Oral History of John Squires

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Tom Gardner: I'm here in Boulder, Colorado, with John Squires to talk about his various involvements in the storage industry. John, tell me about your background.

John Squires: I've had a career in the storage industry, graduating from the University of Colorado in physics, actually, which I think is a good grounding for the industry, and worked at Storage Technology, now called STK, joined the startup called MiniScribe, and then started a company which evolved into Conner Peripherals, which was one of the more successful-- last really successful disk drive startup out of many. And that's-- other than a short stint in a turnaround attempt of Integral, that's pretty much my career.

Gardner: Well I guess we're done.

Squires: Yes.

Gardner: No, let's go back to Australia. I understand you were born in Australia.

Squires: I was, yes, I was born and raised in the bush of Australia, you know, literally no electricity. And my father worked in Sydney and came home on weekends and my mother raised five kids in the bush. I was the oldest and when I was15 my family, my father had a job here at NCAR in Boulder which is the National Center for Atmospheric Research. He's actually the first guy to seed clouds and make rain. And so they offered him a job here and he brought the kids that didn't wear shoes and all that stuff. In fact there's a picture in the local paper of five kids down at the local shoe store, and the implication is that we hadn't worn shoes before then. <laughs> But we came to Boulder.

Gardner: I didn't realize the bush came that close to Sydney. I know so little about Australia.

Squires: There's the Great Dividing Range which runs about 50 miles west of Sydney down the East Coast of Australia. And it's pretty much the highest range and the bush starts right there. And of course nowadays it's been pushed back a little, but still pretty wild and pretty rough.

Gardner: You have four siblings?

Squires: Yes. Two sisters, two brothers.

Gardner: They still in Australia?

Squires: No they're all here. I was the eldest, and I was15 when the family did move. So we all came along, so to speak.

Gardner: So you must have been in high school?

Squires: I started and I spent a few months in junior high, ninth grade, because the school years were offset by six months, I actually missed six months of schooling. But I did go to Boulder High School here,

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and continued to University for two years. I decided that I needed to find priorities in life and joined the United States Army as a medic. , When we're young we're idealistic, and of course, saving lives is, about as idealistic as you can get. So I did that from 1968 through 1971 spending my time in Germany as it turns out, as opposed to Vietnam, where medics were really important. But I then returned to school and graduated in 1973.

Gardner: So what was it like going to school? I guess you went through junior high in Australia and then you came into the American system.

Squires: I did, yes, yes. . The system is slightly different. They called it years one through five. They had one fewer years of high school in Australia than here. But I went to a boarding school for three of those years before we moved here. But it was different. I mean the emphasis of education was different, which was to my advantage in some areas and to my disadvantage in others. But it was a relatively easy transition, and everybody loved my accent back then. And so I was somewhat popular even though I was really an introvert and very, very shy. <laughs> I was able to make friends and enter the community, so to speak.

Gardner: Can you say something for me in Australian?

Squires: Well I'll tell you a short story. On Pearl Street, just near here, there used to be a store that sold products for, it was the precursor of the dollar store. They sold products for 88 cents. And my friends used to love to get me to say the word "eighty-eight" because Australians say it "eye–tee eye-te." <laughs> And so they'd use some subterfuge to get me to describe this place down on Pearl Street. Oh, I'd say, "Oh you mean the eye-tee eye-te cent store." And then of course they would burst into laughter. <laughs> So, yeah, the A's were different and the, our aunts are "onts" and, we had a sort of soft different emphasis on certain words and letters.

Gardner: As much difference as there is between Boston and Texas, I suppose.

Squires: I think you're probably right, yeah. But the Australians are big around the world. People are generally friendly and people like to hear them talk and that was the case in my case.

Gardner: So was the transition from Foster's to Deutsch brew difficult?

Squires: Oh, well I was-- remember I was 15, so I hadn't really developed a Foster's habit yet. <laughs> Plus in the bush there was a shortage of bars, at least where I was, so. So it wasn't that difficult. <laughs> But my son who, as children do sometimes, go back and try to retrace their parents' roots, spent a semester in the University at Sydney, in the University of New South Wales in Sydney, and he said Foster's was pretty good, that he had thought they'd done a good job with that beer.

Gardner: What was it like as a medic in Hanau, Germany?

Squires: I was stationed near Frankfurt in a small town called Hanau, and it was great. As a medic in the Army you sort of had license to do about anything, which, you can't do in civilian practice. I used to do surgeries and things like that in the Army situation. I learned a lot, and I actually considered continuing to medical school when I came out, because I quite liked the job and the people just in general. But it

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was the length of schooling that persuaded me to skip it and go into physics. <laughs> It was, at least another seven or eight years of school that would be needed to get a Ph.D. in medicine.

Gardner: You said you started in chemistry?

Squires: I did. I started the university in chemistry and did quite well until I got to organic chemistry and then I said, "That's it on this subject." <laughs> And about that time I said, "Maybe I'll try the U.S. Army." And then came back and found physics which I think is a great subject to follow through school.

Gardner: Is there anything in particular that lead to you to the scientific avocations as opposed to business or philosophy?

Squires: Business or something like that? Well my father was a scientist. He was actually the second Doctor of Science in Australia, but so there was a culture of science in the family a little bit. But I guess it was just my natural inclination, and I was relatively strong in math, never brilliant. But I guess, the values that were instilled in me growing up were that science was a superior calling <laughs> to others. And so I think that's how I ended up that way.

Gardner: Did your siblings follow that calling?

Squires: No, no. My brother went into mechanical engineering, so, you know, he sort of did, yeah. But so he was, but not true science. But no, the two sisters went the biology route or the 'ology route and my other sister went into teaching. Understanding how to teach people is something I've never figured out.

Gardner: Actually I think you are a little bit underestimating mechanical engineer, I always thought mechanical engineering was black magic.

Squires: Oh, no way. <laughs>

Gardner: So you graduated in '74?

Squires: Yes.

Gardner: And joined Storage Tech?

Squires: Right, right, and at that time I remember there was a recession in progress. It was tough to get a job. I was working as a bartender in one of the restaurants here in town that was actually an island inside the city. Boulder was actually a dry town in those days and you couldn't buy alcohol. And I graduated in May of '73 and really didn't get serious about looking, I mean most people nowadays are--have a job lined up or something two years before they're out of school.

I was not too serious because I had a gainful job, and I'd gotten married while I was in the Army. And I think the recession took the restaurant that I was working for out of business. So I needed to go find a real job and I remember somebody telling me about Storage Technology. I had literally thought it had

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something to do with packing boxes, because they were fairly low profile at that time, but they were long out of the incubator phase. They did have 2,000 people, and they were shipping product when I arrived. One short story about it is I actually submitted five applications and received five rejection letters, two of them after I'd already been hired, but. So they didn't have their paperwork and their systems well oiled at that time. But it was a nice-- it was a good environment and of course I was very green and joined as a diagnostic programmer. They made control units for the tape systems. And these things were monsters. They had about a 98, you know, cards and roughly the size that became the S100 size, about seven inches by ten or something like that filled with integrated circuits and wires. And of course when the machine stopped working, it was the field engineer's job to fix it. You could either shot gun it by replacing one card at a time and attempting a fix or run these programs which I was to hired, with others, to write and run diagnostics which actually pointed to which card should be swapped first. Essentially it was assumed to be a logic failure, an integrated circuit, the little 7400 series chips that existed back then. And it was a great entry into the business because you got to-- while you were on the software side, you had to understand the hardware. You had to understand how it worked, and of course, the challenge was always to exercise every signal, and then look for a response and use, the often very indirect way, and then analyze, how-- what card might cause a failure or something like that. So I actually spent, oh I think, three years or something doing that type of programming on the tape control units at Storage Technology.

Gardner: Had this been in production for a while, or was it just going into production when you joined them?

Squires: There was something called a mod 4 control unit which ran the GCR, and I joined Storage Tech right about the time that IBM had come out with the GCR format. Previous to that had been the NRZI and the PE or phase encoded technology. I did most of my work on what they called the mod 4 that was really like a mod 3 control unit with the GCR upgrades.

Gardner: When did you join, the month?

Squires: Sometime in the spring of 1974.

Gardner: Okay, and the Mod 4 was just going into production.

Squires: I think so, yes. Yes, right. I don't think we had shipped any units at that time.

Gardner: Was this a unique to Storage Technology control unit?

Squires: Absolutely. It was literally a refrigerator-sized box filled with wires and chips sort of thing and very, very, very unique. Too unique you might say.

Gardner: Whose floppy disk did you use to load it with?

Squires: There was no floppy disk. Programs were interesting. It was a fairly wide word, it didn't have an ALU but it had an instruction set and there was a separate read path that was deemed to be much more reliable to read specially formatted tapes that had these little programs that I wrote on it. They just used the absence or presence of a signal to indicate a one or a zero, no timing information. It was just,

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just a very low level primitive. But the programs were just 64 words, I mean the words were not too wide, I think I made them 32 bits or something, maybe 4 bytes. But each program had to consist of 64 of these words. I recall they were actually using the magnetic core RAM at that time. Very early on, it wasn't even semiconductor. RAM was not a trend, not very accessible. Consequently, I was trained to write very tight code. <laughs> To do a lot with a little, so to speak. And again, that was a good basis for the future.

Gardner: How did it initially microprogram load?

Squires: Well there was a tape that was on the tape drive and there was a hardware sequencer that read this alternate path-- it was not this very reliable path to load the actual code. So you could have a totally broken read channel and still load your code from the tape drive is the point. It did not use the main read path -- it had an alternate path.

Gardner: Was there sort of a religious reason for not using the floppy disk?

Squires: I don't remember floppy disks existing at that time. I mean we did a lot of coding on, you know, punch cards and-- you know better than I, when floppy disks when they came into vogue. I know they were-- but there was no floppy disk I can...

