzi's which was my grandfather and ended up being married off to a Rizzi, probably one of those put them together type thing. It turns out she was Irish and English and from southern Illinois. And I learned something yesterday. It was Bill Phillips. He said, "Everybody in southern Illinois had two names." And I found out why my grandmother's name was Mary Alma. I never knew this. We always knew her as Mary but her name was Mary Alma. She was from southern Illinois from that same area. My wife's parents her mother was actually born in Italy, came over

[12] Most likely the RAMAC 3 Versatile Storage Server or the RAMAC Virtual Array Server
[13] ESS Models E10 and E20 announced July 27, 1999. (Source: Announcement letter 199-188)

when she was three for four years old from Sicily. I think it was three or four so my wife is first generation on the Italian side. Her father is Polish. He always used to say he was German and I did some ancestry work not too long ago, it turns out the Polish people who came over around 1860 or so because he was first-- he was born in the United States but his parents were from Poland. But they had to write down that they were from Germany because I think Bismarck or something like that owned all of Germany, owned Poland, they had conquered that whole area. So Poland was basically not Poland until I think after World War II. But they obviously thought of themselves as Polish. So he always used to say I'm polish German and I finally figured it out. So he was really Polish and they were in Milwaukee and the Italian, my mother-in-law in Milwaukee so that's how they got together. I have three girls, I've got twin girls. They're 49. I was born in '38 so I'm younger than you. July 4, 1938. My twin girls are 49. I have a 56-year-old daughter and I've been married 56 years and 9 months and 1 day or something like that.

Gardner: But you're not counting.

Rizzi: But I'm not counting. But 56 years I've been married plus 9 months. So that's probably it. I had more that had to do with the development process but we can talk about that later.

Gardner: Our third panelist is John Teale. John, share with us your perspective.

Teale: Hey, Tom. And thanks for the opportunity to do this. As part of my backstory I'm just going to preface it by saying that my career at IBM was 31 years of tape technology. I lived it. I breathed it. It was my passion. I warn you I can talk not just for days and weeks about it, chapter and verse on every product born since 1978, every problem we had. So in a way my backstory is the story of tape technology from the IBM perspective. So I was born in Alexandria, Louisiana in 1954 which means I only have 60 years of stuff to cover as opposed to Joel's 77 and Al's 105 I think it was. My father was the son of a truck driver from Missouri. My mother was number six of ten kids who grew up on a Depression Era rent farm which they lost through the course of the Depression and her father became a grave differ. We strongly suspect the last two siblings in my mother's family were probably brought up by a couple of the older sisters. That wasn't usual during that day. I mentioned my name is John Teale. My mother would correct me and say that, "That your name is John Lynn." Missouri also has the two name tradition and I have cousins like Mary Beth and people like that. My last name, by the way is spelled T as in Tom, E A L E just so I don't have the Gaudet problem. The silent E on the end is because Teale with an E is a Scottish warrior and Teal without an E is a duck. So that I still remember. So my father was a military man. I wasn't in Louisiana long. We went to Kansas. We went to Missouri. He was Navy, then Air Force. I went to kindergarten and first grade in German schools in Germany because he was stationed there but we lived off base at that time. Eventually landed in Albuquerque, New Mexico where I finished elementary school at an on base school. I got my public education in Albuquerque, junior high, high school, ultimately the University of New Mexico. But before that I had graduated in high school. Math was my passion. I remember sitting in first grade doing arithmetic. I remember it vividly. I loved it in every sense my whole life. I didn't know what to do with it. It came time to go to college. I guess I should back up and say that like Joel no part of my life was ever goal directed. It was all serendipity. I was just standing there and something came alone and boom. I wish it was but it wasn't. Nothing was planned. I was lucky enough to graduate with high school in kind of the academic crowd, ambitious crowd that wanted to go to good schools. I applied to Stanford, Rice and Harvey Mudd. I had a very strong math SAT result and an

extremely poor verbal SAT result. So I got rejected by Stanford and Rice and I saved those rejection letters. Many years later I was an invited speaker to Stanford and I gave the guy that invited me my Stanford rejection letter. It's another story. I did get accepted to Harvey Mudd. Their feeling was you can teach math people verbal stuff but you can't teach verbal people math stuff. I'm not saying I agree with that. That was just Harvey Mudd's attitude was give us the math and we'll do the rest. At Harvey Mudd you were a math major, a physics major or a chemistry major or you weren't anything. So I started life as a math person. Harvey Mudd was the most disappointing year of my life. I thought I was pretty hot stuff coming out of high school and I found out there's a heck of a lot of really smart people in the world. I was humbled. I was discouraged. All of a sudden I wasn't the number one guy. I didn't like the environment. It was a very weird different difficult environment. I came back from Harvey Mudd with my tail between my legs. I dropped out of school. I went to the state employment agency. I got a job driving a delivery truck and here is where serendipity begins. The delivery truck that I was driving happened to be for a company called Bohannan, Westman Huston which was a small civil engineering outfit in Albuquerque. So I didn't pick an engineering outfit. I was just driving the truck. And they did surveying. Somebody mentioned I think yesterday the very large array of radio telescopes outside or Socorro. They did all of the ground exploration because all of those railroad tracks have to be perfectly level and perfectly stable and it's a real delicate operation. But in the course of driving that delivery truck it was a long summer listening to the Watergate hearings in 1973. I was looking over the shoulders and one of the deliveries I made was boxes of punch cards to people who processed them through a computer and gave us printouts back because that's how it was done in those days. Now, very few people could afford their own computer so it was all outsourced to specialty house. I'm looking over the shoulders of the engineers and I'm helping correct their FORTRAN mistakes and helping them with their geometry and algebra and suddenly realized they were making $35,000 a year and I was making about $4500 a year. And by the end of that year I decided I needed to go back to school. Serendipity. I signed up at the University of New Mexico. I started school. Math. And became broke. Wondering around the halls one day I saw an advertisement for a pioneering program from the University of New Mexico called Cooperative Education. So I inquired, how do you get into that program? I need a job. And I was told, "Well, you have to be in the college of engineering." So I went over the college of engineering and said I want to be in the college of engineering, I need a job. And they said, "Well, what kind of engineer do you want to be?" And I said, well, what kind of engineers are there? <laughs> They told me and I picked mechanical because it appeared to be the branch of engineering that was most robust in terms of mathematical application. It's the only reason I picked it. I didn't know anything about mechanics. I wasn't a motor head or anything like that. So I started down that path. I took a couple of co-op tours at the Naval Weapons Center in China Lake, California. I worked on a ground floor of the HARM missile program. I worked on Sparrows and Sidewinders, mostly a wind design because these were weapons that were going to go to aircraft carriers. So they had to fit into aircraft carrier elevators and the wings had to be in the packaging with the missile of the warhead. It's all intact. And the idea is that they can yank them up on the deck of the aircraft carrier, yank the missile out, stick the wings on, get it under wing and they get fifteen seconds to get that plane back off the boat armed. Fun job is my point. I really enjoyed it. I hadn't planned to go to grad school. I was approached when I was a senior by one of the professors who hired me as a research assistant. They don't usually do that until you're in grad school but he-- it was one of these kinds of deals where I said no and he said, "Tough. You are." And he got me hooked on that and it was sponsored by the naval research whatever they call it. And it was all about hydrodynamic lubrication in various forms

which is what I became-- my fundamental expertise. A couple of months before graduation I had met my future wife at the time and she had drug me to a meeting involving her church called a friends meeting, more commonly known as Quakers. She was from a Quaker family. So I didn't talk much about Naval Weapons Center at all. And her mother brought a gentleman up to introduce me, "I think you might be interested in knowing this guy. His name is William Gross." And I had-- in the seventies, college, was common and expected but not-- I was lower middle class. And so most of my friends and family had never been to college. I was like one of the first. And I tended to dumb down in these things. What are you studying? I'd say mathematics or I'd be kind of vague because when I started talking about what I was really interested in I would get a lot of blank stares and people just kind of walking away. So I'm soft peddling this guy, "What are you doing?" Well, I'm going to school. "What are you doing in school?" I'm studying mechanical engineering. "What kind of mechanical engineering?" And at this point I'm looking at him like okay. And he goes, "I'm the dean of your college." I go really Bill Gross, oh you're that Bill Gross. He goes, "Yeah, I'm the father of gas lubrication in this country." Now, I'm thinking yeah this sounds kind of like bullshit to me. I mean nobody is the father of anything anymore. That was 200 years ago. Well, sure enough, later on when I joined IBM I did the academic approach. I did the literature review of the tape interface and sure enough Bill Gross had worked at IBM in 1957. He was the first person to add compressibility to the Reynolds Equation and resolve the then discrepancy between observed and predicted fly heights - he passed away about three years ago. But that was interesting. That got me to IBM. I joined IBM as a head tape interface guy which was really a pretty good company because at the time a great deal of IBM's power structure had a similar background where you had Jack Kuehler way up there, an old head disk interface guy from a million years ago, we had Abuzayyad as our division president an old head disk interface guy. So that turned out to work well in my career because I could go to San Jose and not be totally viewed as a Tucson hick. I could talk the language and ended up having some very good relationships there. Now, I'm going to say the next piece very delicately. When I joined IBM, I'm a kid, I'm a newbie, it's 1978. I already mentioned the biggest hiring boom. It also was a shift in how IBM hired. When I joined IBM the majority of the senior engineers not just meaning the leadership people, not the rank, probably half or more of them did not even have a formal engineering background. It was very common in IBM -- you didn't have to have an engineering degree to become an engineer at IBM. They had a tremendous amount of internal education as Al mentioned. But you also had a lot of CEs, customer engineers that were really good. You know, there were a lot of smart people who maybe just didn't have the opportunity. But at the same time there was I sensed a bias against people that were very analytical in their approach. They were very empirical-oriented. If you aren't in a lab measuring something, what the hell are you doing? And I was sitting at one of only two teletype terminals that we had that sent a FORTRAN job stream to Boulder for execution. And then we had a remote printer that would print out the result. And there were a certain set of the older engineers that felt that I was worthless. But there was another set that embraced me. And everybody had their little pet problem. And even though I was there for a tape interface Reynolds Equation stuff I ended up working on everything. People would call me up out of the blue and say, "Hey, could you do a heat transfer model on an MSS head?" Or they would call me up, "Can you a torsional vibration model on a Prospector arm?" I've got all of these notes. I was looking at them the other day of all of these fun little things. They look like this. They're all scratched out. We didn't have the tools that we have today. It was all done by hand. And I would say for two years I had a blast. It was just a party. I just had so much fun working on all of this stuff. This happens to be the time of the 3340 the air bearing right here. That's the orifice equation, the pending

equation. So this is what resulted in the design parameters. We didn't have pneumatics 3340 at the beginning. I might add in case this slips out I noticed Joel used the word Saguaro and then you had to follow-up wit when did you start working on 3480? Saguaro was 3480. We had cactus names in Tucson. Saguaro became Ocotillo. We had Barrel. We had a bunch of cactus products. I think it was all 3480. Two years later the party ended. A guy named Andy Gaudet came to town. Reorganized the entire lab. It was one of those massive throw all of the cards in the air, reshuffle everything and everybody come to the cafeteria to find out who their new boss is and what their new department is. And I landed in department 76E and it was called integration technology. And I had no idea in hell what that was. It meant nothing to me. I thought I'd be in a department called heads or tribology or tape but not integration technology whatever that is. And I asked Andy what it meant, "Well, you're the glue, You're the glue." And I'm like the glue? I still didn't get it. At any rate, I was working for a guy-- there was one other guy in my department, a guy named Armando Argumento. we worked for a guy named Pete Toriello who worked for a guy named Larry Eisham who worked for a guy named Bob Hyland who worked Andy Gaudet. Two person department and basically mission unknown. Armando was an excellent head processing engineer. He scoped things around and said "This is bullshit." And went to his buddy Neil Robinson (or Robertson) and got drafted back into the head group where he came from. So now I'm all by myself. A week later, Pete Toriello my fist line manager quits IBM and goes to HP in Corvallis, Oregon. A week after that Larry Croizon quits IBM and goes to run a feedlot in Colorado. And so now I'm a one-person department 76E reporting to a third line manager and I still didn't know what I was supposed to be doing for <inaudible>. Long story short, Andy hooked me up with a guy named George Mauersberger, Mr. Integration in San Jose disk. And in their version of integration they ran these things called 747 curve where you look at error rates versus off track type of thing, precision testing. At any rate, I got it and I came back to Tucson and we started building a whole set of tools for doing similar types of activities where we could manage tradeoffs between the pain of the head, the pain of the media, and the pain of the tape path, the pain of the channel. Glue meant making sure everybody was feeling some pain basically. Another weird thing happened in 1980 that brought the party to a halt is that IBM decided to try a pilot leadership program and maybe Joel or somebody will remember this but it was a pilot program to try to identify early young potential leaders. They usually ran it with relatively new first lines but they decided to pilot it on non-managers. It was very cloak and dagger. I got instructions on a Friday, they said, "You are leaving for a week. You are not to tell your wife where you're going. We're not going to tell you why you're doing it." I learned later that this was all kind of testing your relative base brightness and could you handle it because I guess the life of the higher level managers in IBM was that there were lots of absences. There were lots of secret things going on that they couldn't talk about. I don't know. But it was a bad week. I was kind of shy by nature at the time and I got put in these positions that I had never been in, these confrontational things. Like there's one promotion and you eight will fight it out and you not leave the room until you agree on whose person it is. And these kinds of inter dynamic things I was very uncomfortable with.

Gardner: Role playing?

Teale: Yeah, roleplaying. There was a mailbox exercise. You had 60 minutes. You're the new lab director, you snuck in on Saturday. You get a sneak preview and you got your mail out and back then it was paper snail mail and you've got 60 minutes to process that mail and there was probably 80 pieces of

mail in there. So it was designed so you couldn't possibly finish. You were supposed to right on there what the action is. And I remember picking up one that say, "Hi, I'm so-and-so. I represent all of the secretaries in building 61 and I noticed on Secretary's Day that all of the secretaries in building 71 got flowers but none of the ladies in building 61 got flowers." So I made a note to myself talk to the HR manager. Next. This was rough. So the next day we had these third line managers that flew in from San Jose to sit in. So we're sequestered in a hotel room and in those days there's no cell phone. So my wife doesn't know where I am. Third line manager comes in and says, "Okay, I want you go through your mailbox exercise with you." He picks up the secretary one and says, "Have you ever heard of organized labor?" And I'm like not really. <laughs> Why should I care? So he proceeded to give me a lecture on how this should have been a top priority thing and that this is potentially union thing and IBM was all paranoid. And it gives you the flavor of what that class was like. It was run by a psychologist out of corporate facilitated by these higher level managers from San Jose. And I got my report card. They said I had a three percent chance of ever becoming a first line manager and a zero percent chance of ever being anything after that. Anyway.

Gardner: Did you save that one too?