Gardner: Well the first OEMs were shipped around 1972. In 1974, IBM announced the first key to floppy disk system and then the floppy disk drive market exploded. So it could be that this was before then.

Squires: Yeah, not integrated yet.

Gardner: Well, since was the fourth generation machine generation one must have been prior to floppies.

Squires: Right. There was a funny story that I like to relate regarding tape and disk because I was in both camps in Storage Tech. The story, was that the tape guys always backed up their software on disk drives. The disk drive guys always backed up their stuff on tape drives. <laughs> Because they both knew how flakey their own technology was, and they thought the other guy knew what he was doing. <laughs> So the floppies were not a big part of that in those early days.

Gardner: I know so little about tape control that I'm probably taking a little bit of your time.

Squires: No. So we had, you know, One brought in a reel of tape, I mean that was the media with the tests, that had a sequence of tests on it. And so you'd run these 100 tests or something to try and discover what was not working.

Gardner: It taught you tight microprogramming skills.

Squires: It did, it did, yes. Yeah. I'd actually developed a high-level interpretive language to-- well that was in disk, I take it back. Because the disk had the same constraints that allowed you to leverage small, small pieces of coding done with more function.

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Gardner: You did this for about three years?

Squires: I think it was about that, yes. Somehow I ended up in disk, and I actually have a very fuzzy memory of how I moved over. But I went into a similar, diagnostic programming for the disk drives, the 8350 I think was the first big one, which seems like it was 317 megabytes maybe or something like that. It was a big-- the 14-inch platters and had its own control language. Again, it was a refrigerator-sized product <laughs> with almost as many cards.

Gardner: It was 8350, right, that was the 3350 equivalent which is 317.5 megabytes.

Squires: Yeah, I think Storage's disk division also had an 8100 which was the equivalent of the 3330, the IBM 3330. Those were the ones where you screwed the little plastic tab down to change the disk pack. But the 3350 was pretty much a fixed device. It didn't, I mean you could interchange the HDAs, but, it wasn't part of the user interface.

Gardner: So you're now doing diagnostic programming for disk drives in a different control unit?

Squires: Yes. Oh, absolutely, a totally different control unit. Again, a refrigerator-sized box.

Gardner: Different architecture?

Squires: Absolutely, I think the architecture came out of the group from California when Storage acquired Storage Disk Corporation. Again, I was, I was junior at that time, so I didn't have insight on the big picture architectural issues and all that stuff. But it was-- I remember we'd program by drawing little boxes with flow charts between these boxes. , Four-way branches and things like that. It was just-- it was quite specialized. Architecturally it, now that I think about it, it was an IBM architecture; Storage Tech I think borrowed heavily if not, a little bit more than heavily from <laughs> from IBM in that arena.

Gardner: So the 3830, which was IBM equivalent, used a 32-bit word and was a very complex, wide-word structure and a specialized instruction set.

Squires: Yes.

Gardner: And that was essentially the same architecture.

Squires: I believe it was, now, yes.

Gardner: And did you-- I know IBM for testing its drives had a macro language that emulated, executed on that machine, but you were doing control unit microprogramming tests?

Squires: Yes. Now there was a whole set of diagnostics written by other people that did do that same-- that level of testing essentially, I didn't need a computer to do the testing we were doing.

Gardner: The same thing, you were trying to help figure out which board in the control unit was bad.

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Squires: Exactly, and the drive too. It was in both drive and control unit.

Gardner: Have any interesting experiences you'd like to share with us about that?

Squires: Oh, I guess the only thing that was totally outside the box was that people-- I didn't ever do this, but people used to--, these disk drives, , they used to make a little buzzing sound when they did a seek, and people used to write programs that could actually make the disk drive sing a song. Program the different length seeks for different tone for a certain number of seeks and then change the length of the seek, and so you'd hear jingle bells, almost, coming from a disk drive or something like that. <laughs> So that's a little bit, off the wall and sort of <laughs>. But I mean it was an exciting time and there were the product, as all storage products in those days and even today, difficulties., But it was generally a success and I think the team, generally the team was functional. I mean there was no severe dysfunctions which you do find in a project from time to time. So nothing, I'm sure I could ponder further, but those were my days.

Gardner: I'm not sure how to take this thing off line for a second, and so after the 8350 diagnostic programming, you moved into a different disk area?

Squires: Right, well there was the follow-on product, the 8650, which was just a double-density, as I seem to recall, it was 857 tracks per inch and that was a TPI play to get more capacity. I spent a little time on the next generation, which IBM came out with at Storage Tech. you may help me on those numbers. It was the double actuator from the side.

Gardner: The IBM number is the 3380.

Squires: Yes, 3380. I guess Storage had an 8380. I did not do extensive work on that. I think I mentioned earlier that Storage had another program going, the 2700 series, that was one of the world's earliest OEM disk drive products. It was a 14-inch relatively low capacity, maybe 100 megabytes, maybe not, about 6 platters, 5 to 6 platters, and that they were targeting a totally different market, small businesses. And then the manager, Dave Cordano, got ill, and I think it was Juan that said, "We need to find out what's going on." I was asked to go be part of a review team that spent, a week. I'm sure we've all been through these situations where a team outside has come in and says, "What are you guys doing?," and all that stuff, trying to understand if you're actually getting the straight scoop or not. And subsequent to that, they decided they needed additional people and I got assigned to that program for a couple of years. So the 2700 program was my next big step.

Gardner: Dave Cordano was?

Squires: Dave Cordano was the program manager. I believe he was working for Juan Rodriguez.

Gardner: And did he remain, recover after the sickness?

Squires: Yes. Dave, in fact, he and I worked together in later years. I had worked for him at Storage and he worked for me at Conner. <laughs> And in between he worked at Seagate.

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Gardner: Okay. How did the evaluation go?

Squires: Well, it was one of those programs where they promised the moon and were delivering an asteroid sort of thing. But there were a significant number of goals that were clearly, well outside of the possibility of meeting the schedule and unrealistic I suppose. Because it was a very innovative architecture, very innovative product, heavily software oriented, using a Motorola processor 6801. And had a brilliant architect, Maartin Pranger, who had a vision of what a disk drive should be, which turns out was bigger than has ever come to pass. It actually had a word processing editor built into the hard drive! It had a code assembler. It had a PL/1 compiler built into this drive. It had, in addition to logical block access,,, I mean they did actually bypass the cylinder head step completely, which, most products had not. It also had a file management system so you could actually access your data by sending across a file name. And then the drive was responsible for managing that file, which is a nontrivial task in itself. I suppose the other thing that distinguished it was that the electronics were on a single board albeit that board was about 24 inches by 18 inches and of course, multilayered, maybe 8 layers, I don't recall, but many layers to hook things up. But it was a big board, a big board full of relatively low-level integrated circuitry. But, that in those days there were really no PLAs. They were just starting in. The gate arrays were just starting, but there were no gate arrays. Everything was done with discrete TTL circuits. The architecture was such, that the traditional functions that had been done in hardware remained in hardware, the read channel, the server channels, things like that. But the microprocessor they had just controlled handing out that tasks to these blocks that had buffers. Written so the data was buffered, which was somewhat new. I mean it had not been done on the bigger drives, the 3350 or whatever, there were no memory buffers for data, so. There was some progress in there in intelligence and things like that.

Gardner: Now when was this review? Can you date it at all?

Squires: I would have to date it about '78

Gardner: The Pranger article is February '79, so the review probably predates that.

Squires: Yes, probably, yes. So say probably '78 is a good date I think. And yes, that product did well. We shipped a few and I think there were some-- Juan made-- in the previous interview Juan made some reference to some of the issues. It had a dedicated servo which made the mechanics very touchy. I mean you could literally put a punch card under one corner of the drive and the data on the head that furthest from the servo platter was no longer readable, but. <laughs> So there were a few little issues. <laughs> I remember Dave Cordano telling me once that, he felt his big contribution to the product was to put a transparent window in the cover that let you see the actuator move. It was very cute. The trouble was that, if somebody turned on a light switch across the room, the EMI <laughs> interference would cause a read error. <laughs> So he said, "The only thing I ever did was, it was the wrong thing to do." But it was a very, sexy product for those times because you could literally, see the actuator, My efforts there were at the fairly low level, not the higher level, you know, editor compiler stuff, but making the thing read and write and seek and things like that. And I can remember buying an airplane seat for one of these boxes which was about this big, and this high and this wide.

Gardner: Like the EIA 19 inch rack?

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Squires: A 19 inch rack, yes; it was a big heavy thing that weighed about 150 pounds, and it was a heavy monster and we'd actually bought an airplane seat for these things and I took one to Texas in the middle of the night and set it up. But the customer base was quite excited about it because it had its own unique instruction set and interface and people were willing to-- and in those days to go that route.

Gardner: You mentioned Pranger and Cordano and yourself, any other key contributors worthy of mentioning?

Squires: Oh heaps, Dr. Jim Morehouse is probably most famous nowadays for building the head lift mechanism in disk drives. . So that was used on his PrairieTek and Integral products. The real-- two generations and the real one that was successful that everybody had to license, including IBM, was the one developed at Integral and so Jim was, I think responsible for that development. But there are many other contributors.

Gardner: Were head lifters used in the 2700?

Squires: No that came later.

Gardner: Anybody else?

Squires: Oh I can name names, but I can't-- I think Dick Latt did the read write and I know there was-- putting out the power supply was a big deal, because it was, you know, it was a 110 volt thing that you plugged into the wall and that was Mike Utenick . I think there were various groups. My memory's, not that strong in that area. But yeah there were a few other people in the software group, obviously. Art Rudeseal who went on to get involved with the architecture of Storage Tech's answer to MSS which Storage called VSS. He was a major architect. He was involved in the 2700 program.

Gardner: What was that name again?

Squires: Art Rudeseal He was a very smart guy out of IBM I think.

Gardner: I actually have a photo or an art drawing of the 2700 over here, which I don't know if there's anything in that inspires your recollections. I'm interested in the interface.

Squires: Oh it was like, , they had it was a master-slave type thing where you could hook up at least two drives on this very wide bus And well you can see the circuit board in this picture, see what a monster it was. <laughs>

Hendrie: Yeah, you want to just turn it around and hold it up and show the circuit board?

Squires: Sure the circuit board is sort of poking up from underneath this-- well the case was plastic, though I believe it was coated with metal-- coated on the inside. The spindle was fixed just on one side which, as I mentioned earlier, was the source of a few issues, like not being very stable mechanically. But other than that it had the characteristics of what we call today's modern day disk drive.

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Gardner: So it was a master-slave, high-level interface.

Squires: It was an intelligent drive in that the data was recovered by the drive, and any, retries and correction were applied at the drive level as opposed to the host level, and it had-- obviously if you had a file management system, you have a fairly high level interface, so. So there was really <inaudible>.

Gardner: There was no attempt to standardize this or get an ANSI committee approval?

Squires: I think Storage was hoping that being first that they would, get others to follow and standardize. But again, for Storage Tech it was a totally new market area. My understanding, and again I was an engineer, not intimate with the thinking in this area, but they felt this was a new marketplace. DEC had maybe ploughed more ground but they definitely felt that it was different enough that there was no standard in this area, that they would just do it and set the standards, I suppose. And I think they could have succeeded, they could have succeeded. I think Juan needed to-- some of the points in the hallway here recently about, you know, the economics weren't quite there, and of course, there were some fundamental, issues that were not solvable easily, so.

Gardner: This is '78 just after SMD takes off in the disk drive market -- SMD is a dumb interface. They had two years of delay while the controller companies designed. So these guys come out with an intelligent interface, but it goes no place. More than that, you've told me it was prescient in microprogram control of drives. I mean, could you elaborate on that?

Squires: Well, jumping ahead I left Storage and joined Terry at MiniScribe, and he tells a story about a second generation drive which had a microprocessor, and so even that had done at a low level with a ST506 interface, there were functions that were better served by using a microprocessor and it just lead the way. I mean I have developed sort of this internal model of disk drives, they evolved -- the original disk drives were essentially a mechanical device. I mean they were just-- they were all mechanics and in some sense the mechanical group were the top dogs in the organization.

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START OF TAPE 2

Squires: So you know, I developed this internal model which I used later. , , The original disc drives were mechanical and I saw they had hydraulic fluid in there along with other troublesome things They were heavily mechanical and the people that led that tended to become managers of the future products and so there was an emphasis in the mechanical architecture So problems were solved mechanically because often there's more than one way to solve a problem. Slowly that switched over to electronics and problems were solved through clever electronics, that is mechanical problems were solved with electronics. The 2700 example made that next step from electronics into code, into micro-code whereby the difficulties or problems or things that needed solving either in the mechanics or electronics could be solved with microcode. And so I think that was the real contribution of 2700 and of course we use that idea in future products that I've architected. , The drive at Conner where the mechanics became very sloppy, low tolerance which means less expensive. The electronics became minimalist and by using code and clever programming we were able to execute the function that we wanted to. Now, of course since then, microcode has become expensive. Microcoders are expensive and it's often unreliable so these

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functions have been replaced by large integrated circuits, things like two-burst error correction, I used to do it in software and now it's done in hardware, because no microcode engineer ever has to understand how the math works anymore. And it's quite difficult as you would imagine to do two-burst error correction in software or in hardware for that matter. It's solved once in hardware today and put into an integrated circuit. That's where you get the million, transistor chips that Intel does. And so I saw the 2700 and subsequent products, the second generation MiniScribe products, as a step, the next step, a new turning of the wheel to use a Buddhist phrase, moving from electronics into microcode.

Gardner: Can you give me some specific examples in the case of the 2700 of say an electrical function that was moved into a microcode or a mechanical problem that was moved into microcode?-

Hendrie: What about the potentiometers?

Squires: Oh absolutely, all the adjustments were in microcode.

Gardner: No potentiometers in the 2700?

Squires: There were, there were. The read channels still had them and things like that but by and large they were helped by microcode, a very low-level example is retry management. I mean before, that it had been a function of the host and the disc drive industry had sort taken upon itself to provide the specs of a ten to the minus tenth error rate, raw error rate which was always subject to interpretation but basically it meant very, very low error rate. By moving functionality into code, we moved that number down to ten to minus five at Conner so we're talking about a factor of 100,000 higher error rate. Of course you get the associated capacity increase by accepting an error rate that high but making it transparent to the host. The user didn't see the higher error rate. He saw ten to minus 12 hard error rate which is almost never, and that was the spec only because one couldn't test that long. That is an example of the dirty little things going on underneath, it's a bit like a duck on the pond. He looks very smooth on top but underneath he's paddling like crazy to move around the pond, and so microcode allows one to do that. Error management, error recovery was a big area. Obviously the servo area is another area where just the microcode could do a lot where you could actually think about what you were trying to do rather than try and build a piece of hardware that had relatively simple, algorithms.

Gardner: Well for example to the servo channel you could do self-calibration, self-tuning.

Squires: Absolutely.

Gardner: I know you did that in Conner.

Squires: Right.

Gardner: But was that done here? Error recovery-

Squires: I'm trying to recall, I believe the error recovery had some sort of calibration of the magnets, the strength of the field and so that if you had a magnet that was not as strong as in other, it would know that and adjust the trajectories that were expected for the seek arrival and things like that.

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Gardner: Yes, I'm trying to understand how far a step it was towards because what Conner ultimately did.

Squires: I'm not 100 percent sure the 2700 did that, but because it all runs together, but obviously we did do that in latter days. But the idea of having the microprocessor just opened so many doors in the drive, and so new ideas were generated, diagnostics, self-diagnostics and just algorithms, spin-up algorithms. I have a patent on the hall-less spin motor -- by using microcode I got rid of parts and that was both a reliability improvement and a cost improvement.

Gardner: That's a good example. Was that done in the 2700?

Squires: No. The 2700 didn't make too many advances in what I call the hardware side of the disc drive. I mean the spinning, the basic functions, spinning, servo, and read-write were still the blocks that had been developed, though simplified. But still it provided a lot of flexibility and tied them together with a microprocessor.

Gardner: I don't want to put words in your mouth but it sounds to me like it was digital control of traditional functions.

Squires: Yes.

Gardner: As opposed to the more integrated type of control that we see later in Conner and now in every drive.

Squires: Right.

Gardner: Well I might disagree with you on the example of double-burst error correction. At least with today's high-level language, if you write the program right once, it will compile properly. The same thing in designing the chip correctly once. The chip can be screwed up too.

Squires: Sure, and you're right.

Gardner: It's a lot tougher to change the chip.

Squires: It is a lot tougher; however, it needs to be once and done correctly and then if you're an Adaptec or Cirrus Logic, whoever was selling chips, a number of disc drive companies would buy that technology and take advantage without actually have to know how it all worked. Just as no one knows today the actual details of how a microprocessor works, but we all use them.

Gardner: Like my Intel computer that a few years ago couldn't divide properly.

Squires: Oh yes, right.

Gardner: There was a flaw within the machine where a certain division would give you an incorrect answer.

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Squires: Right.

Gardner: So was the 2700 your last program?

Squires: No I did move back-- I moved for a short time to a program, to that 8380 program, the IBM 3380. And as a manager and in a larger group and was there not a long time, not maybe six months before I did leave Storage Technology and that would have been in 1980. Yes, 1980 when Storage had just absorbed, Jesse Aweida had gone on an acquisition frenzy. Storage Technology had acquired a printer company, a chip company and a number of other companies that I can't even remember but I'm talking about five or six companies that were outside the discipline of tape and disc and the energy of the upper management was diluted and there was sort of trouble on the horizon and they did hit that trouble, fairly shortly, maybe a year after I left I think.

Gardner: There was a famous 8650 problem of undisclosed underlying cause in 1982 which is after you left but apparently at one point Storage Tech had as many disc drives shipping back to the factory as they had shipping out to the customers.

Squires: I've heard tell of that, yes.

Gardner: But no details?

Squires: I fortunately know no details. I think those were just standard media, head media interface problems like crashing.

Hendrie: I read somewhere in the material that there was a bad batch of discs.

Squires: I believe it was a head disc and tribology issue. In those days most disc drive issues were head-disc interface.

Gardner: IBM had three famous recalls on the 3380. One of which was spindle bearings.

Squires: Right, you're right.

Gardner: For these famous recalls I'm trying to find out what the underlying problem was for historical purposes.

Squires: Right.

Gardner: As I go around I ask people, since you were there I thought I would ask.

Squires: I've heard tell of warehouses of disc drives, but I actually didn't see them.

Gardner: Enough to have made the 10K. But for the most part a technology company never tells you what the underlying problem is and for intellectual curiosity I ask whenever I can.

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Squires: One of just the miracles of the industry nowadays is the reliability numbers have gone through the roof on hard drives. And now, not only should you not have a problem you have to disclose, basically you're not allowed to have problems. So the products that are shipping today have reliability numbers that are unbelievable in terms of the area we're talking about.

Gardner: It actually goes back to the thing that started with the 2700. Micro program controls allows heroic error recovery.

Squires: Yes.

Gardner: And disc drives today go through heroics to recover your data.

Squires: Absolutely.

Gardner: So how did you decide to leave Storage Tech?

Squires: Well I tell people that if you think of the analogy of the company as a rowboat or a Greek galley and everybody pulls on the oar, I felt as if it didn't make a difference whether I pushed on the oar or pulled on the oar, that the boat was speed and direction were unchanged. , There was just maybe you could say it was a mounting bureaucracy. That might be part of it because the company was maturing. Maybe at that time it had 10,000 people. It was a large company. It was approaching a billion-dollar company I think.

Gardner: That's correct.