Teale: That was a shit year. I did for a while. We got to work. Up until then the technology organization we were kind of laid back. We had Bob Hyland's personality. We had Steve Vogel's a lot personality. We didn't get too worried about stuff. And Andy came in with this level of intensity I had never seen before and that's why I say kind of the party was over because now we need to get to work and start figuring out how we're going to make some revenue. The next big thing that happened I believe was in 1982 there was an all hands meeting at the Tucson music hall. A guy named Jack Kuehler came down and basically told us that it was time to stop screwing around and ship something. And I'm pretty sure he was talking about 3480. So 1982, '83, and '84 were basically hell. We had stiction problems. We had guys sitting in chambers sweating at 95 degrees, 88 percent relative humidity, literally sitting there in their skivvies. They'd take their clothes off before they'd go in the-- and this was mostly a guy environment. I'm sorry. It was just bad. It was wild. And it was kind of a war and then eventually it shipped. In 1983 I had the opportunity to go to one of these excellent schools I was referring to. This one was called Systems Research Institute, SRI. It was an internal IBM college without grades. It was in Manhattan on 42nd Street. It lasted three months. You were on per diem. What a great party. Too bad they don't that any more. But it was a real eye opener for me because I didn't know anything outside of tape and there I learned about S,G & A and all of this other stuff that IBM was into at the time. Came back and because I had been gone three months I came back I was immediately signed to an ISP taskforce or something like that. Instantaneous Speed Variation was a big problem in the 3480. They wanted to make a manager. I politely said no. And they asked me, again, not so politely and I said no not so politely. And then they said, "You are a manager." And I remember it was Bob Mazza that gave me my first line management pin set and welcomed me to management and asked me why I wanted to be in management. And I looked at him and I said I didn't know I wanted to be in management. <laughs> Now, back in those days the first line manager was no special title in IBM. It was just a technical guy who still had to carry water during the day and occasionally had some extra paperwork afterhours to get people paid and promoted and whatever recognized, awarded, blah, blah. So I continued being a strong technical participant as a first line manager. As Ed remembers, that's when I wrote the end of life model and a whole bunch of stuff like

that. And as terrified as I was of it this is part of the serendipity that sometimes outsiders see something in your that you don't see in yourself, I turned out to be a pretty decent manager. It strained some of my relationships with the technical community because at the time the technical community managers were the ones that can't do. There was a little bit of that attitude judgement, Bill Dows [ph?], George Adams' [ph?] whatever. But that didn't bother me. One of the things that I made a point to do was not to force my name on to every invention disclosure written by my team like a lot of managers did. And that had the effect off screwing me out of a hell of a lot of recognition but that's okay. I went cruising along and the 3480 shipped and there was and kind of an air out of the balloon feeling around the plant. There was no immediate plan for a follow on. There was almost a let's wait and see if this thing is going to win. So we all kind of scattered off and did a whole bunch of different things. Al mentioned a whole bunch of stuff. There was all kind of stuff going on. One of the things I worked on was a three-and-a-half-inch double sided floppy disk called Ajo. It held sixteen megabytes. It had an MR Head. This was in 1985. They said that 16 megabytes would not be competitive in 1986 which was our ship plan so they cancelled and Ajo did it. As you know the 3.5 disk I don't think every exceeded 1.4 megabytes in the entire history of the technology. Worked on a number of projects that didn't go anywhere. I don't even want to talk about them. They were painful and horrible. Kenos, Barrels and you name it. I worked on some optical products. I worked on some plated, some phase change, some MO. Dabbled in lots of things. Eventually 3480 gained enough traction in the market and we'll talk more about that later. And I personally think that's attributed to the fact that IBM encouraged industry participation. Our business plan never even accounted for making more than ten percent of the media demand so we encouraged media suppliers to participate. We licensed freely or cheaply. We encouraged other drive manufacturers. And if you look at all of the really great legacy storage products, almost all of them at least in removable media an element of the legacy is the fact that there was multiple participants providing choice to the customer, providing competition. You do have single point products that were kind of proprietary. I could name a bunch of them. I will later. So we decided to enhance 3480 into something called the 3490E and I was put in charge of that. It was brilliantly conceived. Not much to it. Double the tracks. Guess what, we're going to write the other eighteen on the way back. Big deal. It eliminated rewind. It eliminated about 20 seconds of rewind time. This was back when StorageTek had slapped us around with the concept of automation and we were finally getting our act together and doing some automation. And swaps per hour was a big deal. That had to be ready. When the host was ready to talk to you, you better be ready to go. So elimination of rewind meant that we could increase our swap amount per hour significantly. We also went from a cross parity correction code which was not a very robust ECC design and we introduced Reed Solomon into that product. Those are the two noteworthy things of 3590. Other than it was pretty much a no brainer as Andy liked to say. There was a task force in research led by the late great James Eaton. I don't know if any of you remember him. He was a one-time lab director at San Jose who they kept catching him at three in the morning modeling stuff in his office. He could just never let go of the technical and he landed it on it in research. And somebody put him on a taskforce and a bunch of people I didn't even know they were doing it but they came up with an analysis that says there is a lot of headroom in tape. I mean you guys are shipping this 3490 800-megabyte product -- actually it's 400 megabytes and you have a ton of headroom. And he outlined the headroom and a lot of the headroom was going to have to be derived from track following servo because we had dead reckoning at the time. So I was put in charge of a team, a technology team to basically explore what this report had to say and how might we leverage it. And that [track following servo technology] effort, I think, was early on known as Somerton and later as Linden.

[Somerton was a code name for the overall technology (not product) effort that included our first "amplitude based" position error signal. Linden was code name for a product to be derived from Somerton, later renamed Coyote, which finally shipped as 3570 in 1996. However, Coyote did not select amplitude based servo, rather adopted timing based position error signal; Coyote was put on the shelf for a while in favor of prioritizing project Blythe, which shipped as 3590 in 1995. Blythe kept the original amplitude based servo.] Long story short I started that in '88 and it finally saw the light of day as the technology in the IBM 3590 and the IBM 3570 many years later. So I had moved from a front row spectator to basically to coach sitting on the bench doing all of this cool technology stuff. And then we hit a wall as Ric has already implied right around '92ish. We had a regime in that decided tape wasn't interesting. And we were starting to exit the tape business. And we took our head facility apart and I remember putting the equipment in big trucks in the parking lot and sold it on the thin film equipment market. So what next we had temporarily put this 3590 stuff on the shelf. And I was put on managed departure meaning you are going to be released from IBM. We just haven't decided yet. But we all kept coming to work and we all kept working because we didn't know what else to do. It was a scary time in my life because I had lived like a cocoon inside the security of IBM for so long I didn't know anybody outside of IBM. If I had to go find a job I wouldn't have known how to start. I didn't know anybody. Well, shortly after that a guy named Vanderslice came along and changed that whole equation. Decided that there was a lot of opportunity in tape that wasn't being exploited. He changed all of the leadership, put Barbara Grant in charge. Kevin Reardon became the lab director and my boss. And we didn't restart the technology right away. Kevin put me in charge of OEM. IBM made tape drives only for the enterprise, in other words, the mainframe. By then because of personal computers and the emerging Internet there were lots of other server platforms in IBM. We had the AS100 platform, the old ESS that you talked about. We had RISC platforms. We had Wintel platforms. All of those platforms had tape needs for backup, for restore, for whatever and none of those tape needs were met by a $40,000 tape drive. So I was in charge of basically a technical procurement of other people's stuff for IBM. And I didn't think this sounded like a very fun job to go from being the creator of technology to the mere consumer of other people's stuff. And you can imagine some of the early design reviews I sat in a Tandberg Data for quarter-inch cartridge drives. I was kind of an asshole and I'd ask them all of these and they'd say, "You sound like a mainframe guy. We don't worry about that stuff in this space." <laughs> "This is a $500 tape drive, dude." I learned a lot, really. I also met a lot of people. I met every mover and shaker in the entire universe of tape. I was buying eight millimeter from Exabyte I met Juan. I was buying four millimeter stuff from Seagate and I met Shugart at some point. I was buying floppy disk drives from Mitsumi. I met everybody. And all of a sudden it was like this whole new universe. And then they brought me back in and said, "Okay, we decided to get back in the game. We want to dust that stuff off you put on the shelf a couple of years ago and go ship it." Yes, sir, Tom.

Gardner: Kevin Reardon replaced Jay Hasson? Was that the sequence?

Teale: No, he replaced Freisen. Actually, it was Freisen, then Barbara Grant. Then Barbara went over to the business. Kevin backfilled Barbara. Kevin was succeeded by Rick Myers. Then Roger Vogel briefly, Terri Mitchell, Not Terri, she was Site Director not a Lab Director. It was Mike Liddecoat and me. So I ultimately became a Lab Director. So let's get back to right on the precipice of this technology that's been collecting dust. Kevin, by the way, is still with IBM. I would encourage you to reach out to him. He lives in

Armonk and he is the chief executive involved in all M&A activity in the IBM Corporation. He's done well for himself. He reports to the CFO back east. And he's a good friend of mine. In fact, he called me Friday because he heard you guys were coming here. I guess Tom Burneice had called him and so we had a long chat about what was going to happen here. He was excited about it. He would like to have come. I invited him for the optical session but he can't make it. We didn't have a head team. All of a sudden we didn't really have a technology team any more. We had a handful of people that were still here. But how do you get back in the game? And Kevin and Barbara came to me and said, "We want to get back in the technology game but what do we do?" I said, we'll, we're not going to replace the head team. We just wrote off a few hundred million bucks. And he goes, "Go to San Jose and figure out how to make a tape head and disk line." That was my assignment and staff that group. I went to San Jose and I stayed there for seven months. Tape was some kind of bad breath little sister to these disk guys. And getting somebody who wanted to manage a tape head group in a DASD centric environment I was wasting my time. I was interviewing four people a day getting no's. And then I finally realized and I told Kevin, I got a problem. Kevin came out and said, "All right, how many interviews you got lined up?" I said none. I said I need help. Kevin says, "Okay, what we're going to do is we're going to feature this job as a belt notching opportunity for the best and brightest. We're going to sell it to the DASD management as a broadening opportunity for a rising star." It worked. And all of a sudden I had people pounding on my door wanting the job as soon as they realized that all-- see back then if a DASD person was going to make a job move, they had four godmothers and godfathers they had to go talk to before they could even tell you if they're interested. And the career management in San Jose was just ridiculous. We didn't operate that way in Tucson. I failed to mention at this time that Kevin had a new org and he wanted me to the second line manager. And I told him no thanks. I'm having a lot of fun as the first line. He called an all hands meeting the next day and announced me in the job. I could have killed him. <laughs> Remember, serendipity. So I'm going through all of this. We finally get a head team going up there. Great synergy with the DASD team. The LTO stories where all of the came together and we'll talk about it on Thursday. And I'll just keep moving on here. I'm getting close to done. And we had a number of great managers up there. There was something called a spin valve head. I don't even know what that is but there was some gal from research that was working on that and she had done a technology transfer of it. Soleil [something] that saw me. She was my first tape head manager in San Jose back in that time period. We got 3590 shipped. We got 3570 shipped. And then we ran against a problem. The problem was the reason tape almost went extinct in IBM in the first place is because like a lot of places in IBM our participation was limited to the enterprise. And the enterprise growth numbers were not very interesting. And ever since I joined IBM they were at the very top of the corporation somehow maniacally focused on growth. I thought IBM would be a great income stock but I don't think of it as a growth stock. And what was it $55 trading value for about ten years. I mean it's hard to grow a large company. I mean let's face it, you've got to find white space opportunity. You've got to find adjacent space opportunity and it's not easy. And the only way we could grow was to make an open systems tape drive similar to all of the ones that I had been buying. And we had aimed 3570. That was our first lame attempt an open systems tape drive and the specific target for 3570 was to hunt and kill Exabyte where it lived. And we had some success with that. The problem is somebody else hunted and killed Exabyte before we got the job done. It was Quantum bought DEC's DX storage business in about '95, '96. And there was a diamond in the rough in that portfolio. There was a DEC proprietary tape drive that had never been used on any other system than DEC. Quantum kind of found it in the box of goodies, put a SCSI or some kind of open interface on it. And Quantum got a little bit

lucky. Not only did they find this diamond in the rough in the box but they arrived to the market with that just as capacity became king. Up until then you could sell some performance, and you could sell some reliability. But as soon as personal computing and all of these other servers and now the Internet is maturing in the mid-nineties boom the quest for just raw data storage was huge. Boom. Quantum was right there with DLT digital linear tape. And they monopolized the open space. And everybody inside of IBM was envious of that and they would look at me and call me things like stupid. “How come these guys can win all of this money with their crappy little technology?” Long story short that led to LTO, another story for another day. I did LTO for many generations. I wanted to complement something Al said about roadmaps. Roadmaps are a very powerful selling tool. When you’re trying to get customers to change from a legacy format like a DLT or a four millimeter or an eight millimeter having a roadmap that have some credible companies behind is a very powerful change agent creation in addition to job security, in addition to all of those other things. After LTO, again, serendipity. I got this idea, it was my idea of taking the LTO engine out and sticking it in something that would handle a cartridge that looked like a 3480 cartridge. The reason that we had failed in the open systems market was because we kept trying to go down market with enterprise stuff. Impossible. I know. I tried it three times. I failed three times. But you can take down market stuff, stuff that was designed at a lower cost point. You can enrich the functionality of that, tweak it’s performance a little bit. Repackage it. You can go up market with that. So internally in IBM we developed a beautiful model. The LTO cartridge does not resemble a 3590 cartridge. You can see that they’re not the same size. You can see that one is kind of square and dull and featureless. So this was the original dimensions. This actually is a 3480 cartridge. This is a 3592 cartridge. We literally took the guts of this cartridge including its leader pin in here somewhere. There’s a leader pin in there and stuck it in here. It’s a leader pin in there, not a leader block. We reused as much LTO stuff as possible and repackaged it as a 3590 replacement product called a 3592. It was sinfully successful. We were taking something that had a base manufacturing cost, LTOs BMC was in the vicinity of $1200. We were selling it at our OEM channel for about $2000 bucks. We had captured Dell as a customer and they were doing $110 million a year with this. So we had that huge cost base to amortize these lower volumes over. And we put some other special magic sauce in it but nothing very expensive. And we were able to basically sell the same thing for $25,000 over here. All of a sudden the tape business was just hitting on all cylinders. I had as Lab Director in my tenure I had created the concept of the high density frame and shoved it down my automation engineers’ throats. They didn’t want my help but they got it anyway and they were amazingly successful because the game had changed. They were still designing to high swap mount per hour library so fast it was a blur. It was taking two hours to write this cartridge and the picker is over there reading a paperback smoking a cigarette waiting for the next command. In other words it was an archaic requirement. You take that requirement out. StorageTek was killing us on something called gigabytes data per square foot used. And this was a big deal to big IT centers because it’s either migrate your technology or build another building as your data grew. And we had all of this dead air in our library, literally. There was some cartridges that faced the picker and behind that was 19 inches of-- empty 19 inch rack that had to be there for the drives down at the bottom but it was literally mostly air. And so I had the idea of filling up all of that air in the cartridges and we did. And where there was once one, we now had five and they were I these long cool sleeves. We repurposed the picker to not only pick but to be able to-- if you’ve ever played those puzzles where you got three by three or four by four thing and there’s one empty slot and you push them around until you get them in order and make the picture or whatever. As long as you’ve got one empty slot in there you can get any cartridge from anywhere to anywhere else.

Just don't fill that slot or you can't do that. Very exciting. I also threw the baby out with the bath water on our virtual tape system and reinvented it as something called Hydra. The main reason I did that is VTS was dependent upon something called an ESCON channel or FICON channel extender to go long distances. Think of a repeater. You guys probably know more about it than I do. And the company that we got those from I won't name them but they were highway robbers. The Internet was now here. So I wanted to get my connectivity through an Internet protocol and that was the real reason Hydra got born. It became very successful. At the time I made the decision to step down we probably had the best P&L in the entire corporation for the hardware business. We were hitting on all cylinders. We were making a sinful amount of money. Not only that, but the royalties we were bringing in from LTO alone exceeded our entire development budget. And those were checks that just kept coming and coming and coming. More about that on LTO later. The last six months of my career were about as fun as the first six months of my career. In tape we had a hole in our portfolio. I mentioned open systems tape with LTO. We plugged the gap. We were OEM'ing some low end libraries, sticking our technology in it and catching on to servers. We didn't have any virtual open tape. We just had the high end Hydra enterprise stuff. Somebody told me, handed me, told me to go buy a company. Said, find your problem, solve it, go buy a company. So I identified a couple of targets to buy. And I ended up buying a company called Diligent. They were headquartered in New Jersey but the workforce was in Tel Aviv, Israel. I was the point man on that entire evaluation. I worked with the corporate M&A people. It was about a $180 million deal and it was funner than heck. IBM had got this 1500-line checklist of due diligence for doing acquisitions. You look at cost synergies, market synergies, channel synergies, product synergies, portfolio synergies. I mean it's just a huge synergy analysis and from that you build a business case that justifies the acquisition. As a business plan you're supposed to manage to downstream. That's where IBM doesn't do so good. They underestimate the resistance of non-IBM cultures to the IBM culture. So I decided to do that fulltime. I got out of my lab director assignment. We called ourselves or we were referred to in IBM as the dark matter, the invisible people. We never go to work. We all mail it in from home. We're all sitting there in front of our computer in our underwear on the phone; picture that. And I got to work on a project that was top secret at the time and it was IBM attempting to acquire Sun[14]. And I was the only storage guy on the project. So my job, basically, there was a piece of Sun they had bought StorageTek. So there was a piece of Sun that may or may not be of interest in terms of making that an attractive acquisition. And I was in charge of that piece. Well, the people portfolio synergy between IBM and StorageTek products was very easy. I'm going to kick out their shitty tape drives and put our great tape drives in there. Eventually we're going to get all of that channeled down into one platform. Their high end disk solution they were reselling a Hitachi product. They were competing with IBM Shark and with EMC. The biggest funnest part of this synergy was this little guessing game of how much of StorageTek's high end disk business will IBM retain if they were to acquire Sun? There's no crystal ball that can help you answer a question like that. There's no analysis that you could do. So I ended up picking 50 percent, rather conservative. And I'm presenting it to our business leader Andy Monshaw. And Andy was, "John, why 50 percent?" And I said, well, Andy, people buy high end disks from StorageTek for one of two reasons. Either those customers hate EMC and IBM's guts or they love the Hitachi product. I said I don't know how many of those customers we're going to lose when we try to force them to buy IBM product. They'll be able to go directly to Hitachi if they

[14] See e.g. Why an IBM purchase of Sun would make sense, CNet, March 18, 2009

have to. They'll probably be some StorageTek rebels that will go out and enable those customers to do that. And Andy was like, "Well, realistically don't think you think it will be more like 80 percent?" Well, I'm just the technical guy. I said, Andy, you're the one signing up for the revenue, so you write down whatever you want. He goes, "Oh, 50 percent sounds pretty good to me." So now Andy is presenting this to Bob Moffat who was then the CFO of IBM. And this was all last lock and load are we going to pull the trigger and go try to buy Sun or not? And Andy's presenting my storage chart. And Bob Moffat, I kid you not, he goes, "Who is the chicken shit that's only signing up for 50 percent of StorageTek's disk revenue?" <laughs> And Andy Monshaw goes, "John are you on the phone?" <laughs> So I went through my spiel. Moffat said, "Change that to 80 percent." And because of the storage piece, the business case did close but IBM didn't pursue it and I hope I'm not talking out of school because I think it is publicly known that IBM tried. Ultimately, they did get sold to Oracle. We didn't know how to monetize all of the cool stuff Sun gave away. It was that simple. How do you monetize Java? How Sun did even stay in business? We kind of concluded at the end of due diligence we couldn't even figure it out. I wasn't in the room so consider that hearsay and speculation. I wouldn't want somebody accusing me of-- so I retired. Found out right after I retired that I had cancer before I left the business. I didn't know it. That kind of put me on the sidelines for a couple of years. So it wasn't the retirement plan. So when you've been out a couple of years it's a little hard to get back in the game. I came back. I did a little bit of consulting mostly for venture capitalists seeking my advice as a storage technology professional. One of them wanted to buy that old holography company. I forget their name. I told them don't do it. Somebody else was interested in Blu-Ray libraries for big data applications and I said, don't you dare - consumer technology. The last business trip that, in conclusion, I took with IBM was two weeks before I left the business I was invited as a keynote speaker to a Fuji Film end user seminar in Cancun, Mexico. It's kind of hard to say no to that. Good work if you can get it. I can do that for a living. And all I had to do was go down and do my tape ain't dead thing that I had been rehearsing for my entire career and get their customers pumped up about new stuff coming. And I had never googled myself. I had never read my own press. But in preparation for you guys' arrival I decided to sniff around last week and what is on the Internet about tape anyway? And it turns out there's a lot of good stuff up there that I didn't even know was up there. There's some good Wikipedia stuff on LTO and 3480 both. It's mostly accurate. I'm a purest. I won't nitpick it. It's a labor of love that somebody did and they got most of it right so I'm not going to criticize it. I like it. I accidentally found myself. Somebody had written an article about this and it's on the Internet. They had written an article about this speech I gave in Cancun. John Teale, quote, "Disk is the most unreliable storage device ever conceived," unquote. <laughs>

Gardner: Accurate quote?

Teale: It's part of the tape isn't dead story. And I wasn't kidding about job security. And there was a lot more to the story. There was data retention and all kinds of policy government stuff, all kinds of stuff. One of the exciting things about 3592 that differentiated it from LTO was that we had built in encryption at the time. There were tapes getting lost or stolen or falling off trucks. People were having to send free credit reports to all of their customers because they didn't know if the data was compromised or just lost. So we had the first storage in situ encryption device where if you find this laying on the ground you can't read it. So that's what I meant by jazzing it up with function that doesn't cost any extra money or much. That was pretty broad, I guess. I'm done.

Gardner: We have plenty of time. and, again, I apologize being one of those guys who produced those unreliable DASD's

Teale: You know, the best defense is a good offense.

Gardner: Indeed.

Teale: On two occasions IBM Tucson attempted to kill San Jose and both times we almost got our heads chopped off. I mentioned Prospector. Prospector was a spool about this big in diameter [15-inches], about this long [36-inches]. It had hundreds of 14-inch floppy disks on it. It had an arm on the side of this thing. It spun at a very high speed. It had an arm in there that would inject air pressure to separate two of the disks. We had an actuator that would come in and shove the head in there to do some reading and writing. And every time we might have got it a little bit crooked the actuator arm would rip up and hit the ceiling in a millisecond and the entire pack would shred and we'd have to start all over. Fun project. But think of the business case for something like that? It's basically a slow performing floppy version of a DASD array. And it was ultimately killed by San Jose. Hold that thought, Andy. One more we tried to do it. We got a guy named Jay Hasson who has been mentioned. He was kind of an optical bigot. Wasn't much of a tape lover. But he had the wrong vision of optics. His vision was that optics was going to hunt DASD and we were going to have big platters and we were going to be bigger and better and faster. As soon as San Jose got wind that we were trying to do that boom there came a big kick in the ass, gain. Okay. Pause. Andy.

Gaudet: Just real quick. Prospector came out of the Boulder lab. And Boulder did that and they were ridiculed for it because all of the things that happened exactly what you said you try the knife in and you'd be all off track and the thing would just fall apart. But from a technology point of view, from a conceptual point of view it's what was needed but it was…

Teale: It was terrific.

Gaudet: It didn't really see the light of day that I recall, right.

Teale: No, it got killed in Tucson. But we also somebody mentioned Sprat and Bluegill. I worked on that as well. That was a floppy disk sitting on a platter called the Bernoulli plate, although nobody could tell me which of the seven Bernoulli brothers it was named after. Remember, I was a fluids guy I know a little bit about it. I worked on that. That was a fun project. These were all really cool little things. Remember, I said that first two years I was a pig in the mud working on all of this stuff. That eventually left the business and became something called the Iomega Corporation and they very successfully sold and marketed that program for a number of years. Several of my workmates went with that Dave Norton, Tony Radman people you may or may not know,

Levine: Dave Bailey.

Teale: I was invited to go there but it was a little Mormon for me. And that's all I've got to say about that.

Gardner: Either of you other guys have comments on Sprat?

Levine: Well, Bluegill is the reason I went to Hursley.

Gardner: And Bluegill was.

Teale: I don't know the difference between Sprat and Bluegill.

Levine: Bluegill was the name-- we changed it. It was called Sprat in England and Hursley before Boulder got involved. And then when we got there for whatever reason I can't tell you the name changed to Bluegill. So those names are somewhat used interchangeably. And I worked for a guy named Jack Hockley in Hursley during the year 1977. We worked on Bluegill. Brought it back to Boulder in January of '78. At the same time they announced moving to Tucson and eventually we took it to Tucson. And it died a sad death, I don't know, six months or a year after we got to Tucson.

Teale: A bunch of guys took it out of the business. We killed it and then they took it away.

Levine: Right. And a group of IBM-ers who worked on it quit IBM and formed Iomega in 1980. Dave Bailey was the head of it and a whole bunch of other names.

Rizzi: Did Bernoulli?

Teale: You've got to understand in those days when I joined IBM there were two guys that recruited most of the 2000 college students. One guy was named Steve Vogel. He hired me. There was a guy name Dave Oldham, he was a channel manager. Dave Oldham was a senior member of the local Mormon church. So half the new hires were Mormon and half of them weren't. And I remember frequently getting solicited at IBM about my beliefs which given my background of growing up in colorblind military bases of all ethnicities and religions I didn't appreciate it very much but that's kind of how it was then. I mean there was still a lot of workplace discrimination of all varieties back then.

[Editor's note: Deleted overlapping dialog about Iomega]

Teale: Iomega's first product was a Bernoulli disk removable.

Gardner: That's true.

Teale: It's a box about yay big [4.5" x 8.54" x 14.09"][15]. It had been invented in IBM. We knew all of the guys. It was around 1980 that Iomega was formed.

Gardner: Yes I was off by a decade. I apologize for it. But you're right the Bernoulli box with a Bernoulli plate and that was also the Bluegill Sprat concept. That's pretty well known in the industry.

Teale: Well, I don't think its IBM origins are known. I don't know what kind of deal we cut with those guys. There's something else from my perspective IBM frequently encouraged people to take stuff and go do something with it if they had decided they're not going to anything with it. I'll give you an example. Jesse

[15] Iomega Alpha 10

Aweida was no enemy of IBM. He was encouraged to go do what he did. Juan Rodriguez was encouraged to go do what he did. The people at Iomega were encouraged to go do what they did. And the only thing I can say is there must not have been very onerous IP protection around that stuff or I don't know how they would have got off the ground maybe at minimum.

Levine: I remember we investigated that at length and IBM determined that they were not going to take any action.

Teale: Just looked the other way?

Levine: And, in plain English, a lot of people felt that they stole it from us.

Gardner: But then to be blunt about it the Bernoulli product was not a very successful product.

Teale: It was for a while.

Gardner: But not very -- they were really succeeded with ZIP ten or fifteen years later.

Teale: You're absolutely right. It probably wasn't sustainable.

Levine: At that time, a lot of people felt the guys who left stole, strong word, stole from IBM. And so there was a lot of work done.

Teale: Well, and there certainly was theft of people, no doubt about that. There was poaching.

Levine: At the end, the powers that be said we'll not purse it.

Gardner: I'd have to say having observed that in the late sixties early seventies at Memorex IBM's policy then was very tough on people leaving to go into at least competitive products, including suing people by name for misappropriation.

Teale: Everything was managed differently then. I remember John Ganevik [ph?] came from some voodoo optical place and he wasn't allowed to work on optics at IBM because he was firewalled by whatever. I didn't understand it.

Gardner: You guys, -- two of you, at least, worked on Ajo.

Teale: I worked on Ajo. This was my project. He probably didn't even know it existed.

Gaudet: It came up yesterday with Bradshaw. He mentioned it.

Teale: He brought it up?

Gardner: Yeah, tell us a little more about Ajo.

Teale: This was a metal particle media. Our first metal particle foray from Sony. What do you want to know about it? There were no double sided three-and-a-half's at the time. I'm not even sure three-and-a-half's were there yet -- I think there was still a lot of five-and-a-quarter stuff in the world. Boulder had taken a shot at a four-inch floppy[16]. There was some floppy activity up in the Rochester area of Minnesota. I don't remember. I think there was some legacy stuff that they had done. We decided that this was going to be a logical extension of what we had shipped in 3480. We had something called the double bump head. So there was a spherical head on one side and a spherical head on the other side and they had a point of oscillation meaning where they kissed and that's where the media went through and you kind of had an actuator that did that. And we had a micro stepper motor for dead reckoning on tracks. We had a roadmap to about 80 megabytes. It was a fun little project. The real reason it got killed is that-- this is almost a little bit embarrassing but I'm going to tell it.

Gaudet: Go ahead.

Teale: So I mentioned after 3480 a lot of us went off and did fun little projects. But unfortunately, there was a guy named Andy Hopper who thought he was a tape drive designer. And he thought he could acquire a metal head from a company called AMC and a low end non-pneumatic deck from a company called Cipher Data and stick a 3480 head and card in there. And produce a low end open systems attached tape drive that everybody would buy and he literally attempted to run that program out of finance. And it got a long ways without anybody in development really even knowing what was going on. And then all of a sudden Cipher Data raised their hand and said, "Houston we have a problem." This is how I got to meet Jerry Harries and Jack Harker because everybody with big shoes and their corporation landed in Tucson to see if we could fix it. Now, from a technology perspective, the reason I'm so critical of Andy is he may have had the right cost equation and some of the right players. But if you go putting the most abrasive tape ever made called chrome dioxide on a soft metal head, head life was approximately six hours. I kid you not. It just mowed through like a band saw and that's what Cipher was doing. And all of a sudden it was all hands on deck to help fix this project. It became known as Keno. My project Ajo became a casualty and all of a sudden I was plunked on gigantic taskforce to try to save Keno. And this is what I found out what it's like to be a victim of a drive by shooting. I'm having a lot of fun. I'm minding my own business. Steve Ward literally was at home with a collapsed lung recovering. He calls me at home and said, "John, I want you to go help this Daryl Johnson guy," whoever he was and pull together. I'm frantically going okay let's get rid of the metal head. Let's go make a ceramic version of a 3480 head. And the business guys behind the scenes I didn't really realize that had made fairly major commitments to AMC and Cipher and AMC and Cipher had taken significant financially risk of their own accord to participate. So we had a little problem. I learned all of this later. Jerry Harries came to town and said, "John, you keep working like hell and make your work visible," because he was creating a Potemkin village for these companies. In the meantime, in the back rooms they were trying to negotiate exit agreements and so on. And I was supposed to look like we were serious about the product. I thought we were. Then at some point I get a phone call that says "Okay, project is dead. You can go find some other job now." What? I mean I was literally in a technical meeting in Austin working on the project. Steve

[16] Announced as IBM 341 drive and DemiDiskette in 1983 it was withdrawn the same year and never shipped in volume.

called me, again. And I found out that there was big settlement that Jerry Harries had negotiated with Cipher and AMC.

Teale: Bob Hyland was a victim of that. there were a lot of people that got hurt. I got called in to be the hero. They called an all hands meeting and Daryl Johnson hung me out saying the reason this thing is killed because this presentation Teale made to Paul Low. It was the one where he took my foils and threw them on the carpet and ground the heel of his shoe on them he was so pissed off at what I was saying. he goes, "Do you feel bed now?" And I go kind of. I'm a first line manager. You're a division president. I found out later he was kind of nuts, that's all right.

Gardner: Is Shark RAMAC? What is Shark?

Rizzi: No, we did have a RAMAC right before Shark. We used reused RAM. That was the one that was packaged bad. We shipped it. And it had to be redone and that was the taskforce I ran to repackage it and get the cost structure, et cetera and that became Shark.

Gardner: So that's RAMAC.

Teale: RAMAC was a very short-- I mean in the currently technology. RAMAC was, as you know, the name of the very first random access memory something or other.

Teale: But for some reason we reused the initials which was probably unfortunate.

Rizzi: And that product was just very short lived. It was kind of like we've got to get something out of there to replace that.

Gardner: Okay. So RAMAC, I think, was the first enterprise class RAID product by IBM. There was an RAID product I think on the AS 400.

Gardner: So Shark was a complete replacement for the RAMAC product?

Rizzi: Again, the RAMAC was a product that wasn't a cost effective-- a lot of problems with it and we had to replace it right away.

Gardner: But was it a repackaging, redesign or a totally new product? That's what I'm trying to get at.

Rizzi: Well, Shark turned out to be a new product.

Gardner: So next generation, new product.

Teale: Shark is a whole story on its own and you're welcome to-- I'm sure there's a lot of semi-dead people in Tucson that worked on that.

Gardner: Actually, I hope we have time to talk about the RAID product lines.

Rizzi: At that time, weren't very heavily oriented around the 3880-- I mean the control unit, the cache controller.

Teale: I spent my whole life in tape. I have no idea. I mean I don't even know what 3880 is.

Rizzi: As a lab director, you guys didn't have-- wouldn't have the DASD controllers.

Teale: I was lab director and removed from media. DASD always had its own lab director. Always. They were never in the same room.

Gardner: You guys need to space your discussion apart so it transcribes well.

Teale: From a tape perspective, tape has always been an internal RAID architecture by virtue of its multi-channel and its ability to distribute the ECC. So for us RAID controllers are like no big deal. But for a lot of people it's the universe, I guess.

Gardner: I hope we get a chance sometime today probably late in the afternoon to talk about the RAID programs. I'd also like to actually discuss something you brought up but perhaps Al or Joel could talk. Also the controllers, the dash 11 and dash13, and then the follow on dash 21 and dash 23. Pretty interesting products. Now, as I understand it I'm a little confused. Was the fundamental 3880 done in San Jose but the dash 11 and perhaps the 13 was done in Tucson?

Rizzi: From the cache controller part of it, basically. Tucson added the cache and the software to support the cache. I can't remember exactly. One was maybe a fixed block version. The other one was a CKD.

Gardner: The eleven was a paging device in IBM's lexicon. And the thirteen was a caching device. The eleven had a fixed 4K record but it was not an FBA device. It was a CKD device with a key length equal zero and a record length equal 4K. And it was used as a paging device for the VM, Virtual Machine OS whereas the dash 13 and then the dash 23 were two caching devices where the data are staged and things like that.

Rizzi: To really get into that you really need a separate set of people.

Gardner: Well, I'd like to hear what you guys have to say.

Rizzi: I don't think any of us have a lot to say about it because other than I owned that space just for a short period of time before I went over here and then I went over here kind of stuff. But it was putting the cache and then that whole area allowed for Shark because Shark was an extension of that because you're starting to manage the RAID and functions and such. And in that process, somewhere in that process we basically moved the storage subsystem stuff down into Tucson out of San Jose. The San Jose development basically started-- basically disappeared in that same timeframe. And it became a Tucson product centric area around the cache controllers.

Gardner: And the Shark controller was the 3880?

Rizzi: Well, it was basically the follow on. It might have even been called the 3990 or something.

Gardner: That was the next generation mainframe control unit.

Rizzi: But it's an extension of that with the same type of people. This is where Rick Connolly and Daryl Jones and Mike Hartung.