Squires: So it was a serious company. It had many irons in the fire in other areas, but I was in my mid-30s. I had a little fire and interest in me and Terry Johnson had left Storage Tech probably six months prior to my leaving, maybe more. I didn't know Terry well but we had a few interchanges at Storage Tech and just knew each other a bit, had a respect for each other. I knew he had started a company and there were many details which I learned later about the early days, the first days of MiniScribe. But I said "Oh, I'm gonna go talk to Terry, and maybe he's looking for some help." But anyway I did end up being employee seven of MiniScribe and we started that in his basement.

Gardner: Could you tell me the other five? I know Terry.

Squires: Terry, well there was Walt Oshetski.

Gardner: Say that again please?

Squires: Walt Oshetski. Chris Adams was a relatively junior read-write guy but he was just out of school, fresh out of school. Rick Altabellus [ph?] was a mechanical engineer. Glade Bagnell, G-L-A-D-E. Glade is old timer in the industry and there's got to be someone else. I can't think of at this moment.

Gardner: You're number seven.

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Squires: Yes I remember that part, and we played around in Terry's basement for a couple of years and of course Roy Applequist -- Terry feels Roy was his mentor and guiding light. Roy was probably the mechanical architect on the product.

Gardner: Was Roy an employee?

Squires: No, Roy came out for a day or two every now and then and pointed out things that he felt were in need of attention.

Gardner: I looked around for who were the founders and I could only find Terry's name, so I thought I'd see what you know.

Squires: Hoppe, Bob Hoppe was the other I remember .

Gardner: That gives me six.

Squires: Yeah, I think Hoppe ended up at Seagate. He was a mechanical designer. Terry tells a story about the one guy showing up on Monday morning. You've heard that?

Gardner: No.

Squires: The legend of MiniScribe is that Terry left Storage Tech and had organized sort of a coup. Seagate had just come out and Terry recognized that the five and a quarter-inch product that Seagate had was the future of the industry and said "I can do that." He assembled a team of high-level people out of Storage Technology, big names and I could tell you some of them, but the bottom line is it was sort of like a South America coup. where there was a plan that on Monday morning everybody was going to go in and resign. Somehow this plan got leaked over the weekend and there was a team from Storage Technology, I think staring Jesse, to contact everybody and say don't do this, whatever, with threats and incentives and things like that. So there was a team of maybe ten people that were destined to go to MiniScribe and start on Monday morning and of course by when Monday morning came around only one person showed -- the mechanical designer, Bob Hoppe! Had Bob not actually showed up Terry said he would have been too discouraged and he would have just done something else, but given Terry had one employee he needed to get something started. So that was the origin of MiniScribe. The rest of the team all got turned around essentially through various threats or incentives.

Gardner: I'll have to ask Juan about that.

Squires: Juan probably knows more. , A little bit about it because he was probably on the other side, I don't know.

Squires: Well I know Dick Latt who is well-known as read-write engineer is one of them and Bob Ganter who is a mechanical engineer, PhD in mechanical engineer and of course Terry would know all the other names but I know those names.

Gardner: Ganter actually ultimately went to MiniScribe.

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Squires: He did, yes we hired him.

Gardner: You hired him.

Squires: We hired him, yeah. I think I hired him as my boss but I had to hire him anyway.

Gardner: That's always a privilege.

Squires: He's a good guy.

Gardner: So by the time you joined in January, the exodus was July of 1980.

Squires: Right.

Gardner: And you joined in January so if Terry had to reconstitute a team.

Squires: He did.

Gardner: He did not get off to a flying start.

Squires: He did not, no, no.

Gardner: It was still in his basement?

Squires Yes, and it was for some months to come maybe six months to come.

Gardner: Did they have anything when you walked in?

Squires: Yes, they had mechanical and rudimentary electronics. I believe I was hired to build a control unit and of course I leaned heavily on the 2700 architecture to do that. I mean so I actually designed a board this size instead of this size. It was an S100 board and it had the full control unit but architected around a testing function because you know, you needed to build these things and test them. And so the drive plugged in and it ran and did things and it was at fairly low cost board. So that was my first job there, to do the control unit. And of course I had no experience in designing control units but I made it up and it worked, and I made up a lot of things actually as well in many areas but not everybody found out about it until later.

Gardner: So this was not a product then for MiniScribe that you worked on. It was a piece of test equipment?

Squires: It was basically in the production floor, it went in the production floor and it was also in development. The data separator, for instance I mean I had no analog experience but I designed this data separator to try and recover data. It was a learning experience. It was good, so even during the

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development of the drive you would use this piece of test equipment to look at the drive. The tools were very rudimentary then. Nowadays you buy a piece of test equipment from a company to look at a new HDA or something like that. They do amazing things. But then it was not the case. So that was my first part. But what I was hired to do? You asked did anything exist? Yes, the rudimentary, the drive existed. I don't think we were shipping anything yet but there were a number or examples and prototypes.

Gardner: According to the prospectus, the first shipment was in October of that year so lots of 24-hour days?

Squires: Some, actually I before I joined MiniScribe I had signed up for a trip to China and so I went to work for Terry for a week and when I was hired I said "Terry I've got this trip to China planned. I'm going to be gone three weeks." It was sort of an unorthodox beginning but I did take off to China for three weeks or something back in '74. But not excessive. It wasn't an excessive work schedule in those days. It got worse later probably because then, I was an employee as opposed to a manager. It's the managers and the people who have more at stake that tend to do silly things.

Gardner: Were there any other managers except Terry at that time?

Squires: I don't think so, no. There were only seven guys.

Gardner: So Hoppe was the mechanical architect with Roy.

Squires: No Glade would be the mechanical engineer. Hoppe was more the mechanical designer.

Gardner: Okay.

Squires: So yeah, he did the drawings and of course he worked out a few details, and Rick Altobellus as well was a mechanical engineer.

Gardner: Who did the electronics?

Squires: I think that must have been Walk Oshetski along with Chris Adams.

Gardner: And possibly Terry himself?

Squires: And possibly Terry, yes, yes. I know, yes, Chris Adams was relatively junior but there were chips available and with effort and persistence some of these things happen.

Gardner: I don't know anybody in that group that that ever did anything with stepper motors.

Squires: Correct, right. I think when I arrived I never heard of a stepper motor. Yes. That's right. That was what Seagate had. It was just an old floppy disc technique we worked with.

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Gardner: What strikes me looking at MiniScribe is the proliferation of models. The MiniScribe I ships, but it's replaced the next year by MiniScribe II.

Squires: Right.

Gardner: And the MiniScribe III is announced the next year and it's one of four different half-height models, some with two heads per disc, some with one.

Squires: Right.

Gardner: It seems chaotic.

Squires: Well I suppose it was. I mean the market-- the big win, the first couple customers of MiniScribe were small guys.

Gardner: Who were they?

Squires: Tall Grass in Kansas City, Dave Allen? Do you know that name?

Gardner: No.

Squires: The famous name out of that company was Steve Volk came out of TallGrass Technologies. He was a dentist that went to TallGrass and TallGrass made controllers. Little controllers that sold. I guess we sold to them and they sold the package. But I met Steve at Tall Grass in '74 or something. And a San Diego company it had some initials but I don't remember the name. But then a big win was IBM. , We'd hired some marketing guys and we were knocking on doors at a number of places, but at that time, floppy discs were the standard storage device for S-100 bus based computers, 8800, is that right? That processor was typically an 8800, 8800 or something?

Hendrie: What? Oh the microprocessor?

Squires: Was it Intel or was it somebody else?

Hendrie: It was the 8008.

Squires: Yeah, 8008 and then the 8088.

Gardner: But the S-100 was sort of a bus standard?

Squires: It was a bus standard, right. CPM was the operating system.

Gardner: Right but it was supposed to be processor independent but it was dominated by somebody and I just couldn't recall whether it was the 6508 or an Intel microprocessor.

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Squires: I think it was the 8088.

Gardner: So you won the IBM contract with the MiniScribe II.

Squires: Yes, the twelve megabyte MiniScribe II.

Gardner: So what was the difference between a MiniScribe I and a MiniScribe II?

Squires: Well, a MiniScribe I was pretty much a knockoff of the Seagate architecture. You know it had TTL circuits. TTL chips to perform the functions and the MiniScribe II did put a 6801 processor which allowed a few improvements. One is it could connect to the ST506 interface, which was actually an extended floppy disc interface. The host would provide a pulse which told the actuator to move one track and of course, then the drive would go away and move one track and then later say, I completed that. If you needed to move more than one track it would do it again. So using a processor allowed the pulses to come in at a higher rate and buffer them and then actually, , we actually ramped up the stepper motor. I mean we tried to make it a voice coil type thing, because the stepper motors did have a limiting velocity. You couldn't go too fast with them and then ramp it down as it approached. So this allowed a slight access time improvements but it also allowed some spin control improvements. For instance in the MiniScribe II, I did all the spin commutation spinning out with the microprocessor. so there were fewer gates and switches and things like that.

Gardner: So basically electrical change? The same rack and pinion?

Squires: Same rack and pinion, same read channel, The interface was the same, there was no data separator or intelligent management of data so it was just more spin motor and stepper motor management.

Gardner: So it was basically a cost reduction and performance enhancement in things like seeking and start time?

Squires: Yes, yes.

Gardner: Not fundamental?

Squires: Right, right, yes.

Gardner: Not capacity or anything like that.

Squires: Correct, though I think we did double a capacity with that product.

Gardner: Well that's the sort of a thing that I find unusual.

Squires: Twelve referred it to the unformatted capacity, so a 12 was really 10 megabyte formatted.

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Gardner: Well the MiniScribe I was a 12 megabyte.

Squires: You're right. The Seagate product was five which is where MiniScribe thought they could compete.

Gardner: Right, Seagate first came out of the ST506 and that was with unbuffered seek, and then they tried to do a 512 which is sort of like you guys tried – they tried to put two heads on one surface.

Squires: That was later. I think Rodime came out with that idea and somehow we got a customer that said they liked it ., Just because of the access time issues. But actually there was very limited success with that product. We had somebody nickname it "the dog with four heads" in Spanish.

Gardner: You folks did it in half-high.

Squires: We did.

Gardner: So that way you got 12 megabytes on a single disk

Squires: Right. At that that time you know the head disc technology improved so it could have been a double capacity in a two-disc version but there's nothing about the two heads per surface that increased capacity. The two heads only use the same surface. The surface area had the data. So it just reduced the stroke length of the maximum seek.

Gardner: I agree with you but why did you do it?

Squires: I thought it was a terrible idea but marketing guys can fall in love with these sort of strange variations and I think Rodime had a product that did that and so it was like well Rodime's got it, we need it type of thing. And I think and I said it had a limited run, limited success.

Gardner: Yeah, actually Seagate first 512 was a 506 double track density.

Squires: It was.

Gardner: And they couldn't make it work.

Squires: They had the band which had its own intrinsic problems, you know, the stainless steel band instead of rack and pinion. And the band was positioning, it was all positioning. It wasn't amplitude or read signal it was just reliability of the positioning over temperature.

Gardner: So you moved from doing the tester then to actually doing code on the operating drive.

Squires: I did, yes.

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Gardner: For the two because that's where it had the microprocessor.

Squires: Yes, and that's when I did work a little, that's a little bit more.

Gardner: I'm sorry?

Squires: The longer hours. You were speaking earlier about did I put a lot of hours in.

Gardner: The longer hours.

Hendrie: Worked a little harder.

Squires: I worked a little harder. I suppose I had my name on it more.

Gardner: Because that was shipped the following year -- July 1982 was when the MiniScribe II shipped. And there was a big announcement at NCC in '82 also where the MiniScribe I goes away and now the MiniScribe II, III, and IV are announced.

Squires: Right.

Gardner: So what happens after MiniScribe II?

Squires: I think we did the half-high III series. The MiniScribe III I believe was half-high.

Gardner: Yes.

Squires: But essentially it was unchanged. I mean there was development in the spindle motor. That was a difficult area for that class of disc drives. Pabst out of Germany was sort of the leader in that area and they were supplying Seagate so we were pushing some technology in the spindle motor and the half-high just because of the reduced bearing spacing issues, it had issues but-

Gardner: You went through a whole series of models. Ultimately you guys were very successful in the half-high five and a quarter, but it was your fourth try.

Squires: Was it? No the models, I don't recall the model numbers.

Gardner: Okay.

Squires: To me I think well, I don't remember any big distinction between the milestones. One was blue and one that was red or there were fundamental differences so I don't have something I can really-- you know, it was really just an extension of the MiniScribe II technology. There were actually no particular difficulties in the half-high. The spindle motor was a bit of a challenge. The electronics were really very

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similar. Everything was very similar, so while you may be correct in what you just said I don't have direct recollection.

Gardner: Let me show you two pictures, three actually.

Squires: Oh we did have a 3025 but that was a double capacity. Ah so it is a media issue related, yeah.

Gardner: Yeah, so the one on your left is the MiniScribe III. That's the first one and I'm pretty sure it's one disc with four heads although you can't see the heads in the picture.

Squires: No, no. No, no. The architecture that had the two heads per surface is shown in the center. And that's they all look like that. The heads were side-by-side. It was disaster. It is what it is. So that appears to be a plated media as well.

Gardner: I think the three, that's why the MiniScribe III is a very strange picture because the literature says it's plated but it's clearly oxide.

Squires: Right, it does. I mean it is clearly oxide. I take your word about that, what the literature says. Yeah, we also, I mean the very first MiniScribe I had nickel zinc elements in the head and MiniScribe II went to manganese zinc and some of these things you know were sort of like well, they both worked. One worked a little better than the other and so I think that may apply here as well where the oxide worked, I mean the plated just had a stronger signal.

Gardner: What's really bothering me is the 3412, is that the one that has a two heads per surface?

Squires: It is.

Gardner: But your really successful product was the 3425?

Squires: Yeah, the M-III was just the half-height version and really the big challenge was it was a spindle motor and that was and then of course the plated media started to become available and so that was put in and used.

Gardner: But initially you could only get a single disc in the half-high form factor.

Squires: I'm not sure. I'm actually confused about that at this point.

Gardner: I think if you look at the 3425, I think you described it as different mechanics.

Squires: I did.

Gardner: And that was a very successful product compared to the prior ones.

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Squires: I don't have a memory of the marketing, how successful it was.

Gardner: Yeah. In fact the whole industry went from full-high to half-high.

Squires: With that product? Okay.

Gardner: And Seagate had a version-

Squires: Maybe I was working too much to really notice that impact.

Gardner: So what were you working on if you weren't working on that?

Squires: Probably one of those things like childbirth, I probably blanked it out because it was so painful.

Gardner: Stepping off the current subject and jumping way back, married? When? In Germany? A German girl?

Squires: No, no. American girl but I got orders to Germany and it's like she said, "Gee if you go to Germany and we don't get married, you may not be interested in me when you get back," so we got married. So yes, an American girl.

Gardner: Took her with you to Germany?

Squires: Yes, she moved over and we had a son over there and we came back.

END OF TAPE 2

START OF TAPE 3

Gardner: Married. One child?

Squires: At that time, yes.

Gardner: At that time. Subsequent children?

Squires: Yes, yes. I have another boy.

Gardner: Uh-huh, two boys?

Squires: Two boys, yeah.

Gardner: Both moved on to?

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Squires: One's in high tech, the elder one. He's 37 now. And yeah, the younger one is involved in his mother's father's business, which is building fiberglass-- structural things, like they're building a bridge, yeah, out of fiberglass for a highway, you know. So fiberglass is way stronger than steel in some applications. And so, he's doing that right now.

Gardner: Does he drive across his own bridges <laughs>?

Squires: Yeah. Well, they take a tank across these bridges. Yeah, it's funny. Seriously, fiberglass has some surprising properties – Not well known.

Gardner: So we're returning back to MiniScribe and half highs and full highs. The 25 megabit half high product was very successful. Were you involved in that one?

Squires: Sure. Well, I was involved in all of them. But, you know, there was a lot of leveraging going on. So, you know, the model numbers mean much less to me than, some of the concepts and things like that. But it was still the MiniScribe 2 architecture with a microprocessor and, you know, the ST-506 interface, relatively simple. That was mostly a mechanical, you know, improvement to go with a half high.

Gardner: What were you doing?

Squires: I don't know. Probably code and test software and a little bit of customer interface.

Gardner: Solving problems?

Squires: Possibly, yeah. Probably. But yeah, things start to roll fairly quickly. And they've been working on that next generation, the M-4, which was just the next capacity point, things like that.

Gardner: Actually, the M-4 was a two-thirds high.

Squires: Oh, was it? Okay.

Gardner: Yeah, that was sort of a brief non-product because Shugart Associates had a two-thirds floppy, but the half highs killed the two-thirds. The next big two products at MiniScribe were the three and a half inch and there was a 6,000 series?

Squires: And that was about the time I left MiniScribe. I was running a three and a half inch program. Yeah, I do have a few stories to tell about that because…

Gardner: Before we go into three and a half, can we finish any stories about the five and a quarter?

Squires: No. No, not that I remember. Nothing jumps out at me. To me, the half high was a logical progression of, you know-- there was nothing architecturally different for Apple, from like an HP or…

Gardner: Okay. You were still an individual contributor or now managing a group?

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Squires: I'm not sure, probably individual contributor. But again, at that end, it was still small enough to be fairly loose. But when I did go three and a half, I did kind of form a little group, so then I was the manager there. But I don't know if I was manager before that. How funny. I don't remember that <laughs>.

Gardner: And your involvement in the big sale to-- the big win was the sale of the MiniScribe 2 to IBM.

Squires: It was.

Gardner: Make a lot of trips to Boca?

Squires: I did. I did make quite a few. And that was a big deal because, IBM sort of invented the industry. I mean they invented computers from our point of view. I mean they invented everything. And I mean to sell to IBM was sort of the ultimate compliment. That's what we felt especially since they, you know, had their own disk drive division. I guess they just weren't as far along. But there was nothing special. I mean I guess there is one anecdote that is worth relating -- IBM announced the personal computer and were ordering drives from Seagate and MiniScribe. And, you know, both companies were happily chunking along making drives. And I think we started some production in Singapore at that time for manufacturing costs. And one day, when I spoke with Finis-- the way Finis tells a story, he says, "Somebody opened a warehouse and saw it was full of drives." And he said, "Call up both companies and tell them to stop shipping" <chuckles>, which, you know, sent this shockwave through those two companies. But I ran into Finis at one of the Comdexes That was the first time I met him. I was with Dale Carson who was the MiniScribe salesman responsible for IBM. The culture of MiniScribe was conservative, you know. If you know Terry, he's a conservative guy and he's a straight shooter. And of course, Finis was something in the other direction. He talks about contracts on bar napkins, so much looser. So we were discussing after this event, the impact on various companies. And Finis says, "Well, I called him back and said, 'I can't stop. You got to keep going, all right.'" So MiniScribe played by the rules and Finis kept shipping <laughs>. It turns out that, you know, the warehouse bubble was really a bubble and that IBM had-- again, their manufacturing, you know, skills had not, in this arena, worked well. They really did need the drives but it just about took out MiniScribe. But for Seagate it was sort of a ripple. They weathered it considerably better just through the way that they managed the customer. And I thought that was-- I was very impressed by the way-- a response to a bad situation can have a major impact. And of course, eventually MiniScribe starts shipping again but, you know, there was a considerable amount of layoffs and things like that along the way. So that was my first interaction with Finis, which-- you know, he had a big reputation. That was my firsthand experience of how the other side, the human side, of business. And I was more in the, you know, engineering side as was Terry. You know, Terry was an engineer converted to company president.