Levine: Mike Hartung would probably be an excellent source of information.

Teale: Is Mike still around?

Gardner: Okay -- actually, I've got a couple but one for the whole panel is John's comment about IBM business management starting here in Tucson and approved at the corporate level made making the strategic decision to cooperate on media standards.

Rizzi: Is this the LTO?

Gardner: That is sort of the antithesis of old IBM which tried to exclude competitors.

Teale: It was old IBM [where we freely shared interchange requirements with the industry to promote the format through promoting competition]. For 3480 Judd McDowell was assigned to take the interchange specifications, not the knowhow of making anything to both ANSI and ECMA[17]. Because like I said, what I was told at the time was that we only had capacity to serve about 10 percent of the 3480 market. And we weren't going to build anymore. So we invited EMTEC and 3M and TDK and everybody and their brother ended up making 3480 media.

Gardner: Traditionally IBM wanted 100 percent of the market. Punch cards, even.

Teale: Well, for some reason in tape that was not the plan. I vividly remember that.

Levine: Before what John's talking about which IBM had a change of heart that they were 100 percent and then wanted to bring in the partners. When they were still at the 100 percent point one quick war story. Andy and his team were responsible for the media and all of that. But we still had responsibility for the polycarbonate physical cartridge. But there was a lot of tradeoffs between this and discussions and things of that nature. And one day I was sent to Atlantic Richfield's corporate headquarters in Wilmington Delaware because Atlantic Richfield manufactured the polycarbonate pellet. "Joel, go carefully tell them what we're doing but don't tell them anything." It was one of those kind of assignments. So I had to go there and in front of the board of directors of Atlantic Richfield which was sort of an interesting group of people in a conference room that would make this look like a dump. I told him a little bit about what we're doing and the chairman of the board of Atlantic Richfield turned to me and turned to one his guys and

[17] Issued as ISO/IEC 9661, Information technology -- Data interchange on 12,7 mm wide magnetic tape cartridges -- 18 tracks, 1 491 data bytes per millimeter, and
ISO/IEC 11559, Information technology -- Data interchange on 12,7 mm wide 18-track magnetic tape cartridges -- Extended format

said, “Take that boy down and show him what we’re doing down in Florida.” Take this boy. So they all finished doing their talk. This guy comes over. He introduces himself. He was nice and polite and he said, “Come on let’s go down to Florida.” And I said, now? He said, “Well, yeah, it’s only a few minute over to get on the plane. So magically we go over get on their corporate jet, the first time I think I was ever on a private corporate jet. I was impressed. Go down to Florida. We land at some airport in Tampa or near Tampa and two big black Cadillac’s come out and these guys come out and it was just me and this other guy who went down but it took two cars to take us. We went over to this big injection molding plant. And they wanted to impress me with their injection molding capability thinking before what John’s talking about where you want to bring it up that they could make all of the cartridges. They had two to three injection molding machines. And maybe they were each capable of doing 16 or 18 at a time as far as the size of the mold goes. No way in hell could they even come close. And I remember coming back and I said, it would be nice for modeled parts or something of that nature which is about what this particular company’s capability was. I’m not badmouthing them but that’s what they were. And it wasn’t long after that that after they started doing the arithmetic they came to the conclusion, we’d better find some partners to make this thing because no way in the devil are we ever going to make them all.

Teale: I realized another little interesting tidbit about this cartridge on the subject of the plastics, when I joined IBM, IBM was wanting to lead American industry into the new universe of metric measurements.

Levine: Oh yeah.

Teale: I came out of college. All I knew was metric. I didn’t actually know the English system units. That’s what they were teaching in college. I came into IBM. Everything was metric or most stuff was in metric. Unfortunately, nobody in industry followed IBM. And subsequently when I was working with vendors we were constantly spending more time in our meetings transferring millimeters to how many mils is that?

Gardner: And agree upon the tolerances.

Teale: One of the cool things-- the way this cartridge is retained that’s called a brake button. You see some ridges and that’s what the motor collection gage is to spin it. But this thing is locked by that brake button. There’s a thing that sticks out of the top of the cartridge here. The brake button has a slot in it so this will not rotate unless that button is pushed completely to the top. There’s a spring loaded thing in there and then this thing is free to rotate. I remember early days of IBM walking into our labs and hearing this screeching all over the place. It was the screeching of these brake button mechanisms. And this was designed. Somebody said it earlier to be four by five by one inch but we had to convert it to metric. And if you measure this cartridge it is 24.5 millimeters high.

Rizzi: It used to be an inch.

<overlapping conversation>

Gardner: Right, no.

<overlapping conversation>

Teale: We even know who made that error. And I'm not going to tell you his name but I will tell you that I exited him from the business. But all of the other dimensions were transposed correctly. And so that was this brake thing pushing up against this thing kind of semi engaged and semi disengaged and it just made an awful racket. And we ended up changing the design of the brake slightly to give it some clearance.

Gardner: That's actually a great segue into another set of follow up questions for you, John. So that is a 3480 cartridge.

Teale: It says 3480 right on it. It's an original.

Gardner: What's the yellow thing? The golden thing in front of you?

Teale: This is an LTO cartridge but it was actually-- this is now how LTO cartridges appear when they're shipped. This was a cartridge presented to me by the IBM Japan team as a thank you so they…

Rizzi: Gold plastic.

Gardner: But it's physically a LTO cartridge.

Teale: It's a real LTO cartridge. One of the things was so we did this for LTO and why didn't we just use this cartridge? Well, IBM wanted to but you'll hear later that HP and Seagate had very good reasons for not wanting to use this cartridge because they had their eye on the business opportunity for 5¼-inch half height tape drives. This would not enable a tape drive that thick [1.75-inch height]. This does barely. And there was a lot of arguing about the design of this. Ultimately, this is a design by committee and it has some ugly things about it that clearly were designed by a committee. But one of the interesting things is when I wanted to take this technology and put it back into the high end I talked about that what became the 3592 I had to sell this to a guy name Walter Risner who was our business leader at the time and my boss was <inaudible> Charles Little. Walter is on the phone and says, "What's this about you've got a new cartridge?" Because we had to reinvent the 3480 cartridge to replace that leader block with a leader pin. So this is a leader block. It pops out. It was a source of much pain to many people because it's very poorly designed. This is a leader pin, there's a pin in there that you grab just like the LTO cartridge has a leader pin. So in order to take as much of the LTO technology and port it, if you will, and I hate to use the word port it because as a technical person nothing ports. But program managers love that kind of term. It makes it sound simple somehow. Sorry, Joel. And Walter is not getting it. He is not getting it.

Gardner: Well, I'm not getting it, the third cartridge you held up is the 3492?

Teale: It's the 3492 but we wanted to use the LTO engine so we had to take that leader block off and so there was some money we had to spend to reengineer the 3480 cartridge without changing any of its external physical interface because it had to go into existing automation. And the existing automation in the enterprise didn't take this cartridge because this wasn't in the enterprise. I'm trying to explain this to Walter Risner. And he goes I don't understand how come you can't just use the LTO cartridge? And I said

Walt, do you have an audio cassette player? "Yes, I do." Do you have a video cassette player, VHS? He goes, "Yes, I do." And I said can you put your audio cassette into your VHS player? And he goes, "Of course not." Can you put your VHS cassette into your audio player? "Of course not, you idiot." I'm like he's making my case here. How do I close the deal and get the money? Well, it's the same problem man.

Gardner: So you have a bunch of other objects to talk about?…

Teale: I wanted to illustrate-- earlier I talked about how once upon a time performance and reliability had some value in the open systems and Exabyte took advantage of that. If you recall these were cute little storage products derived from consumer technologies. So there was four millimeter audio DAT and HP and Seagate conspired to convert that into DDS which was the storage version of the audio. So they were porting a technology engine. The same with the eight millimeter. That was originally a video recorder which got converted. It's a digital video recorder. So it's not a big leap of imagination to concert that into a more generic storage device than just video content. That's what Exabyte did. Tremendous. The problem was, as I told you, the capacity requirements weren't that big prior to personal computing and the Internet. So there were a lot of these dual reel cartridges in the market including the four millimeter, the eight millimeter and the quarter-inch cassette. This happens to be a 3570 Magstar MP with the mid tape load. The whole idea is you get a really simple drive. You just shove it in here. You don't even need the tape path. You jam two motors in there and it goes right on to the recording head. You're locked, loaded, ready to go. It's fast. It's efficient. It's relatively cheap. The problem is Quantum came along and inadvertently changed the whole midrange equation to capacity and cost. That's the only game. This is very limited on the number of square inches of tape you could put into approximately the same space as a single reel cartridge. So all of these little dual reel cartridge things, every single one of them is extinct as a storage device. I don't have a DLT cartridge with me. It's a really super ugly cartridge. It looks a little bit like an LTO cartridge, kind of clunky, squarish. This was intentionally made a little bit longer than it needs to because people didn't have to shove it in-- you needed something to hold on to, to get in and out. And so what's what that reference was all about. Quantum really changed the game. And that's why this was too little late. And that's what propelled us to the LTO concept that we'll talk about Thursday. The other thing I wanted to mention on the StorageTek deal the synergy was so cool. I had the whole thing reduced to fifteen what do they call it sustaining engineering team for legacy StorageTek products. And I was going to burn the factory down to the floor. That was the business plan. And by the way I left IBM when that deal fell through.

Gardner: Let's try to wrap up. You have a piece of tape there, a wide piece…

Teale: Well, this is an old MSS. I didn't know how much technology we were going to talk about. MSS was a super product way ahead of its time. I barely worked on it. I worked on the head on this project called delta where were trying to put another head in the loader and do something with it. I was first in automation. And it was first in a whole lot of virtualization elements. It clearly had a different form factor of tape.

Gardner: You are now holding a piece of tape from that cartridge.

Teale: These guys probably know a lot more about it than I do.

Levine: You see the diagonal stripes on it, John?

Teale: Yeah, it was a helical scan decoding device, rotary scan whatever you want to call it. I don't know if you have can see it or not.

Rizzi: There's no formatting though, right?

Gaudet: No, it was dead reckoning just like all of the tape drives

Rizzi: So the head itself was writing the track.

Teale: Yes. And it was doing it-- there's a difference between helical scan and rotary scan and it's a very subtle difference. I'll try to explain it. You've got a round drum with head or heads. They're coupled inductively out to the channel, no wires obviously. If you stepped this tape, scan it, step it again, scan it, that's called rotary scan recording. You're stepping the tape and then the tape is fixed as the head swipes by. If you're continuously moving the tape as you're writing it that's helical scan recording and you get a slightly curved, very slightly curved result because the tape is moving, not that that's a distinction anyone cares about. But I'm pretty sure this was a helical scan recorded device, way ahead of its time. StorageTek came out many years later with they called it Redwood. We called deadwood.

Gardner: One of the sides of that piece of tape seems to have the scans visible.

Teale: It might. I don't know. Maybe there's been some developing fluid dusted on there at some point for some reason or another.

Gardner: Yeah, I don't know if the camera can see it but there's a definite diagonal stripe here about that long [7-inches]. And there's also apparently something recorded on both edges top and bottom. So it appears maybe this has been a developed piece of tape that somebody's developed.

Levine: The two edges, if my memory is right, are basically wear marks.

Gardner: Okay. It could be wear marks. But I mean you can clearly see a scan path.

Levine: There was nothing-- the head John's describing is the only head. So there was nothing recorded longitudinal. It was all helical.

Rizzi: With a single head or a multi-track?

Levine: Single track.

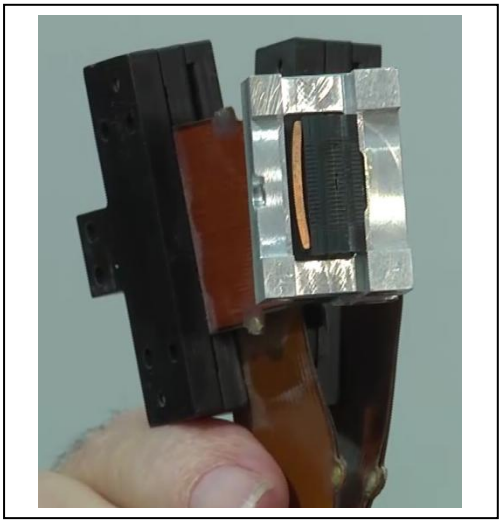
Gardner: Single track.

Rizzi: So those are multiple scans

Teale: Oh, that's got to be a whole bunch of tracks. Just another artifact. I can tell you what this head is. Let's see if anybody else can?

Gardner: Is this a graded exercise?

Teale: Yeah, there will be a test later. This is a 3590E. The reason you can tell is a 3480 head only wrote out and rewound. It had a write module, a read module. As you wrote the tape you did an immediate read back to make sure you recorded it. And you went all the way in the tape you're done and rewound it and put away. The 3490E I already mentioned we decided to stick 18 more tracks interleaved with the 18 out and write 18 more back. So now you needed two cables out of each module because each module now has alternating write and read elements in it. The other way you can tell is if you studied that contour I can see that there's a dual rows of bleed slots on both modules because I designed that. I think it's TI.



Rizzi: This is the similar head with the staggered read/writes going each way on that head?

Teale: See, this head has 18 writers with 18 readers on the other module out. And then there's 18 more writers sandwiched in between the 18 readers to write and read coming back. No rewind.

Rizzi: No rewind for the product.

Teale: Now, one of the problems we found is that sounds like a brilliant idea. We subsequently did some analysis. So now we're talking more generically about 3480 itself. We did a study once because we wanted to understand that we had right market requirements. We had shipped 200 megs. We had shipped 400 megs. Now, what? We did this big study and guess what we found out? The average enterprise customer wrote 20 megabytes on a 3480 cartridge. And guess what? System 370 JCL and TSO had a one to one correspondence between the tape volume number and a physical tape piece of tape. So what we found out is why do we have a 100-megabyte cartridge in our roadmap when these customers are writing 20 megabytes of data on average. Almost nobody ever fills up a tape. This led to the intention, creation of something called virtual tape. So the idea of virtual tape was that I can take this cartridge, this physical cartridge and I can associate many logical names with this physical cartridge. I can concatenate that stuff. And I can fake the host out. It thinks it's asking for a unique physical volume but I've got a translator in front of it, oh he wants that one that is sharing sixteen other things. And that virtual tape system had to be disk cached because we would stream all of that stuff to disk so that we could make sure that this tape had room for that particular one before we appended it on to the tape. A number of benefits because all of a sudden tape customers suddenly experienced what appeared to be disk like performance even though it was fundamentally on the back end a very large tape device. They got the benefits of utilization of media which was a huge customer buying proposition and I'll conclude like that. Like I said I can talk about this subject for the rest of your life.

Gardner: How about just talking about that small reel of tape to your right?

Teale: I just brought this in case nobody knew what they looked like. I mentioned that there's a braking thing in here where the brake button come through in the spring. I think there's about a mile of tape on here. I don't remember. I think the dimensions of this was always fascinating. I don't know if Rick discussed it. But the thickness of modern tape is approximately a tenth of a thickness of a hair on your head. That's how thin this stuff is unbelievably thin, less than a thousandth of an inch modern tapes. And yet it is almost a mile long and a half inch wide. It's a little bit like the solar system it's hard to draw to scale because the scale is just so weirdly out of proportion. It's a wonderful thing. But I had no specific purpose. This is just the guts of the 3480 cartridge.

Gardner: This is now after the lunch break. I think we established that IBM early on, maybe right from the get go on the 3480 cartridge, made the decision to cooperate, in fact help establish media standards in the industry. Somebody said they had planned on ten percent of the market, letting the rest of the world supply the rest of the media market. Any more elaboration on who made that decision and how early it was made? It sounds like it was right from the beginning.

Rizzi: Well, let me just give an observation, listening to what they said, is you got a manufacturing plant facility, Building 10, that had a maximum capacity, if you wanted to provide more than what was projected, you'd have to build another facility and the company wasn't going to do that. Therefore, you know your capacity, you project what your volumes are going to be and it must have been like a ten percent projection that our capability was against the volumes and therefore you had to do something different. Is that somewhat correct? Because I was listening to that aspect of it.

Teale: I know that when I joined in '78, there was already a plan in place to produce an ECMA and an ANSI standard, it was not an afterthought, it was, as far as I know, it was from birth. And I was told that the actual projected media worldwide demand for 3480 was going to exceed IBM's ability to produce by a factor of ten and it was on purpose that we did all this. Now, for all I know there might have been some royalty stuff going on that I didn't know about as a young engineer.

Rizzi: That justified it.

Teale: Don't know. That justified it, right, I don't know.

Gardner: Joel, you also go back to that era.

Levine: I don't have anything to add to that. Originally, if I think back to when we laid out the specs for the Building 10 in Boulder before we moved, part of the decision was what we thought at the time was we would be able to handle our capacity. Now that decision was obviously wrong by ten times.