Gardner: Any interesting stories out of Boca, your personal trips down there?

Squires: No. It's one of those things. It's like you hold IBM in awe and consider them to be infallible and things like that when actually you get up close and personal, there were quite a few warts in the organization. They were actually learning about the business, you know, not much faster than we were. And so, that was in my opinion, it really was a new industry, the personal computer and they also had a lot to learn. We all learned and perfected so many skills. That was a surprise. I mean when they sneezed, you know, we watched which direction they were sneezing in and sneezed in the same direction because

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they had the reputation of being ahead. And subsequently, to everyone's shock they got out of the business. It's like you can't do that. You're IBM <laughs>.

Gardner: After the IBM order, MiniScribe went public. Do you have any comment?

Squires: Oh, there was a heady time, as you can imagine. I mean none of us had ever experienced, quote, "going public." And it was a lot of fun and Terry had, given people stock options. And so, there was a little, as Finis used to say, green in the jeans <chuckles>. And there was fun. That was a very innocent time, that you don't find today, you know. Now, stock options in start-up companies actually sort of don't have the value and all the attraction that they once had. People are more realistic and less idealistic, I suppose, about, what's possible with start-up companies.

Gardner: Were you involved in the road show at all?

Squires: No, not with MiniScribe.

Gardner: Yeah, that'd be probably just Terry and the CFO.

Squires: Yes. I remember going-- that would be fun to go on, you know. And I did go on the Conner road show, which was fun. But no, I didn't.

Gardner: So sometime you said-- I think you started working on the three and a half?

Squires: I did. Yes, I did. I had…

Gardner: That was MiniScribe 5? What was it called internally?

Squires: It had a name. And I'll have to think of it. We didn't use numbers to anything back then. We just used their product names. But it had a bizarre name. Yeah, it was a rotary actuator. It was a voice coil. Oh, I'm sorry, the-- well, the M-8-- I'll take it back. The M-8 was a stepper motor three and a half. And that was a big deal. I skipped a whole section. That was a big seller and we sold a lot of those.

Gardner: That was huge, yeah.

Squires: Yes. We made two disks…

Gardner: Three and a half inch. Ampex media?

Squires: Yes. That was Ampex media because of the-- you know, that we kinda needed the performance of metallic media. Oxide wouldn't do it because we were doing the same capacity on a smaller one. But I guess the little anecdote that-- Rodime was first with the three and a half inch. And what they had done was take a five and a quarter inch disk and cut it down to 96 millimeters. But basically, it was a five and a quarter inch disk. I called up Sanjoy Ghose at Seagate at that time, who I actually have not met but we did talk on the phone, and said, "Well, we can do a three and a half. I know you guys are too. What do

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you think we should do about the disk?" And my mechanical guy, who is Scott Robidart, said, "I need that to be 95 millimeters. I can't make it fit with 96," which is where Rodime was at in mechanical packaging. So I said, well, we want it at 95 and we'd like to go thinner just because it makes sense because it was-- I think the five and a quarter inch disk was 75 mills thick. And so we wanted to go to 50, just for weight, you know. And the stiffness requirement was less. And then we wanted to, you know, make the inner diamond smaller to get more. So the current surface is-- so we picked the 25, you know, the five and a quarter and 40 millimeters form the I.D. So Sanjoy Ghose and I over the phone kinda set the standard. And then we got the disk companies to just sort of build that. And that's how the standard got set <chuckles> over a single phone call like that, ordering the size of the three and a half inch to the size...

Gardner: That's a huge story because Rodime…

Squires: Yes. Yeah, I know all about that <laughs>.

Gardner: But I mean that media became the industry standard. The industry had a disaster with the eight inch where everybody had a different, you know, inner I.D. or outer I.D. or both. Seagate forced the five and a quarter to be standard. But Rodime didn't do anything. Did you and Sanjoy do anything special beyond just to agree upon the numbers?

Squires: It was like a seven minute conversation. That was it. And then we went to Ampex, whoever, and said, "Sanjoy and I, we agree it should be this." And they put it on the disk spec, just kept going and started making them.

Gardner: You must have at some point sent your ANSI reps off to the ANSI Committee X3T9?

Squires: We didn't have any of that. No, I'm sure that happened but I wasn't involved. I was not involved in that, you know. Just the basic dimensions are what I'm talking about, you know, that we just-- 95, 25, 50, you know. That was it, three numbers.

Gardner: Well, it's huge. I'm pretty sure Seagate then used the ANSI committee to force an ANSI standard in that area.

Squires: Yeah, we were at Colorado, somewhat away from the center of gravity in the disk drive industry. And if we could the vendor, in this case, Ampex, to make the media, we actually sort of didn't care too much <chuckles> about standards and committees. And it was more if the supplier would go along because the supplier, you know, Ampex, they had been part of that whole let's make this a standard. But really the first guy to show up with a P.O. gets, consideration as being the standard.

Gardner: When you look at the history industry, there was this chaos in the eight inch. And then Seagate forced the industry-- or lead the industry maybe is a better way to say it.

Squires: Well, they did the first product. I mean they had the first five and a quarter. I mean that's how you do it. That's how you make things happen.

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Gardner: But Rodime had the first product and they didn't make it happen. And that's sort of the distinction. How did you guys make it happen? And it's a delightful story.

Squires: Well, I think Rodime was just going to their supplier, you know, Dysan or whoever it was because I believe they were still using iron oxide. I just said, you know, take a standard disk and cut it down, just cut down the blank. And so, it was an easy deal for those guys to make. There was no retooling, yeah, no new machines. And we said this is a bigger deal than, a quick and dirty fix. Let's do it right, I mean. And they probably got it pretty close to right in terms of the numbers.

Gardner: Right or wrong, that's not where the industry went

Squires: Yeah. And so, the required tooling for these guys, retooling. And so, Rodime, I think they couldn't have made it a standard because there was nothing to really make a standard. It was just a five and a quarter inch disk cut down. I mean they could have made it standard.

Gardner: Well, for example, SyQuest tried to make a 100 mm a standard. And a lot of people were trying in that time period-- and the truth may be it's as simple as MiniScribe and Seagate, two of the three largest companies in the industry agreed -- who is going to disagree at that point because the Rodime diameter was not such a good choice. I don't think Seagate was doing any metal media at that point.

Squires: I know. And in fact, I don't even think they had-- they probably had an active three and a half inch program but it wasn't as far along as we were. I think we were ahead. That's my recollection at that time.

Gardner: Yeah, I think MiniScribe then went on to dominate the market segment in three and a half but because of capacity issues it wasn't a large market until Conner came along. But the product itself was probably the most successful three and a half until Conner comes along and then there's a whole new story.

Squires: You have probably a bigger perspective than I do. I mean when you're in the trenches you don't look out. You don't stick your head out above very often. And you were out wandering the battlefield and probably saw more than I did.

Gardner: So while you're in the trenches on the three and a half, what monster did you overcome?

Squires: It was density. The big thing was thermal track positioning because it was an open loop system, right. Oh my God, you know, you had to overcome things in the microprocessor-- I remember I got involved the tiniest bit in doing some off track stuff. If we could somehow infer that a retry was in progress, from the host, we would do a little shifting around on the off track. And we actually did it in diagnostics. We actually checked the off track read performance, so things like that. So we did a little bit of that...

Gardner: So if you saw a re-read to the same sector…

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Squires: Yeah, I don't remember the details but we were-- yeah, there was some goofy stuff going on because we were pushing-- yeah, you're just trying to use what you got to do what you can and push things as far as you can. So it was that.

Gardner: Still rack and pinion?

Squires: It was, yeah. So you had the rack and pinion, you know, which was actually terrible designs at some level, but, you know, it worked. You know, Roy was a clever guy and, you know, it actually had fewer problems than the band, the path that Seagate followed for all their stepper motor drives. So even though it used to spew out, you know, lubricant and things like that, there was-- and the shape of the teeth was very critical and things like that <laugh>, it worked. And people used to go, "This can't work," you know, and all that stuff.

Gardner: Let me guess, you crush ground the rack[1]?

Squires: Yeah, I think so. Yeah. But the real problem is, you know-- gears are really fascinating because if you have gears with the same metal, when they wear, they wear to the perfect shape. But the problem is the shaft and the stainless steel and the rack was aluminum. So, you know, you had to really get the shaft correct otherwise the rack would wear in. We'd have to wear in the rack during the manufacturing process to get the shape just right, things like that.

Gardner: And then every tooth had to be just right.

Squires: Oh, yeah. And then, you know, there was the half stepping thing. To double the capacity, you know, the number of steps per revolution of the stepper motor was, you know, I don't remember, maybe 200 or something. And you had a certain number of stopping positions. So you'd play tricks with half stepping, which was to position it in between the nulls of the stepper motor and things like that to get double the tracks. So there was micro code stuff going on in that area. There was even some pulse width modulation going on, all microcontrolled or managed again.

Gardner: You were involved in…

Squires: Yeah, you know, sure. Yeah, I did that stuff. I was sort of-- yeah, I guess I was the, you know, architect, I mean, in that sense, you know, the systems architect. Not so much mechanical stuff.

Gardner: Now, you seem to have successfully used the Ampex Alar.

Squires: Well, you know, my recollection is that we probably were successful. I mean if you talk to a manufacturing person from the company, they may have a different perspective <chuckles>. But I felt yes, there were issues, you know. There were issues with Alar. And of course, you know, Alar, they were learning. They started out with-- I mean I made many trips to Ampex that had to do with texture and then the thickness of the lube and the testing, you know, the defect certification and things like that. But I consider, you know, for the time, that's a successful, you know, product. I mean every M-8, every three

[1] Editor's note: Roy Applequist used a crush grinder to manufacture the racks used in the Memorex 630 and 660 disk drives.