Teale: The other 12 media vendors entered.

Levine: And the other thing is, that decision was made long before we really had a good handle on what the tape drive looked like. So as we learned more about the tape drive, what John's talking about comes into play that all of a sudden the projections for quantity increase significantly well beyond what the plant's capacity was.

Teale: I mentioned, it was a big hold breath after we shipped it, we were later to market than we wanted to be.

Levine: We made early decisions in Building 10 long before we knew enough about the tape drive to know its total quantity. So it was the tail chasing the horse.

Teale: It's also my understanding that 3420 and its predecessors were all standardized and not proprietary to IBM to my knowledge and lots of people made those compatible tape drives. I think it was kind of a tradition when the media was removable to enable the interchange. So I don't think anybody questioned it,

Rizzi: You said we assigned somebody, was it Vogel?

Teale: Judd McDowell and later on Paul Sager took over that role but Judd did it for a long time.

Levine: There's one more factor in there and that is, we protected that cartridge very closely, highly confidential, even when we had the early beta test sites, we had to go out there and inventory them and keep track of them and all that because we didn't want anybody to know what that form factor was until we announced it, actually shipped it, So we realized also, there would be a lag between when we started and when other vendors could start producing that other 90 percent. So that was another factor, we wanted to not release any information until the very last minute and then whoops, how long does it take the other guy to get up to speed. So there's an obvious gap in there.

Rizzi: It seems that, because I don't remember this part very well, but listening to the conversations of today and yesterday, that we realized when we shipped Sonoita and testing other people's media that ours was really only media that worked well on our drives and if we only had ten percent capability of the projected volumes, did we do anything to enable the other vendors to be able to produce a Sonoita type tape so they wouldn't wipe out our drives?

Teale: I don't think anybody here can answer the question but I know that we did a tremendous amount of competitive media analysis and I know that we endorsed some and didn't endorse others. I remember there was one particularly bad actor, I forget which one it was, Verbatim or somebody that was dumping in South America because we recommended so strongly against it.

Rizzi: Yeah.

Teale: No, but I think we provided our test capability to give them the feedback they needed to make a product that we could use.

Rizzi: Okay.

Gardner: Okay. So can we talk a few minutes about library activities in Tucson?

Teale: Well to me we really haven't even started, hardly started the drive discussion, I mean we can-- well, let me give you a perspective on the drive and then we'll see what we want to do. I don't actually

think the automation discussion is a very long one. The first thing people see when they look at a 3480 tape drive was, "Where are the vacuum columns?" and, "What's that square cartridge?" because that open reel and those vacuum columns were what a lot of people thought was the mainframe, to tell you the truth.

Rizzi: Yeah, screwed up by the movie people.

Teale: It was in every single picture, it's the only thing that moves.

Rizzi: Right.

Teale: The implication of those simple two observations alone led to years of technical goof. So let me tell you what the vacuum columns were for. That was a mechanical buffer before electronic data buffers were viable and cheap. When the host said, "Data's coming," you had to be repositioned and ready to take it the minute they got there and you had to take it off. The accelerations of that capstan and sometimes there was rubber stuff on that capstan to make it grippy, believe it or not there was a vacuum in that capstan. Because we accelerated that tape at 1,000 inches per second squared, that's an enormous acceleration, to keep up with the host.

Gardner: Thirty Gs?

Teale: It's huge. Somebody did a sparkler on the math and said in a second, that would be like here to the moon three times or something, I don't know how far it really is, but the mechanical implication of that. So what came along was this concept of an electronic data buffer, it wasn't very large but it was large enough to buffer enough data to give the 3480 time to reposition because when we got rid of the vacuum columns, all the repositioning was reel to reel, those motors were a lot smarter because we wanted the two in one deal. The acceleration got knocked down to 40 inches per second squared in 3480, it went to 15, in Coyote, it went to 10 and LTO, acceleration is bad and it leads right to the next big deal, what happened to the open reel. I hope Ric convinced you yesterday that all claims about the life of data on a media and I don't care whether it's an optical media, a tape media, a disk media, are all completely marketing bogus concepts. The fact of the matter is if you protect the media environmentally and through handling, that stuff will stay magnetized until the sun explodes, it's that simple, there's no such thing as 70 years or 20 years. Open reel tapes were highly prone to handling damage, in other words, the biggest error mechanism in tape is handling damage, literally damage to the media - back hitches creating Z-folds. In fact, when they had threading problems in 3420, they'd just whack off a couple of feet of the lead tape and rethread it and then at some point they would whack in too far and then all of a sudden you've got a whole unreadable tape. So the whole idea of the cartridge, I'd love to say that IBM was super prescient it and was looking forward to enabling automation but they weren't, it was all about getting the media in a protected environment so that you could eliminate handling as a failure mode. Those two things had enormous consequences. I'll give you a simple example, the 3420 recording head, could be changed in a customer office. The tolerances required, now that we didn't have these vacuum columns, we have this reel to reel thing were so difficult, you could no longer replace a head and we invented something called a head guide-through, a head that was attached to guides that let in and controlled the tape path. And I could go on and on but the point is just those two observable things alone, enabled by a

small electronic data buffer eliminated years of mechanical grief and there was a lot of like Al said, a ton of mechanical engineering opportunity in what appears to be an electronics field. There were many other innovations in 3480, chrome dioxide was a pretty thick coating, it was a fairly high coercivity particle and we had trouble overwriting it and we would tend to drive the heads beyond the saturation point, typically 110 percent was our so called write current, 110 of said current, because of all the interchangeable, you had weak heads trying to overwrite strong heads, and you got all this stuff. And we didn't invent the thin film write head, that came from disk land but we adopted it, we used to drive that with what we call the full cell write driver so we have the current all the way plus V until it was minus V until it was plus V in some modulated fashion to produce the data pattern. And our write head coils were burning out like light bulbs in approximately four hours. So I remember working a night shift once, I was sharing the single track reliability tester at the Grant Building, we only had one or two in the whole site, so time was valuable on these testers. I was playing around with cleaner blades, a guy named Dave Grissel was playing around with trying to pulse the write current instead of doing a full cell, because he was trying to solve the problem of burning out the write heads. And one night, he hooked up his cards and I hooked up my cleaner blades and we had been running reliability passes for a long time and one night we'd get an E6 and the next day an E4, so think of it as soft error rates in your terminology, next day a E5 and the occasional E7, wow.

Gardner: That's one error in ten to the seventh bits.

Teale: Yes, one in ten to the seventh [bits]. So all of a sudden, one magic night the thing ran stable E7 all night long and all the, I call them the pointy heads, the McDowells, the senior leadership engineers, Dave and I were just experimenting, came in, "What did you guys do?" And we looked at each other and said, "Well, we don't really know what we did. We could tell you what we did but we don't know why." So Dave explained what he was doing, I explained what I was doing, they all took it away. Judd McDowell was one of our luminary channel guys, recognized that there was something more than meets the eye here, he did something more than just solve a write burnout problem. He literally assigned Dick Schneider who was somewhat junior at the time to mathematically look at what Dave was doing and see what it meant. And Dick Schneider subsequently wrote the book on write equalization, so that was the birth of write equalization at least in tape storage and not only did it solve the burning out of the write problem but in order to overwrite the media, we were driving it to hard that we were creating what they call a second harmonic distortion, nonlinearities off of the MR sensor because as you know the MR sensor has squared response curve, we try to magnetically bias it so that you're operating here but when you overdrive it, you'll get rabbit ears in one side and a flat spot on the other and what's called a second harmonic distortion and it's poison to the channel, channel can't do anything about it, can't filter it. And low and behold, second harmonic distortion was vastly diminished. And thirdly Dick proved theoretically that you could use variations of these pulses of which there's an infinite number of ways to go, a lot up, a little bit down, you can do all kinds of things with electronics. And he discovered that you could effectively dial in an equalization response that you wanted through the way you wrote the tape to be a very good match for the read channel when it was coming back off the tape. And this is what I call super elegant innovation. Elegant innovation usually occurs, first of all it's never invented, it's almost always discovered, usually by accident, usually an unintended consequence of solving a completely different problem. It had three gigantic payoffs, it was the first in 3480 innovation and I just use that as an example of the problems

that were presented. And perhaps I should have prefaced it by saying, why magnetoresistive read-head, that was not shipping in DASD at the time, it was not a proven technology? Well, the other piece of the story on 3420 is that with that gigantic acceleration you also had very large speeds. Why did you have very large speeds, because the read sensor in a tape drive was a inductive sensor, that traditional, literally was a wire wound coil.

Gardner: Absolute speed or speed variation?

Teale: Absolute speed, ISVs are a whole different can of worms. And we had gotten to a point where at the linear density goals we aspired to, our signal was just vanishing. And the magnetoresistive sensor which was not invented but discovered, although many people subsequently patented the discovery, that's just how it works, was speed independent, wow, just what tape need. Disk wasn't worried, they could still keep cranking that RPM but tape was out of gas particularly on this new platform. And we originally started it with no pneumatics by the way, our eyes wide shut. <laughs> So the magnetoresistive and this write equalization thing all to address this absence of vacuum columns. Tomorrow I think Dan Winarski will tell you a little bit more about the evolution of the mechanical deck, I did work on it. As I mentioned, we started without pneumatics and we had terrible problems, we had head wear problems but we also had guide bearing wear problems that were severe, it was damaging tapes particularly on the edges, it was leaving all kinds of crap in the tape path whereas Nick Donofrio, used to say, "Shit on the head." <laughs> It's a technical term, disk guys probably had the same term.

Gardner: I think we use crap.

Teale: Okay. The other thing that was really bad, this was a horrible consequence, Joel may or may not remember this because this was not a technology problem, in theory by the way, this was the first microprocessor controlled reel to reel servo system that we had ever done. When you think about the servo system on the 3420, you get this reel keeping that column in tape, this reel watching that column and a capstan in the middle, that is a primitive control system when you think about it, it's child's play. Now we had to go to this reel to reel thing. Now in theory, you could dead reckon position, get pretty close through counting tachs [tachometer marks], you could estimate the radius of the tape in the two reels and do reasonably good tension control, but you couldn't do quite good enough tension control, so we had tension transients that would affect head wear, tape damage, other things. So we had to put something called a tension transducer in the tape path, we'd never done this in a tape drive before. There were probably 20 people in a task force that last for three years under Tom Mostraday, I remember the pain of it, very painful. So I'm just showing you the ripple down effect, just a couple of little things that look kind of obvious become huge areas of invention required on a schedule. Drives needed a lot of such work, I've got other examples that I sent you in an email, I don't have email in front of me but those were a couple that I think were in there.[18] By the way, on the cleaner blade, it turns out the Grant Building was undergoing some renovation, some construction, and I thought I had really contributed to this, E7 night, you know, Dave was part of it, but I got a piece of that. So I analyzed the debris that I had captured in a screen in the vacuum line of my cleaning blade and it came back 100 percent gypsum dust floating in the

[18] Teale's list of unique 3480 attributes attached as Appendix A to this transcript.

ambient atmosphere due to construction in the cafeteria. Now our tape was not back coated because there was no tradition of back coating tapes. I was a strong proponent of back coat but if Dr. Bradshaw didn't agree with you in those days, it didn't happen. The consequence of that is that we had humungous amount of static electricity that would build up throughout the tape path, we had precautions in the head that bled it away, we had precautions throughout the tape path that bled away and that gypsum dust was just landing on the tape, on certain nights when it was bad and that was probably more responsible for the E4 one day and the E6 the next than anything else. I went ahead and patented it by the way.

<laughter>

Gardner: Just a question from someone that's not so familiar with technology, I thought tape in the half inch reel to reel was quite commonly back coated with carbon.

Teale: Not at the time.

Rizzi: No.

Teale: We had no back coat at all on our media.

Gardner: Oh really?

Teale: I'm not saying other industries didn't do it, IBM didn't do it, it was not a tradition to my knowledge since 1952.

Rizzi: None of the earlier tape drives.

Gardner: Really?

Teale: It did become a common practice later on. Now at some point, Dr. Bradshaw did buy in because he recognized that there was a stress balancing that could be achieved, but that was after we left the tape media business that we became a fan and we were looking to 3M. I don't honestly remember if 3590 was back coated or not, it probably was, but I don't know, I'd have to go look. To answer your question, no, it was not the practice. And static electricity, frankly had never been an issue in 3420, it didn't have the components like the MR head that did the damage to it.

Gardner: Again, it's my ignorance, I have a recollection of carbon coating being fairly common, I thought Memorex and other's like Black Watch at 3M had it[19]

Teale: It might have been but we didn't do it.

Rizzi: I don't think we did it.

[19] Memorex disclosed carbon back coating on video and computer tape as early as 1970. [Source: Memorex Annual Report 1970]

Teale: It's just a fact, I know we didn't.

Gardner: Okay.

Teale: I'll tell you why I know we didn't do it. So I had a brilliant idea, I wasn't going to bring this up but this is on the tape deck design. So we had a deal where it came off a reel and went over a bearing, over the head, over another bearing and came back around a tension transducer and back onto the other reel. It made for a semi elegant threading mechanism, kind of a cammed thing, took the leader block out and stuck it in a take up reel inside. And we were having all these problems and especially on the guide bearings and I had this brilliant idea of flipping the head over onto the other side and turning the tape inside out. Now I'm an associate engineer, you would think that I would have been completely blown off on that suggestion, but I'll be damned if everybody didn't jump on it and do it. So now we had to thread over a bearing, back over the head, over the bearing and there was something called a laugh track threader that was like a choo-choo train that did that. And we did that without even a review -- I honestly that there would be 14 smart guys that would review this before we just went and tried it, it was a colossal waste of money, it was my fault and that Mylar, uncoated Mylar stuck to those non-pneumatic air bearings like you wouldn't believe, the drag in the tape path was horrible, it was so bad we would snap tape when we were trying to accelerate. So we put the head back on the other side, put the old threader back on and that's how I know that we did not have a back coated media because I experienced it.

Gaudet: Good experiment!.

Teale: I finally concluded that we needed to put pneumatics in the tape drive and that idea met a lot of resistance, pneumatics are not all that reliable, they're noisy.

Rizzi: Money.

Teale: Money. But I wrote a memo, I proved it, I designed the air bearings, we put them in the product and it turns out we need air for lots of other reasons that we didn't know we needed air for, we needed a vacuum on the cleaner blade that went in later. Believe it or not, our stiction problems were so bad between the head and the tape that in between the two head modules, we put a, I don't know what you call it, it was called a tape lifter but it was a…

Levine: Tape lifter.

Teale: It was a pneumatic air guide so that when the tape was stopped we would actually at high pressure clean the modules and lift the tape off the head.

Rizzi: And pour air through.

Teale: Because that's how paranoid we were and particularly when the tape was at rest for a long time and some environmental stress. It was so bad you could pull a 3480 tape drive across the room by grabbing the tape stuck to the head, it could be that bad. And Ric talked a lot about these problems yesterday, it was mainly associated with what we called the Pegasus media before, Ric's Sonoita formulation became available. And I'm going to take exception with one thing with Andy and I don't mean

this at all critically but in fact and in hindsight it might have been an error, we did ship 3480 without Ric Bradshaw, not because of him, we shipped Pegasus because Ric's stuff wasn't ready, we shipped 17 million cartridges of Pegasus before Ric's formulation was ready for prime time and we got 12 million of those back <laughs> in something like the first 18 months of the program.

Rizzi: They did talk about that somewhat yesterday when you were playing golf probably.

Teale: I was playing golf.

Rizzi: But yesterday they talked about it being about 9 million, so it was actually like 17 million, got 12 million back.

Teale: I remember 17 and 12.

Rizzi: Yeah.

<overlapping conversation>

Teale: Because I was in management by then so I was kind of in tune with the business as well as the technical.

Rizzi: Right.

Teale: Don't have my notes, these guys can chip in, there's a lot of other technical horror stories that are kind of interesting.

Gaudet: We covered a lot of that yesterday.

Teale: Yeah, good. So just what you could observe was a significant challenge for <inaudible>.

Gardner: Actually we sort of covered stiction in great depth from the medium's perspective. I don't think we used the word head to speak of.

Teale: My guess is you were focused on the heads and I was more involved in the tape and air bearing. Well the real stiction problem was with the head.

Gaudet: There was stick and stiction.

Teale: But it doesn't matter which, the point is we've covered it.

Gaudet: And we covered that very well yesterday.

Teale: So now you know the motivation and what the ramifications were.