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and a half inch drive shipped was, you know, with that plated media. So, you know, I don't know how many we shipped, I have no idea, but there quite a few.

Gardner: And there was never a retrofit for oxide media that you know of?

Squires: Well, you know, oxide rose to the challenge -- they were improving the coercivity and improving the magnetics of their product. You know, we may have had some oxide in one of the products. It wasn't main stream. And I don't have a strong memory of whether we put oxide into the M-8. I know we put it in experimentally. I don't know if we shipped it.

Gardner: No. It's other people had reported difficulties with Ampex. Most of them that I'm aware of were five and a quarter. And I wonder if-- or maybe it was just later. Three and a half is later and they solved their problems.

Squires: I think that's part of it. Yeah, I mean Ampex was, as I said, learning. They were improving. I mean they were-- and so, yes. And I know there were-- some companies had jumped on the five and a quarter inch plated media fairly quickly and heavily and did suffer as a result. I don't remember an excessive amount that we did for Alar for <chuckles> the part of the trench I was in.

Gardner: That's good to know because Ampex has a terrible reputation in the industry for Alar.

Squires: Sure. But on the other hand, they were the pioneers. They're the guys with the arrows, right.

Gardner: Plating is a cheaper process than sputtering, but plating is so denigrated because of the Ampex problems that it just died out. No one makes plated media today. And yet, you know, here we have a success story.

Squires: But that is the performance issue. I mean it would sputter and you can do so much more than plating. I mean you can control the-- everything, the thickness, the composition so much more. So I think sputtering was the natural evolution of improvement. I don't think-- you know, the Ampex problems were never magnetic. You know, they were always the tribology, the head disk interface. And there's nothing about sputtering that's inherently better. I mean carbon sputtering hadn't come along[2], you know, at that point. So carbon, it did solve a lot of problems. But, you know, the substrates were made and then they had to rough them up so that the heads didn't jaw block. So that technology, you know, had some hiccups so to speak, you know. And then, of course, to help out, you know, there was a lubricant added on top, stearic acid. And that, you know, had issues and of course, you know, flying height and all that stuff, operating temperature. I mean everything entered into the equation. So, no, I think we shipped a lot of Ampex through the 95 millimeter media.

Gardner: I don't think too many folks in the industry realized that it was successful for anybody. And that's interesting.

[2] Editor's Note: SyQuest began shipping carbon overcoated plated media in the early 1980s but the technology was not well known at the time of the MiniScribe 8425.

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Squires: They were good guys. I mean, you know, I thought they were trying hard. I mean that's really what counts in this industry, is your supplier is trying hard. I mean you can get by with a lot if you're trying hard <laughs>.

Gardner: We've been talking about Ampex and its success for MiniScribe. Getting near the end of your time with MiniScribe, two other late programs, the M-8 and the M-6?

Squires: The M-6 was a high performance voice coil drive. We had hired some heavyweights out of storage tech, Bob Abrams, you know, and Charlie Sander and those guys, who'd dedicated servo experience. It was called servo experience. We were stepper motor guys so to speak. And they went off. I mean we went off first. I mean CDC had, you know-- I mean there was some voice coil high performance drives showing up at that time. And so we had the M-6 linear actuator, which had its set of problems just because of the shock and vibration issues. But it worked. And that was a-- as, you know, it happens in these companies, you know, you would start to target different markets. And that was targeting the higher capacity, higher performance market. And the M-8 was more the portable, you know, going after the Compaqs and what we felt was the new generation of portable computers.

Gardner: And your involvement in either?

Squires: I was very little involved in the M-6. I kind of did the M-8. And then this other product, whose name I've not yet recalled, which is-- didn't come to-- well, I left in the early part of it. I did the basic mechanical and electronic architecture. And to a certain extent, some of the ideas-- the direction I was going there was continued at Connor. So it was clearly the way to go. It was an embedded servo product, rotary actuator, three and a half inch, two disk, I think, a half high product.

Gardner: Your role in that? You were responsible for it? You were doing firmware?

Squires: Yes. No, I was responsible for everything on that product. I had a small team. It was more of a back room thing. If I remember I was a little bit itchy and, you know, wanted to do something different I mean than what I had been doing. And this was intended to be an intelligent drive and a skuzzy drive and things like that, so that challenges there appeal to me. So the M-8, you know, really had a limited set up, you know, electronic challenges. This was a big, new direction.

Gardner: And the M-8 is the half height?

Squires: Three and a half inch half high, the 8425.

Gardner: Right. Okay, that was announced while you were there?

Squires: It was. Yeah, we shipped a lot of them when I was there. Yeah, the M-8, right.

Gardner: Any key guys you want to identify.

Squires: Well, Scott Robidart, as we talked about, was mechanical engineer-- Steve Ray was his mechanical designer. I'm trying to recall some electrical engineers and other people on it, possibly Lou

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Shrinkle and also Ron Ruckert , who is the name that Juan was trying to think of, that came out with SDC. Ron Ruckert was a read write guy. Three of those guys were involved. But it was a relatively small team. I mean in those times, you know, the teams tend to be small. Today, you know, a disk drive is a major, you know, deal <chuckles>. You know, 50 guys are not enough to do one. You know, in those days two key guys were what you needed -- because it was much simpler. So no real stories other than-- well, I mean one time, I was working Saturday and I was in a less than, happy mood. And Terry, at that time-- Terry Johnson had just gotten into flying. And he knew I was a little bit, you know, antsy or something like that. He said, "Go get your pilot's license" <laughs>. So I mean one thing lead to another and I did. But that was intended to keep me from thinking too much about disk drives, I suppose. So that was-- but I went to Conner and I took one flight. And I said, "I'm either going fly or do disk drives." I can't do both <laughs>.

Gardner: The 8425, the three and a half, is really unusual because apparently it began shipping in late '84 but wasn't announced until '85. No recollection about that?

Squires: I can't shed any light on that.

Gardner: Yeah, the official announcement date, you know, I have a copy of it, is April 8, 1985. But according to the annual report and according to this announcement, it was actually shipping in late '84 to selected customers. Nobody does that in this industry.

Squires: Not anymore, no. But not anymore and it's when you need customers is when you announce it, right. I mean we must have had enough customers. But, you know, MiniScribe's-- you know, they talk about the three legged stool of a disk drive company, the engineering, operations and marketing. And MiniScribe, never really had-- they had lots of marketing guys but it was never their forte. I mean whereas Seagate was sort of known for marketing. They had Finis so they knew how to market things.
I don't think MiniScribe could have, sort of ever developed marketing concepts and things like that. They tended to focus more on the engineering side of things and then, of course, the operations, which you need to have. So, that lack of announcement may have just, you know, been an oversight <laughs> almost. But I don't think there was-- you know, it just means the marketing guys weren't at the top. I mean they were…

Gardner: Well, it was also during a time of turmoil. I mean the IBM order is cut back. Terry resigns.

Squires: He does. Yes, I think he left toward the end of the year.

Gardner: Yeah, that's '84. I believe Terry left around October or November, which is probably about the right-- about the time the product started shipping according to the-- and the IBM cutback was earlier that year. And there were a series of layoffs. So maybe there's no one around to make the decision.

Squires: Oh, no, Terry was fully involved. You know, he'd tell the story, he made the decision overnight. You know, he went in one weekend and cleaned his desk out <chuckles>. Nobody had anticipated that. But he hired in that time frame a new president, Roger Gower, I think the name was. So he had paved the road for his departure. But he felt that, he was not the right guy. I mean we were entering into, you know, a more difficult phase of the company with, being bigger and having more, you know, need for structured environments and structures, you know, normal corporate structure. Like I said, Terry, it wasn't his strong

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suit, so to speak. I think the board of directors, who included, you know, venture capitalists were putting a little pressure on him to-- so he just said, “Oh, I’m not the right guy to go on” and then left.

END OF TAPE 3

START OF TAPE 4

Gardner: So ’84 was a difficult year?

Squires: Well, ’84 was difficult. I left in ’85.

Gardner: The end of ’84 is when the three and a half inch products started shipping but no one announced it, which is a remarkable incident. So what happened after the three and a half inch?

Squires: Well, as I said, I started off on a small back room project to do this, intelligent interface, it would have been SCSI, higher performance three and a half. And I had a small team of people. And we were building a mechanical model with some things like that. We were learning about pack writers and stuff like that. So I had, you know, Mark Stefanski . He was a mechanical designer but was strong enough to actually sort of take the lead and be the mechanical engineer. And obviously, I did a lot of the architecture and the electronics. And we were working, , down that road when the financial situation and things like that had continued to sort of go down. And MiniScribe acquired an infusion of $20 million from Hambrecht & Quist at some cost of loss of control. Specifically, I think Hambrecht & Quist, started to dominate the Board. I wasn’t too close to that. But Q.T. Wiles came in then and took the reins so to speak and then brought some discipline, brought some ideas and directions that he felt were the right thing to do.

Gardner: Well, Gower was still president.

Squires: He was. Yes, but I think he got replaced. I don’t remember that.

Gardner: Actually, Gower and you left apparently about the same time, he must have left after you but it was the same month.

Squires: Q.T., at that time was CEO of many companies, like more than five, maybe 10, I don’t remember-- I remember being overwhelmed by the number of companies that he was somehow over. Many of them were sort of turnaround situations, companies in trouble. And he had a team of people that he brought in. And he brought in a new president. And a part of the structure of his company was to run quarterly meetings, which he called Dash meetings where everybody got up and essentially answered embarrassing questions <laughs> and they reported on the situation. And, what today might seem somewhat naive but, you know, disciplined. I mean a disciplined approach to the business, a maturing of the business. I mean it had been homegrown by engineers. And engineers are not known for their love of bureaucracy, so they <laughs> probably needed a little bureaucracy. Obviously, I was in the company but I went and basically sat through the first Dash meeting without being a participant. And being a participant means sitting essentially in the hot seat and being grilled and I did resign the next day. I think some of the stuff is good. I think most of it’s good but it’s just like it’s just not what I want to do. It’s a different company. It’s a different-- and I suppose part of it was, you know, engineers ceased to be the Gods and the businessmen became the Gods. And so, it was starting to be run as a business as opposed to an

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engineering endeavor, which is the environment that I, you know, matured in. And I was obviously loathe to abandon the ideal of the engineering principals and things like that.