Rizzi: John was talking about the technology advances that actually were key to being able to do the product. And this is going to be kind of a question, but I'm asking these two guys, Boulder time frame,

probably comes down, we got a new plant site and probably a new crew were being hired because you don't move everybody down when those transfers happen, so a lot of new people come on board, et cetera. But the Saguaro was probably in our product projects at the time, 1980 time frame and the commitments or the technology, I'll call it advances that were required, how many of these were committed at that time, not committed per se but an assumption like that MR head, was it an assumption? I know that the buffer had to be to get rid of the thing. But it's like the MR head, was it one that was assumed and was the film iron oxide…

<overlapping conversation>

Teale: It was there <inaudible> because we knew we had the velocity problem.

Gardner: And the chrome dioxide was the requirement?

Teale: Well, and in theory the thin film head, both the magnetoresistive and the inductive could be deposited on a much harder material than a traditional metal head, typically a calcium titanate or some type of ceramic which we thought would give us some improvement in terms of wear characteristics. What we didn't know was how incredibly abrasive chrome dioxide really was.

Levine: But building ten in its design was designed around chromium dioxide, right?

Teale: Oh, it was.

Levine: Yeah.

Teale: So he was saying, well what was assumed and then what was sort of not in the plan.

Rizzi: And this is very typical,

Teale: Oh we assumed metal particle, we assumed MR head, we assumed no pneumatics although that turned out to be not true.

Rizzi: You know, this is very typical of the development process, as other gentlemen have been involved in development would know. The management teams have to be able to commit to what they think is achievable to be able to put together a product that has the capacities and the cost et cetera, so that's why I was asking, I kind of assumed that the MR head was probably part of that, at that time it was called Pegasus media, and maybe a different name, Stallion or some name like that before.
[Editor's note: Code names for 3480 media in chronological order were Stallion, Mustang, Pegasus and finally Sonoita]

Rizzi: But they committed to build a facility that was going to be able to build that based on what the engineering team said they could do. The type of problems that you get then during the development process are really basically the execution of what the commitments were and the inventions that are required are significant to be able to really get there. And I think that's what-- it's typical to every development but I think 3480 was unique in some way, it was not incremental in any way really.

Teale: No.

Rizzi: It was a complete jump forward on what kind of approach was going to be used.

Levine: And another piece of that, while all this technology is going on, we're moving people from mostly Boulder, some San Jose and a couple of other sites into Tucson, so you have not only the work environment of new people trying to work together, "I've never worked with this guy before, what's he like?"

Teale: A couple of thousand new hires.

Levine: New hires and all of that in parallel with people's personal life of, "Gee, I just had to buy a house, my kids have to be in some new school. I have to find a new doctor or dentist in this town," and all of the personal side were all going on all at the same time. And we talk about developing a product, and yes, there's all the technical aspects of it and the wear and tear on the individual to make it happen, whether you're in product tests all night long in your underwear or whatever it may be, but all of these, not all, but many of these people had a personal side, they were dealing with in parallel and I don't think that should be overlooked from the viewpoint of how things happen. When you go home at night, you can't divorce yourself from work and when you go to work in the morning, you can't divorce yourself from family, so they're intertwined, and I think that was a very interesting piece of it all going on at the same time.

Teale: Yeah, that was a management challenge for my senior management because I was just part of that mix. Back to Al's thing, I've now lived through a whole bunch of product cycles, shipped a whole bunch of products, I had a few failures, a lot of them were baby out with the bathwater - brand new, a lot of them were just incremental. Al's exactly right, you start with about three or four assumptions that are usually driven by the requirements. So I'm pretty sure in 3480 that chromium dioxide was an assumption because of the challenge of the requirement to support a linear density. I'm pretty sure the MR head was a requirement because of the reduced velocity that we wanted to achieve in the reel to reel system. But what I learned many times over and over in my career is that what you tend to get bit by is what you didn't know. We didn't know the issues within film writers and magnetoresistive heads and the impact that would have to the circuitry in the channel, just so many things that we didn't know.

Rizzi: Didn't know there was a <inaudible>.

Teale: You mentioned ISVs, let me talk about instantaneous speed variations because it really mocked us. One thing we didn't know because vacuum columns were this wonderful buffer from whatever was in that reel, we didn't care, because vacuum columns buffered, now they're gone. Here's what we found out, we found out that when you wind a tape on a cartridge in a factory, that it is full of residual stress, some of that is what we call a hoop stress and some of that is what we call radial stress but it's loaded with stress. In fact, when you look at a roll of toilet paper, you'll see that the inside cardboard thing is often quite misshapen, that's the accumulation of what we call winding stress. These winding stresses would accumulate in a cartridge and then we might expose them to a thermal stress, we might expose them to a mechanical stress. So we had been doing this thermal stuff and sticking this stuff in a drive and all of a sudden experiencing a lot of permanent errors; "Wait a minute, that's not a soft error, what the hell

is this?" Because what could happen is that you could have, the ISV was basically a shockwave going at the speed of sound in Mylar and there was this phased relationship on the head.

Rizzi: Is that due to acceleration?

Teale: Occasionally you could write something that had a gee-haw in it that would sneak through the read side and not get caught on your read after write and then you'd subsequently try to read that tape another time and all of a sudden you got something that was written dead on arrival, and it's all the tracks, you couldn't recover like you can from an correction code. So I got assigned to go try to help figure out what was going on and part of my problem was that my ability to turn experiments around was limited by this 12 hours I had to wait for the thermal cycling to create the effect. And one day I accidentally dropped a cartridge on the floor, oops, picked it up, shoved it in a drive and I had all the ISVs I could possibly want, I didn't even need that thermal cycle to create this problem. That was cool because now I can really get a lot of data in a hurry, all got to do is bang the cartridge on the end of the table and stick it in the machine.

Gardner: So the thermal cycle was causing…

Teale: It was just another stress reduction mechanism.

Gardner: Which was reducing the stress.

Teale: Remember I said thermal or mechanical, there were probably other stresses that might have caused it. It turns out that it was pretty much invisible to the channel when it happened and we ended up putting a special IV detector looking specifically for the signature of that Theta, I called it Theta, you probably have a direct delta function name for it or something. And the ISV detector would go off and say, "Hey, you better rewrite that block," it would create a soft error, force a rewrite or something like that. So we didn't solve the problem, we didn't know how to solve it. We tried a few things, I won't go into what they were because we didn't do any of them.

Gardner: So the ISV turned out to be a mechanical separation causing a write error.

Teale: Yeah.

Gardner: So the fix did not…

Teale: But in some cases the write error was undetectable and that was what was so bad about this is that it is not correctable.

Gardner: Yeah, you can't detect the write error until you read.

<overlapping conversation>

Teale: We always did read after write.

Rizzi: We read right after.

Teale: We always did read after. We're not like disk, we're after reliability.

Gardner: I understand.

Teale: Okay.

<laughter>

Gaudet: Thank you, John.

Teale: Hey, I spent a life getting sand kicked in my face, now it's my turn.

Gardner: Was that recent?

Teale: No, that was a tradition in tape since 1952.

Gardner: Sure.

Teale: Disk had the ability, it's called a turn on write verify, it costs you latency. I turned it on in all of my home computers but a lot of people either didn't know it existed or they didn't want the latency, because it is a significant latency.

Gardner: It does have a serious performance issue.

Teale: So the point is the distance between the write gap and the read gap creates something called a spatial filter.

Gardner: Of course.

Teale: So you got a gee-haw over here that's got a fair amount of frequency content, some of that frequency content is going to be an integral number of that distance and it won't get caught. It's kind of weird, I'm probably not describing it very well. But the point is, it was possible to write something that was incorrectly written, it wasn't caught when it was written and it will cause a subsequent permanent error.

Gardner: Because harmonically the read transition appears to be good but it's really not there.…

Teale: Yeah, we called it a spatial filter. It's been a long time but I was giving you an example because you brought it up. So this was another consequence of vacuum columns used to kind of separate it all and keep all that crap away from us and if it happened, it was usually, it didn't make it all the way up to the head, but in this case it did.

Gardner: So you would add cache wouldn't you, to one of the three major assumptions?

Teale: Oh the cache was an assumption, and here's one of the most interesting things about 3480, listening to Joel earlier, with all this pain that we're talking about the 3480 did not move the football very far down the field. We went from 160 megabytes to 200 megabytes, we went from one and a quarter

megabytes per second to three. For the technology investment we made, that wasn't a lot of yardage down the field. And this was in a day and age where what 3480 really was, forget about intelligent business plans, forget about-- this was an end-of-life replacement product for 3420. The capacity requirement was originally 160 megabytes when I arrived because they wanted to make sure a 3420 tape could be copied onto the new cartridge, that was the only requirement. These days you couldn't do a business case for a technology investment that doesn't move the football in order of magnitude down the field, and that was what was always amazed me about 3480 was the investment IBM was willing to make to simply replace 3420. 3420 was fraught with end-of-life parts, this hard for even me to believe but when I joined IBM in 1978, I got drug into a factory somewhere on a motor task force and I said, "What, we make our own motors?" And somebody said, "We design our own motors." Well who's [ph?] got 18 million motor patents from-- design their own motors, are you kidding me? So the end-of-life issues on 3420 plus its nagging reliability and head replacement rate in the field, because as it aged, sweet old Bob Riley [ph?] had this brilliant idea of increasing the tension in all the vacuum columns to improve the soft error rates. Just pull that damn tape harder on to the head, six months after he released a field bill to do that, we got about 75,000 worn out heads back.

<laughter>

Teale: And then we went to Montpellier, I remember we flame sprayed a zirconia oxide and there's one-- I hated chemistry by the way, there's one column on there that has aluminum, hafnium, zirconia, and there's a whole bunch of these elements that when you put them in oxides, they're quite hard. And we were able to flame spray it on top of the head without affecting the magnetic performance. The point is 3420 maintaining it was probably getting to be as expensive as funding the 3480 technology which was not cheap.

Rizzi: Well it was a cost to the customer too, so part of the business case was when we just if you can replace the drives that are out there, you're going to make money on those drives and then you have the media. And there was a lot of performance and mainly I call it maintenance cost reductions that the customers needed. I think there was a lot of justification for the product just based on those needs

Teale: Just on that, yeah.

Rizzi: Without having to be at capacity.

Teale: Because we had largely a lease model, in fact I gave Joel the history of tape drive pricing up through but not including 3480, it's all lease numbers. <laughs> So in other words, that was a cost to IBM.

Levine: You talk about we didn't move the football down the field very far which meant?

Teale: Technologically.

Levine: Yeah, and obviously I agree with you. But I think part of the motivation of the 3480 as far as its size and style and all the rest was yes, we had all the problems with 3420s that's for sure, and at the same time, we had a lot of competitors who were making 3420-like looking boxes, STC and all the rest.

So part of it was if we're going to do something to replace the 3480, it's got to look different, That was a very important

Teale: Sure.

Levine: I remember talking about that many times over, and out of that, it's got to look different, was what we said, "What are the problems?" Well, squeezing the reel and the human handling of the big reel, the size of the reel and what it took to get that reel moving, , all the tape columns, not only that they're great debris collectors, those tape columns, but then we had to use cleaning fluid to clean them which wasn't in-- it's the same stuff, dry cleaning fluid, [Editor's note: Tetrachloroethylene] and at that point in time, that had a bad name as far as the environment and all the rest goes. So all these things came together that yes, we got to replace the 3420, yes it has problems and we want it to look different for multiple reasons, okay? So a lot of that thinking was, get it to look different more so than move the football down the field. In other words, that factor started to override the factor of let's just have a major technology breakthrough.

Gaudet: Another factor that I'd like to interject here was that it gave us a base for extendibility which we didn't have. I think we mentioned yesterday, that it gives us the extendibility, higher capacities and data rate.

Teale: We didn't aggressively pursue it though, the march up Moore's Law back in the day, first of all we didn't even know what Moore's Law was and we didn't care, and when I first heard it, I didn't believe it anyway, I thought that's armchair science. I mean 160 to 200 and that took years. Well believe it or not, we did not even increment the platform for another six years, then we doubled it. Now that's not Moore's Law. And just as a footnote, I agree with you [Joel], I think what it was we were trying to protect the business and we badly needed a replacement product. And there really wasn't a large technical driver there because as I mentioned, customers weren't complaining about capacity, we didn't know why they weren't and we discovered they only wrote 20 megs on those things any way.

Levine: And, you know, that 20 megs on a reel, I remember back from 729 days, that was an equally true statement, they never filled up a reel of tape, okay? And you talk about chopping off the first end of the tape, you run it to the end, flip it over and then you start from the other end, , and you keep chopping off more and more. So, I mean, nobody ever used up the full reel of tape, they only used a small part in the front.

Teale: Let's talk about why that was true by the way because this tape application has evolved and changed dramatically over time, tape was part of the data processing operation in the enterprise for many years, they did actual database sort merge, they did all kinds of actual jobs on tape that are handled by disk today. Because it was not dominated by backup and it was not dominated by archive which do fill tapes. The concept of backup and archive in big data evolved much later. So we weren't driven by technology so to speak, we were driving by reliability and performance, we needed to get faster but not necessarily bigger. And that's where the 20 megabytes comes from, that was a typical mainframe job or maybe a typical database size of something like a Social Security something or a Census something. And it was when all of this big data and Internet and everything that I talked about that made Quantum

king, it probably wasn't until the mid '90s that capacity became king and everybody tried to get on that Moore's curve.

Gardner: And so today if you did that survey, you'd probably find the whole length of the tape is used?

Teale: It's all archive or backup.

Gardner: Completely filled?

Teale: It's filled, yeah.

Gardner: There have been a number of published studies that show that you have 1,200 feet and it's maybe only the first ten feet used. [Editor's note: This is maybe an urban legend; upon inquiry and some searching no such published material has turned up with regard to reel-to-reel tapes.]

Rizzi: One of the advances that we made was the solid state buffer, I'm assuming that was part of the 3480 requirements

Teale: I am assuming that, I wasn't there, but I don't know how else we could do it.

Rizzi: Right. I assume that was kind of part of the 3480 product design and such but I did notice in kind of getting prepared for this that about a year before that, we announced one of the 34xx series, the reel to reel type had a solid state buffer.

Teale: I don't know.

Rizzi: One of the products that we had-- do you remember that product?

Levine: No.

Rizzi: It's a tape product with a buffer in it.

Teale: Oh, you know what, let me slightly digress here, I think you might be right. Let me tell you what happened. There were flavors of compatible 3420 tape drives coming out without vacuum columns, so other people went a different route.

Levine: Yeah, okay.

Teale: So if you remember Sunfish, they were kind of, oh, the size of an oven and you'd set it on top or maybe it was slightly slanted.

Levine: Right.

Teale: Well clearly that did not have the acceleration characteristics of the 3420. My guess is there are people who took the solid state memory and instead of going our new baby, new bathwater route that the

3480 was, they just said, "Well let's keep making 3420 compatibles and just use a piece of this emerging technology."

Rizzi: Yeah, we announced the product. I did Tucson and I think it was in 1983.
[Editor's note: The 3430 code named Sunfish was announced in March 1983]

Teale: I think it was Sunfish and we did it in 1983.

Rizzi: Okay, that's what it was. So I thought maybe that was a spinoff of some of the technology activities that were going on for 3480.

Teale: It was an alternative, it was an alternative way of protecting our base but I don't know how the decision was made to continue 3480, I wasn't part of it. But it's a good observation.

Rizzi: Yeah.

Teale: So obviously the problem is that when you think about 3420, it was a 1952 reel base and it had not been evolved for my goodness, 30 years before we finally replaced it. So my guess is solid state buffers were around a long time, we just didn't pick them because we didn't need them.

Levine: Never married the two technologies.

Teale: Never needed it, yeah.

Gardner: So the concept of caching actually was proven elsewhere -- it was shown to work on the Sunfish type of product and perhaps by your competitors.

Teale: Probably. I guarantee you, tape didn't invent it, I'm just saying it was something out there probably for some completely other purpose maybe even nothing to do with storage, we just knew it was there and we needed it and it solved a big problem.

Gardner: You mention an ISV, an instantaneous speed variation detector, how did you do that?

Teale: I don't remember, Judd McDowell did it, he put some kind of differentiator on-- I don't know how he did it, Andy might know.

Gaudet: You would have to detect it and then you were able to force a retry.

Teale: Or a rewrite.

Gaudet: And just looking at the signal or the space in between the transitions and you could tell very easily based on the clock code that we had, the recording code that we had, those were un-allowed transitions so they got to the point to where the timing was not recognizable in terms of what we were trying to write. It was a fairly dramatic speed variation because our phase locked synchronization with the data, it was out of whack with that. So it was detectible.

Teale: So the funny part of that story is Judd came up with this idea, Judd was always the guy getting awards and we used to make fun of him, he got an award for the damn idea, we thought it was kind of an obvious idea, but whatever. And Judd was Judd, it was perfect. Hi Judd, in case you're out there. And then we got it out in the field and we had a lot of false detections, forced rewrites that didn't need to be rewrites and it had a performance impact. There came a point in time on 3590 where Judd took the ISV detector out and got another award for that. I kid you not.

<laughter>

Teale: We made a movie for his quarter century club where we mercilessly satired all of the awards Judd got. And he's God and all that stuff.

Gardner: So was it really necessary?

Teale: I don't know. It was probably an overkill. My guess is the channel caught 99.999 percent of them and this one that got away was a very rare event but the problem is we were in the enterprise. In the enterprise, the biggest sin you can commit is to corrupt data and not know you did it, that's the biggest sin. Then you can corrupt data and know you did it and send up a big red flag, rerun the job. So there's a lot of lesser sins that are permissible, but when it came to what we called permanent data loss that you didn't know about, that is almost a situation that can create a liability.

Gaudet: It's sacrilegious.

Teale: A customer can do the bartender who served argument and that was the problem with some version of Lotus where two plus two didn't equal four. When you discover these types of issues internally and your product testing and we found many, it all of a sudden went, "Need to know. Hush, hush, hush. Circle the wagons. Alert the lawyers. Have we shipped any of these?" It became a big deal, you probably remember some of these things as they occurred. And we had our share on 3480 and on just about every tape product I've worked on, we've had some flavor of that sin.

Gardner: And I think the same thought process applies to enterprise DASD also.

Teale: I'm sure it does.

Levine: Yeah, it's got to.

Gardner: Thou shall not corrupt permanent data.

Teale: But that was a big part of the reason why we couldn't scale down later in our business life because we had this thing so hardened, so bullet proof, we had so much cost in it that we just could not take it down and market, you couldn't attach it to a UNIX server, UNIX, they're just backing stuff up and, "Oh hell, if yesterday's backup is no good, we'll use the day before's or tomorrow's or we don't care." It was a whole different environment.

Gardner: So I've written down seven now, key assumptions about the 3480 that came to Tucson probably, chromium dioxide right from the beginning, MR heads, right from the beginning with separate inductive writer of course, cache, orders of magnitude improvements in what IBM I think calls UI or did call UI, unscheduled incidents and scheduled incidents, I mean what we talked about yesterday in a reel to reel tape drive, cleaning the system three times a day, replacing heads, X times a month, to no scheduled maintenance and five years life on the head, that's really pushing the football down a different field.

Teale: Yeah, that's called product speak and us technologists don't even know what a UI is and we don't care. <laughs> That's his [points to Joel's] concern.

Levine: But all of the things you just mentioned come under my heading of reliability from a customer's viewpoint.

Gardner: Right. I'd also add 180 megabytes because you had to be bigger than the prior reel and…

Teale: I think it was 160.

Gardner: Oh, 160? Oh, I'm sorry.

Teale: I think, I'm not sure.

Levine: Yeah, 160.

Gardner: And you were going to be a cartridge which directly supported the improvement in reliability and usability.

Levine: The 3420 was not that reliable, so we had to come out with a product that really made the point about reliability, okay, and whether it's the permanent error thing or the cleaning or the handling, all those things come under this big umbrella that the customer can see from an improved reliability viewpoint and that was a very key factor of why I should buy it and I think that was a major selling point.

Gaudet: Even floor space for the storage, I mean the reels and the cartridges at one quarter size, 1.25 times the capacity at a quarter the size.

<overlapping conversation>

Rizzi: More efficient handling by operators.

Gardner: Do you guys have an recollection of a Reliability Plus in that time frame?

Rizzi: Yeah, but not much. Remember the Reliability Plus, that's other people that testing us out.

Gardner: Yeah, was that a driver in this issue at all?

Rizzi: We did our own.

Gardner: But in terms of the UI, whatever term you want to use, MTBF or UI, in terms of those objectives, Reliability Plus took IBM's EREP, error reporting and turned it into a report on everybody in the industry, Memorex, IBM, StorageTek – everyone.

Teale: Yeah, I kind of recall that.

Gardner: All of a sudden there was this perhaps not such a insightful measure of the product's reliability but all of a sudden you were getting reported as having so many hard errors per megabyte transferred and this really caused a focus in the industry at least from my viewpoint at Memorex there was all of a sudden an incredible focus on how do we improve our Reliability Plus…

Levine: Numbers.

Gardner: …numbers. The first answer was the numbers are blown and we don't believe them but then the customers believed them so we were driven to improve on the disk side, I was just curious as to whether you saw that here.

Rizzi: There was that kind of pressure inside but I don't think it drives any of the product specifications or requirements per se, it becomes then an assumption that later when you're out in the field, you better be top notch, because Reliability Plus was there at that time, I recall. But you also remember probably in that same time frame Crosby quality, it was just a tremendous drive towards improved quality, I think there was something going on from Japan, there was a quality measurement.

Teale: Deming.

Rizzi: It was Deming, right.

Levine: Deming.

Rizzi: He went over there and worked for the…

Teale: Six Sigma.

Rizzi: Six Sigma, yeah. That stuff was all on top of program management and higher then program management, they all knew there was that pressures and, I mean I went to the Quality School of Management, you know, Crosby in Florida, you may have too, I don't know, you [Gaudet] did. So the management was, we were pushing quality and the result of that is improvements in the products. So you can't separate them through that process, that Reliability Plus, I remember it as you do.

Gardner: It was painful for me because I was responsible for the double density 3350 at that time and it was painful.

Rizzi: Well you didn't do TMR [track misregistration] studies is why.

<laughter>

Rizzi: Because we knew you couldn't do double density on the 3850, that's why we did 3375.

Gardner: Yeah, the industry sure proved you wrong on that one.

Rizzi: No, you said you had your problems. No, we gave you an opening by the delays on the 3380…

Gardner: Yes.

Rizzi: …it wasn't because we did 3375.

Gardner: So we talked about some of the inherent things and then the surprises that caused invention, we talked about several of the inventions, write equalization, the ISV detection, which may or may not have been in an invention. The lifter I guess to lift the tape off the head.

Rizzi: The whole mechanism probably itself is an invention. You [Teale] said that the load block was one.

Teale: It was design work.

Gardner: What are some of the others that are memorable challenges to getting it out or to doing it?

Teale: Tomorrow Dan Winarski going to be able to help you a lot with that because he was very much in the middle of the implementation and the day to day problem solving.

Levine: He'll remember better.

Teale: He was on the product side, I was on the technology side, so I kind of remember the technical challenge but not necessarily the invention required in loaders and threaders and all that stuff.

Rizzi: One of the things that goes on in these type of products especially when there's so much riding on it, the 3480 was a monstrous investment, right, is the involvement of upper management and its impact on the team. I mean beside being stomped on, on your foils , on a different product, we had Bertram down here, Dr. Bertram was our president after Anderson, probably brought in because he was a hard nose guy that was going to drive the hell out of us. And I mentioned that he [points to Joel] was able to withstand all of the management changes, which is a quality that allowed him then to do this this [West Press], I guess. But Mazza moved on because of the pressures of upper management, Rosato moved on, in their own ways, there's a stubbornness that involves a lot of the type of interaction between top level managers. But Bertram brought in new management, he was here every week, brought in Gus Vassiliades, he brought in Hasson who I'm not sure why but he brought in Hasson. And then of course we had Harries behind us every day.

Levine: Jack Harker came every week

Rizzi: But Harker was a soft guy relative, he was a guy that probably gave feedback, but Harries was not the kind of guy that you wanted on your back, Bertram was a guy that you didn't want to go and report every week but we did. So I mean every week we were in there.

Levine: Every Tuesday morning.

Rizzi: And we had a no smoking at our facility except for Vassiliades's and Bertram's cigars. But anyway, just driving the program…

Levine: The conference room was what, roughly this size, maybe a little bigger [15-ft x 45-ft]

Rizzi: A little bit bigger than this one, yeah.

Levine: A little bit bigger than this. Jam packed with people, okay, no place to sit, guys standing around the outside, those two guys smoking cigars, the room got this blue haze over it. I used to go home at night and my wife would go, "Ew, you smell like you-- " all that smoke you get in your clothing like that.

Rizzi: And during those days, it wasn't just development that was under the gun, manufacturing was already producing and having to go through yields and your yields on the medias and so there was significant pressure. And, you know, Bertram's coming down from San Jose, Harries is coming down from San Jose and he brought Vassiliades in and so Vassiliades was a Bertram guy, I don't think Rosato was a Bertram guy, Mazza was a Rosato guy, so all of a sudden we lose two guys and these two guys are guys that I was involved with quite a bit. So the Bertram, Vassiliades, Hassan environment was not the easiest management structure to work through especially…

Gaudet: Only when you look to direction from your management, if you didn't then you were okay.

Teale: So I wanted to mention one more technical thing that was interesting that was a direct consequence of removing vacuum columns that we didn't know, it's called tension gradient. Tension gradient. Tension gradient across the half inch width of the tape, with vacuum columns that tension was uniformly distributed because it has to be, because a vacuum is a vacuum and it doesn't change

Levine: It utilizes [suction] <inaudible>.

Teale: Unfortunately when you get rid of those vacuum columns, you now have bearings that are tilted different ways, you have distortions in the tape that come from the factory, you might have some distortions in the reel it was wound on and we had a lot of problems, again, as sort of an indirect consequence of no vacuum columns with something called tension gradients where we would have edge track problems where the tape might be flying higher than it is on the other side and we actually had a way to measure it and do all kinds of stuff to it. We had serious edge wear problems, severe and we were using something called a center-tapped shunt biased magnetoresistive head. Disk people would not even acknowledge that as a magnetoresistive head because to them the biased layer needs to be infused into the nickel iron layer that's called a soft bias head and that's a read head to them. But we literally had a separate layer adjacent to the nickel iron layer, we'd run a separate current through it to create the biased magnetic field and the layer of interest and it was center-tapped and the cool thing about the center-tap was for free you got something called common mode noise rejection. The problem is that when you severely wore an edge track because the tension gradients wore at an angle so half of the MR became shorter and you degraded your CMR and we had premature failures due to really not a whole lot of wear. But now we had a dead track and pretty soon we might have two dead tracks. Big

problem, armies of people, huge infrastructure and life testing, wear testing, start stops, training, environmental wear, just another flavor of an unintended what we didn't know, we didn't know what we didn't know.

Gaudet: We covered that to some extent.

Teale: Okay. Well there's a media perspective on it but then there was the impact.

Gaudet: The head design, they corrected it.

Teale: All right.

Gardner: Was that a head design correction?

Teale: Well it turns out it was never totally solved, but we did implement tension gradient testing, we implemented it in the media plan to ensure that we weren't producing too much but we also implemented it in the drive to make sure we were aligning components correctly. There was a lot of actions that were taken.

Gardner: It sounds like a tape guiding…

Teale: But the head was the head and it was cylindrical.

<break in recording>

Gardner: So before we switch to a discussion on automation, one last pass at are there any other innovations that solve significant problems you'd like to mention in terms of the failure effects and failure mode?

Teale: I think we're going to have a chance to sleep on it and we're going to be back on the air with Dan Winarski tomorrow and I think that's going to stimulate some more memories I suspect.

Levine: That's a good point, good point.

Teale: So I think we can rest our case on the 3480 tape drive for the time being. There perhaps is one thing that never gets mentioned that needs to get mentioned, tape drives were actually pretty dumb in those days, 3480 was an analog interface, it had very little actual, if not zero channel intelligence in it, it had an automatic gain control to control that output to the controller. Electronics was very expensive in those days and we would amortize the cost of electronics over what we called a string of drives and there was a whole body of science there called a controller. Now a modern controller is not a very intelligent device, it's almost just a glorified switch some CRC function and some protocol translation, a modern day controller is not that interesting. But back then, the whole recording channel was in there, all the data detection, all of the ECC embedding, all the handshaking of course with whatever the interfaces were, I don't know. I never worked on controllers but I know that it was a significant part of the 3480 story and I

know very little about it, maybe you guys do, I know very little. I think that was the Rick Conway and Kirby Domans, I don't know all.

Levine: Harley [Oppeboen] worked on it and his team. I've got to sleep on it, as John would say.

Teale: So maybe tomorrow, maybe Rick Conway will finally call me back and I'll just kind of invite him ad hoc and we can maybe do something ad hoc. But I wanted to acknowledge that that there's this whole thing that we haven't…

Gardner: Things you need to think about as DASD controllers being free but very similar to tape controllers: DASD only has one head reading or writing at a time so they have only one data separator, issues but then in tape data separation with 18 channels in parallel get to be exciting. Beyond the data separator you start thinking in terms of the serializer, deserializer, formatter, deformatter which is very different I think between DASD and tape but fundamentally the same idea, you're taking the customer's data and surrounding it with headers and ECC or a CRC. Tape that was somewhat pioneering actually with the 3480 product in its adaptive cross parity.

Teale: Well it's because we could because we had the 18 parallel channels, we could afford to put the ECC intelligence in, that was very difficult to do with a single track device until you got more into read types of things.

Gardner: Disk guys stuck ECC on the end.

Teale: Well you demarked bad sectors, you did a lot of other things that tape didn't do, we just plowed right through bad tape and just rewrote downstream if we didn't like it.

Gardner: Then there's a whole micro coded error recovery process which may include lots of steps.

Teale: And back then it was more like assembly language on bit slice pieces of-- I mean there wasn't even microprocessors really or at least they weren't called that.

<overlapping conversation>

Gardner: And then finally you've got the channel interface which is a whole other art. So to the extent that that refreshes your recollection about controllers.

Teale: Just wanted to acknowledge that they're not represented here but I don't want them to be forgotten and maybe some other time.

Gardner: Understood, accepted and agreed with.

Teale: Okay.

Gardner: So you wanted to start on automation?

Teale: Yeah, I want to talk about automation, I'll set it up and then my colleagues will help me. And I apologize, there certainly are some automation veterans of the automation wars in Tucson, it wasn't initially an agenda item so I didn't try to smoke those people out but like the controller story if we wanted to come back some day and give it the treatment it deserves, there's still Bert Slossens around, maybe there's Herb Day around, maybe there's whoever. But let me set it up like this without being at all defensive, StorageTek deserves credit where credit is due. Let me tell you that in IBM it wasn't that nobody thought about it, it wasn't that it was some big foreign thing, we certainly shipped it in the mass storage system, was a fully automated solution. But my understanding is the conversation went kind of like this, "If we do it, how much market share are we going to gain?" "Oh, probably none." "If we don't do it, how much are we going to lose?" "Oh, probably none." There was a perception in IBM that at the time labor was relatively low cost and why are we asking customers to replace a relatively low cost labor component that used to be called tape hangers with a potentially a multimillion dollar capital investment that now the customer would not only have to make that investment in place of the labor but they would then need to protect that investment and perpetuity which of course is what later came to happen. So there was a view in IBM that it just wasn't going to be that helpful to our business. We did recognize that some form of an automated cartridge loader would be value to a customer, we made something that hung off the front, you could stack, I don't know, six or eight cartridges in it so that you could kind of queue up a series of jobs which cuts your labor a little bit. And other than that, it kind of went dormant until StorageTek started rattling their sabers and releasing little itsy bitsy bits of news and fuzzy pictures of this thing that was coming. And I'll be honest with you, a lot of people at IBM kind of wrote it off and kind of viewed it as StorageTek's folly and customers aren't going to want it, prove us wrong, and they did. My hats off to them, they discovered that there was a demand that we weren't aware of, customers weren't beating us up for it, could have just been a heck of a marketing job they did, it could be they had a heck of a value proposition that we hadn't thought of yet. So we got drug into it to maintain market share that we started losing for not doing it and we didn't know. Because our analysis of if we don't do it, we won't lose market share didn't assume that anyone else was going to. That was the big flaw. So obviously we had to scramble and there was no way with our development cycles where we were going to be able to respond to StorageTek in a timely way without getting hurt pretty bad. So come to the rescue once again are planners that think they're engineers, I already-- a guy named, I believe his name was Herb Day, a planning guy, apparently he had some kind of stock in a company called Growel, Growel had this gigantic…

Levine: Robot.

Teale: …two ton yellow robot arm that was used in the automation of an automotive assembly and painting. There it is. Let me see that and I'll hold it up to the camera. So the idea was let's make a train track, so we already had these strings of things, so now let's make a train track and let's put this-- this robot is a heck of a lot bigger than this picture does justice to, it was a monster and it was heavy. And so we did engineering like, what's the wheelie coefficient, what's the peelie coefficient and how fast can you accelerate it before it wheels and how slow before it peels. The engineers frankly were a little embarrassed about this concept but it was probably the quickest path to market with an answer that any sort of minimum requirements and so we, I won't use the word I normally use, I'll just say we shoved it at them. And much later on we of course did considerably more intelligent things. And that's kind of what I

remember and it's really in my opinion StorageTek's story to tell, deservedly as just a part of tape history in general. But we got a pretty black eye out of that, didn't we, ultimately?

Gardner: That was Herb Daly?

Gaudet: Herb Day.

Teale: And for all I know, he's still in Tucson somewhere, he was a big guy in the middle of a lot of that stuff.

Teale: That yellow robot came from a company called Growel. And later on of course we became very innovative in that space, we developed our own internal products, we had a lot of robust library management function that we put in them for optimizing how to get jobs done, where to do things all the way up to the high density frames that were very innovative. But we were pretty much second to market in that race.

Rizzi: I was telling you earlier, you, being Tom, my recollection really falls very, very closely to the same story that John said, I was had the storage subsystems at the time when I came to IBM, Tucson and I had a manager that was responsible for the <inaudible> Tape Library, we had the 3850 mass store, we had concepts that were probably more elegant than the Growel thing at the time. And when I moved over to the tape products manager, he moved with me and reported to me. He probably got let go back in the '87 layoff. And I would think that when we did the cartridge itself that the people had an idea that you could automate that, cartridge, this conception because they already had done the mass store, so the same people who were inventing the 3480, would have already had that in their mind. But anyway, and as I said earlier is that the biggest problem was getting the planning group who were responsible for establishing the volumes, the business case part of it, because we knew what the cost structure would be to give us enough volumes to be able to justify the product, to take it really fully into development to justify it. And the funny part of that story, so we basically didn't really implement, the funny part of that story is the same planning managers, the planning people who couldn't build a business case then are then engineering the product.

Teale: They engineered the product.

<laughter>

Rizzi: Herb Day was working for Andy and those guys. So it's that kind of story, if you can't build a business case, it's really hard to justify the amount of money because it wasn't going to be a small effort to put a library in place.

Teale: Nor was it going to be a small cost to our customers to adopt.

Rizzi: Right. But anyway, so we're basically kind of I would say in agreement of what really happened and we finally did get out there.

Gardner: So any thoughts or speculation, I mean you essentially had 100 percent of a market with the 3850, I mean there was really nothing that competed.

Rizzi: Yeah, but there wasn't big volumes.

Teale: Small market.

Gardner: Well that's usually where business planners start, you're here at a point and you either come out with a new lower cost product at the same performance point or the higher priced product at a much higher performance and yet somehow that didn't seem to happen for this product until StorageTek came along.

Rizzi: Exactly, it's exactly what happened is we couldn't build a business case, our planners, business planners weren't creative enough to really understand probably what was going to drive that space. And I didn't remember people saying that, "Are we going to lose or win market with it?" I think John's probably right there, I'm just saying I don't remember that part of it. But it's 35 years ago or 30 years ago to remember everything. But we were spending resources on it, we had design people, mechanical oriented design people more so than anything else. We ended up not doing it for a long time.

Gardner: Were you driving in the direction that StorageTek went which is mechanizing the physical library as opposed to the way you had done it with the 3850 which is virtualizing the physical library? I mean, it's two different approaches between a 3850 and a StorageTek 4200 I think.

Teale: Well the result was what I would call kind of a brute force solution, we replaced a tape hanger with a robot arm.

Gardner: Yeah, which is basically what StorageTek did.

<overlapping conversation>

Teale: I don't think there was any other glamourous intent

Rizzi: That's what our plan was, it was just to replace, it wasn't to try to do a replacement product per se for the mass store, it was really, we got a cartridge that we wanted to automate, all we had to do is load it in, you have places to store it and you move them from here to there. That's what we were planning to do.

Teale: I mentioned the legacy, half of it.

Rizzi: You've had your half hour.

Teale: Oh yeah. Not only was there an internal discussion about business planning but what was the value proposition to a customer is what we couldn't quite get our hands around. And let me tell you something that happened that I know for a fact happened, I know for a fact that Herb Day promised a lot of customers that if they bought the big yellow robot that IBM would protect that investment for the life of

that asset, it becomes an albatross around our neck through time, we had to be able to upgrade the technology, upgrade all the media, even stick 3590s in there at some point in time way down the road. And so when you're trying to sell but you're not willing to make that type of a promise to a customer, it was really hard to get them to make a huge capital investment just to lay off a few tape hangers that you're probably still going to need to get tapes in and out of the library anyway. We didn't know how to make a customer value proposition out of automation, we had no idea that customers would want to adopt it, and I think we were blindsided personally, but I don't know.

Gardner: What do you think StorageTek's value of operations turned out to be, was it inflation that drove the labor cost up or bad mounts?

Teale: No, I think that they made promises that hadn't even occurred to us to make.

Gardner: Lifetime investment that it would be replaced with new technologies?

Teale: Protecting the investment, always making sure new technology was compatible with what they've already bought. Also, they made some other promises-- their implementation was a little different from ours, they could scale differently from us. So when we finally did get to market with the big Growel machine, it really wasn't a very scalable solution, I suppose we could throw a couple more things on the end of the string and make the railroad track a little bit longer and that basically was our linear architecture for all of our high end automation devices. But a library image was a library image and if the data of interest was not in that image, it basically wasn't available to us. StorageTek invented something called pass-through and they had this beautiful honeycomb geometry where they could glue a couple of-- have a common side on two of these things and get a cartridge from way over here to way over here when they needed to. So I think there's some things that they anticipated correctly. I mean, they took a gamble, I'm sure that this was a big risk in their business, it was a risk we weren't willing to take. And I think they might have made initially some better architecture decisions than we made and they were able to promise customers more in the way of investment protection and give them that insurance that this large capital investment has a long term payoff to you, not just in labor cost. But unfortunately that's a lot of speculation on my part, I'd love to hear their side of the story.

Gardner: I think they in fact did deliver on that promise.

Teale: They did.

Teale: We never did do pass through, we had a million excuses why we didn't think it was worthwhile and it was no good and yet, it was just our head in the sand.

Gardner: Plus I think they put LTO in that library.

Teale: Sure. They put DLT in it, they'd put anything in it, whatever the customer wanted and we weren't quite that willing to do that because our bread and butter, once we went away from the lease model, our bread and butter was turning it, we wanted to turn it, we want to replace all your media every five years, we want to replace all your drives every five years and we didn't have a business model for automation that was even compatible with the business model we were operating under, we'd have to go back to

leasing if we wanted to make those types of promises. I want to warn you, I'm super speculating here, but I'm just kind of reacting to your comments. Yeah, there were better ideas that we consciously refused to adopt because it probably wasn't compatible with what we wanted to do.

Gardner: Joel, you're shaking your head

Levine: No, I agree with him.

Gardner: You agree?

Levine: I was not involved in the area that John's talking about but I'm agreeing with him and it makes sense.

Gardner: Any last comments on 3480 or Tucson?

Rizzi: Thank you for having us do this.

Gardner: Oh, it's been a pleasure.

Rizzi: Coming down and listening.

Teale: It's a real honor for us to participate, we appreciate it. I failed to mention that I did visit the Computer History Museum a couple of months ago on my own time. I was up in your neck of the woods.

Gardner: And we appreciate that.

Teale: I should have let you know. To give you my reaction to it, I walked through it on my own and I thought, "This is the most cluttered lab full of junk I've ever seen," because that's what it looks like when you don't know the schema. So I was about to leave-- and so I was kind of on the alert for tape artifacts and there's a couple of tape drives here and there, but I noticed nothing, no 3480, no 3490, no LTO, it was all vacuum column stuff because that stuff is fun to look at I guess. There were a few tape cartridges, they weren't labeled particularly accurately and they weren't even in my opinion the winners in the marketplace, they were just something somebody cleaned their desk out I guess. About to leave and I noticed that the docent was queuing up a tour and I decided, well, I'll go for the guided tour. And all of a sudden everything clicked really nice and real smooth. He talks about man's eternal fascination with computer, better ways to add and subtract and we start with mechanical computers, the abacus, moving up through a whole series of mechanical computers, Enigma machines, then we go to analog computers then we finally get to digital computing and it's bigger, faster, faster, faster, make the wires shorter, make them round then chips, large scale integration and then that runs out of gas because of power, so now we're going to do parallel processing and the whole thing really flows when it's guided and I would recommend a headset or some way for people to do that. Because even as a relative expert in the field, it was pretty hodgy-podgy [ph?] to me walking through by myself. Of course I was alert for tape stuff and there wasn't much, there was an operational RAMAC that three old guys would turn on and off periodically, there was the 1401 demo room, but that isn't really on the museum floor and a large amount of the public probably leaves once they get through the walking tour. So I'm excited about the fact that

you are more interested in tape. I was invited to join the Storage SIG by Tom Burneice years ago and I declined -- and I sent some stuff in and I participated in a few calls but I didn't sense any real love for my presence because there's John Best and Chris Bajorek and Bob Scranton and basically the whole San Jose disk mafia sitting there, "Who invited this guy?" So this is refreshing. Thank you very much because it deserves a place. Leave you with one last thought on that. What I always told people, in my view after 30 years of immersion and not just in IBM but throughout the industry knowing everyone in the world who participated, tape is to disk as China is to Japan. Tape is the mother culture, tape came first.

Gardner: True.

Teale: Tape always was the leading edge everywhere, tape was all the way down in the trash '80s, long before disk was down there in the form of a cassette. So the Japanese are faster, shinier, smarter but they still are wary of the mother culture and they still acknowledge the mother culture. And I just wanted to say that for your benefit.

<laughter>

Gardner: Joel?

Levine: Thank you.

Teale: <laughs>

Gardner: And again, Joel, thank you for hosting us, it's been great.

[Editor's note: here start part three of this oral history with an interview with Joel Levine]

Gardner: It is now Wednesday, our third day in Tucson on tape history and we've brought back Joel Levine to talk about his very early days in Poughkeepsie as a technician making tape drives including the Hypertape. Joel?

Levine: Hi. One of my first memories of IBM, I joined IBM March, 1960, I was given a little short tour through the plant, show me where the men's room was, the parking lot and, et cetera and I'm walking down the hall and I see these enormous test cells where they were assembling systems including the tape drive and they put them all together and cabled them all up to test them before they went out to customers. Overhead were these large signs of the name of the customer where they were going. And I see all these names like the telephone company and the IRS and Boeing Aircraft and names of that caliber, that level company, major, major corporations. I'm saying to myself, "This job's not going to last," I said, "There's not that many corporations or government entities of that size that would possibly could buy and afford to buy all this equipment, where are they going to put it, it must cost a fortune?" I said, "This job is not going to last." And here I still am. Thank you.

Gardner: And these test cells were…

Levine: The test cells, I'm guessing but I bet they were a couple thousand square feet at least, say if they were 50 by 50 that would be what, 2,500 square feet, they were at least that big, they were large, and they were the 700 Series computer systems and they were hot. That's the other thing I remember about it, the heat, because they were all vacuum tubes, the heat they generated and they had all these fans all around in these little portable air conditioners sitting on little almost like a pallet, , but it was hot in there. The biggest thing was I couldn't believe there were enough companies in the world that could afford these things and I was convinced the first week I worked there that this job wasn't going to last, but it did for 30 years.

Gardner: Now these were complete systems put together…

Levine: Yes.

Gardner: …and then…

Levine: Totally, all the tape drives, the channels, the mainframes and all the peripheral equipment was all cabled together and tested as a total system before it was disassembled and shipped to the customer. But the thing in my mind is the job wasn't going to last.

Gardner: But also you worked an interesting shift situation at Poughkeepsie.

Levine: I was working on the 729 assembly and then test line and they started to install all the 360 system as it was announced right in that general time frame. And they got the technicians to go out and install the tape drive part of the systems at different customers. So we ended up working like a couple of days off during the week but we would work on Saturday and Sunday and given a couple of days off during the week. And almost every weekend, we would fly to some city, help the local CEs at the time, the customer engineers, install the system, upgrade it, whatever changes they wanted. We worked like two 12 hour shifts, starting Friday at five o'clock when the company was closing down and the name of the game was you were going to be finished by eight o'clock Monday morning. That was like the answer to the question and we'll give you the question later. And I got a chance to go to many, many different cities all across the country. I can't tell you a thing about the city because it was get off the plane, check in at the hotel or motel and then go to work. And after working 12 hours, you weren't interested in sight seeing anyway, so that's how the weekend-- and some of the places were really interesting, I remember being sent down to Brookhaven Labs in Long Island and they gave me all sorts of stuff to let me through the door and the gate because of security reasons and all that. So I was given all these special credentials and things to get through the door and I get up to the gate and the guard is waiving me on, like he doesn't want me to stop because I was going to hold up traffic and here I was so convinced I had to give him all this information that they gave me to prove that I was okay to go through the gate and he's just waiving me through. So he waives me through the gate and I'm saying to myself, "Now where do I go?" because I was going to ask the guard where's this building I was supposed to go to. So that was a lot of fun. I remember we installed a system at Rand out in California, the Rand Corporation and versus the guard who waived me through we were met by guards, multiple guards and stood next to us through the whole weekend. I had to take a break, I said, "Where's the men's room?" And he says, "We will go there together." And I sort of look at him funny but there we went. And yes, he stood next to me and I

was never more than probably six feet away from this guy through the whole weekend. He was a big guy, I'm not that big. That was interesting. A lot of stories like that. We installed one in Reader's Digest in New Jersey and this guy comes out from Reader's Digest and he says, "That thing's either working by eight o'clock Monday morning when we start in again or you push it down to the freight elevator, and let me show you where the freight elevator is." He made his point. It worked. A lot of stories of that nature.

Gardner: Sure. So did they pay you for your travel time?

Levine: Yeah, they paid for the-- obviously they paid all the expenses as far as travel, a hotel and all the rest. There was a certain amount of overtime we were paid because we were hourly employees, but we were also given a couple-- so it was a five day week with a lot of overtime, if you think about the Saturday and Sunday part.

END OF THE INTERVIEW

Editor's process notes:

1. Initial edit commenced June 13, 2016 and was completed July 8, 2016.
2. Comments on initial edit received from Gaudet on August 29, 2016 and incorporated into working document sent to Bradshaw September 3, 2016.
3. Bradshaw comments on working document received on October 29, 2016 and again on December 5, 2016.
4. First final draft completed on December 31, 2016. Additional changes after first final draft include
    a. Changed name of session from "3480 Overview & Evolution of Tape Technology Panel" to "IBM Tape History – Session 2: Overview of tape products and product management"
    b. Changed name of associated files from "102737994-05-01_3480_Overview …" to "102737994-05-01_IBM_Tape2_Overview_ … "
    c. Changed of associated video files from "3480 Overview Part x.mp4" to "IBM_Tape2_Overview Part x.mp4"
    d. Moved list of 3480 technologies to IBM Tape History – Session 3: 3480

5. Memorabilia offered by interviewees and accepted into the museum's permanent collection have CHM Lot Number's X7617.2016, X7620.2016, X7677.2016, X7678.2016 and X8091.2017.

6. All unknown or uncertain names, dates, places, products and other facts were verified to the extent possible. A collection of more than 100 pdf documents collected in conjunction with editing this transcript was provided to CHM as Incoming Receipt A2017.5820.

Attachment 1 – Lab Directors at IBM Tucson responsible for tape products

Based upon extensive discussions with the participants and direct contact with several IBM Tucson Lab Directors it is fair to say the "Lab Director of Tape" was a valid job title for someone in Tucson from 1977 to 2008, with the exception of a brief period beginning in 2000. The following table identifies those individuals responsible for IBM tape development from 1978 to 2008, most if not all of whom held the title Tucson "Lab Director."

IBM "Lab Directors" in Tucson responsible for tape products

Seq	Name	From	To	Comment
1	Dauber	1978	1979	
2	Rosato	1980	1982	
3	Mazza	1982	1984	
4	Hassan	1985	1987	
5	Unterberger	1988	1994?	Friesen VP of Dev or Site GM, but not Lab Director
7	Headrick	1995?		Grant VP of Dev
8	Reardon	1995	1997	Grant VP of Dev
9	Myers	1998	2001	
10	Aviles	2001	2001	
11	Liddicoat	2002	2004	
12	Teale	2004	2007	
13	Boca-Luca	2007	2008	

In early 2000 the entire storage division, which included San Jose, Tucson, and a number of funded satellites around the world, was split into two divisions which only lasted about 2 years. What was the old storage division was renamed the "Storage Technology Division", with Glenn Larnerd as GM and the new one was the "Storage Subsystems Division" with Linda Sanford as GM. The title "Lab Director" may have not been in use for a brief period within the Storage Technology Division.

John Teale describes the Storage Technology Division, as:

> "The 'gearheads', i.e. the physicists, scientists and engineers doing the heavy lifting climbing Moore's law, were isolated in STD where a separate financial construction could be enabled (to establish value?). These are the 'brick makers' like the disk drives and tape drives themselves."

Ultimately the disk portion of the Storage Technology Division was sold to Hitachi with all remaining storage product responsibility including tape product consolidated in Tucson.

The Storage Subsystems Division, later the Storage Systems Group was responsible for storage servers such as NAS and/or SAN systems.