Gardner: And this is all within two months?

Squires: Right.

Gardner: Because I think Q.T. Wiles joins the board in May and Gower is gone the last day of June. You left in June. So the Dash meeting must have been May or early June.

Squires: Yeah, it was right then, probably June 1 or there abouts. I don't recall.

Gardner: So he must have been using Gower's organizational structure.

Squires: Right. The Dash meeting was, Q.T.'s really first appearance at the company. And the imposition of the structure that he wanted them to follow. So, yeah, I left and, you know-- but MiniScribe had gone through some tough times. And, you know, there's always soul searching about, , seeing your friends leave and whatever, which had happened. So I was not without ideas of my own of leaving though I left without a, you know, clear plan. , when you're young, you don't need plans I guess. Well, the next step was I was living up a Canyon here nearby. And an idea sort of slowly developed. Actually, the day after I left, I think Terry called me and said, "You know, I'm going to Russia tomorrow," because he was in a traveling phase at that time. And he said, "But, if you want to do something, I'll help you out" sort of thing. And so, I was very sensitive to the fact that I had been working on an intelligent drive at MiniScribe. And so, I was concerned that, if I did start something in the same line that that would be-- you know, you don't get sued unless you're successful. And if you are successful, you will get sued.

But I wanted to at least minimize the exposure there, so I approached Q.T. and said, "You know, I'm doing this thing on the side. And if you guys want to invest some money, I'd be willing to take it. And, you know, I'll give you first rights on the design" and things like that, you know. It was a bit of gamble but I actually anticipated that I would be rejected and was actually hoping that they would reject me. But I felt that it gave me some distance from-- or some position to have that, you know, should I be successful and should they, you know, decide that I had actually appropriated some MiniScribe technology or MiniScribe-- you know, something that I had worked on at MiniScribe. But, you know, those things are always very subjective <chuckles>-- so it turns out my approach was successful and that I did avoid a confrontation with MiniScribe even though they continued on the project that I'd started and put a new manager on it and good engineers, you know. As all good engineers decide, you know, that that guy that just left, you know, didn't really know what he was doing. So I happened to be the guy that just left. My offer was soundly rejected <laughs>. And the company I started, you know, went on to be quite successful.

Gardner: Any recollections from the first Dash meeting other than you quit the next day?

Squires: It was a combination of intimidation, humiliation and, you know, threats. I mean it was a very intense meeting, which as you could imagine. A turnaround situation, they're tough. I mean people get fired and there are projects that get cancelled. And it's a tense time. I mean you're trying to figure out to best spend your $20 million and make sure it's sufficient to turn the company around. So it's a very tense time. And it was a tense day.

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Gardner: I'm told that the Q.T. Wiles' style at those Dash meetings was very intimidating.

Squires: Yes. I think that's-- and he's a very clever guy. And so, when you're clever, it's easy to intimidate <laughs> people. So it was. I always remember another-- it wasn't that Dash meeting but later, I went to one of the board meetings of MiniScribe and it was in Denver. And there had recently been a "New York Times" article about Q.T.'s style of management. It was literally front page. But anyway, there was a reference in this article to Q.T.'s managers being zombie-like. I mean it was literally on the front page about, you know, zombie in the sense of, you know, following orders and things like that. And anyway, during the meeting, Q.T. was doing a very informal, easy going presentation to the shareholders at the annual meeting and was introducing his senior staff. But I mean he did something and made some guy stand up and sit down a couple times. And he turned to the audience and said, "See what they mean about zombies" <laughs>. I thought that was a little low brow. But, you know, I mean he had his faults but he was also brilliant in many areas. I won't take it away but his style was not a classic engineering style, you know, of respect and for your fellow man or whatever.

Gardner: Did he fire anybody at that meeting?

Squires: Probably. Yeah, not serious. Not that stood it and he may not have but it may happen very shortly afterwards. And he had been known to do that, yeah.

Gardner: He definitely had a reputation for intimidation -- I don't know whether it's a true story or not but I'm told that at Dash meetings, he would literally fire people and take away the return ticket when they were in Palm Springs.

Squires: Yeah. He may have -- maybe I was in shock that I don't recall but it doesn't stand out. But it was intimidating.

Gardner: The last thing he did and maybe you'd already left was he reorganized the company into operating divisions. It was a full height division, a half height division.

Squires: Yeah, I had left.

Gardner: Anything you'd like to sum up on MiniScribe?

Squires: Well, it was, you know, a fantastic experience. I mean it was a true start up in the sense of start-ups, which one doesn't find nowadays at least in a hardware company, you know. A couple guys see an opportunity and, you know, manage to somehow pull things together. I mean it was an immature industry so there were opportunities. In looking back, it was a necessary step to, you know, the next phase. And I have a lot of friends and respect. And everybody's gone on and graduated, a heady time. And I was just there four years but a lot happened in that time.

END OF TAPE 4

START OF TAPE 5

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Gardner: Tape five of the John Squires interview on July 15, 2009 in Boulder, Colorado. The last tape ended, John, I think you had left MiniScribe and were thinking of founding CoData and talking to Q.T. Wiles.

Squires: Right, right, right. Just too quickly summarize. I think that I spoke about the delicate balance involved with leaving a company-- and as I said at that time, I didn't really have plans, but I did have sort of an interest in doing something. And that usually involves founding a company, and obviously in the same general area I had been in MiniScribe. So there's a balance that has to be found in that transition, and I spoke about the way that I had approached Q.T. as a potential investor, and as a potential customer for the company's product. Because we didn't have a real structure in mind that we'd be a manufacturing company at that time. So just the mechanics of the founding of the company, somebody from-- out of MiniScribe the mechanical engineer-- he's actually an designer, but he was a good engineer as well, Mark Stefanski , and Tom Fiers, who at that time was at Amcodyne, which was an eight-inch disk drive, removable disk drive company right next door to MiniScribe. We had many friends down out of Storage Technology in the company.

Gardner: Would you repeat that second name, please.

Squires: Tom Fiers, F-I-E-R-S. The three of us, you know, we sort of-- Terry spoke about, you know, one guy showing up on Monday morning to start MiniScribe. This was sort of a similar story with, you know, when you have two people you've hired out of gainful employment, you actually sort of need to get serious about things. So we went out, and on a relatively small amount of money initially, like 10,000 dollars, <laughs> we actually, you know, purchased an oscilloscope, and Terry volunteered his guest house, and we-- which was also a barn, so we had the lab in the garage, and you know, bedrooms were offices, and the kitchen was a conference room and things like that. And so it was-- and Terry, we used to smile at Terry as he drove by every morning, or a couple times a week with his trash can on the hood of his Mercedes, 'cause he lives up at the end of a long driveway, and he had to take it out to the main road. So it was definitely, the startup was literally 50 meters from the place where MiniScribe started, which was in his basement of his main house. So there's a little bit of, you know, nostalgia there. We were-- the initial source of funding was myself and Terry, but we also said-- we had a list of people that had invested in MiniScribe, made a little bit of money, and that were-- that Terry knew, and we actually approached them. And Terry's idea was to approach Finis, just because I think, Terry had some insight that, you know, marketing wasn't important. You know, engineers tend to think of marketing as, oh, not very important. And I can add to that, but you get the idea. And so they don't focus on that. But I think Terry had the insight that, you know, this was a marketing challenge, and especially in-- there's a story about the Comdex, that would have been in the Fall of 1985 where the venture capitalists were not overly receptive to the idea of funding another drive company. They'd lost some money in the IBM hiccup with companies, and the market in general, and there were a lot of startups, as you probably remember, Tom, in the disk drive industry. Everybody that sort of knew how to-- was very smart and had a good idea was starting a disk drive company, or had started it. There was some consolidation and failures.

Gardner: I think Jim Porter says that 1985 is the year the industry peaked at about 85 or 90 companies?

Squires: Yes, unbelievable. Just parenthetically, — at the Integral turnaround somebody from Quantum, I always thank them for doing this-- had gone and analyzed all the disk drive companies. And at that time, because Integral was sort of a turnaround situation, had counted 200 companies that had exited the hard

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drive business. And that included the large companies, <laughs> like Digital Equipment. Well, anyway, so it turned out Terry flew down in his airplane-- he had a little Bonanza-- to Palm Springs to meet Finis.

Gardner: This is post-Comdex now?

Squires: Yes, this would be in December of '85, post-Comdex. We had a little fire on the plane on the way down, had to do an emergency landing. <laughs> But it worked out, and we arrived, and showed Finis what we had, which was sort of, you know, it was a sort of a breathing product, but you know, very labored breathing, and asthmatic breathing, but it was there.

Gardner: You were in form factor?

Squires: Yes, yeah, basically.

Gardner: Had electronics working, maybe not reading and writing well?

Squires: Right, yeah, something like that. You know, I don't remember the exact details, but there was something there. We had been going since June, and this would be December, and you know, three guys, we made good progress.

Gardner: I'm impressed you had a circuit board in form factor. I mean, that sometimes can be a challenge.

Squires: It can be! It can be. And it may not have been doing everything, I just don't remember. In fact, we had more than three guys by that time. We had at least five. But so Finis listened to us, and was interested. And but in the conversations with Finis and Terry, sort of became clear that they would not both be involved in the company. And that was probably just because they had radically different styles of doing things. You know, Finis saw things from a marketing perspective, and Terry saw things from an engineering perspective, and so one of the difficult moments I had was, you know, soon thereafter, probably in January, I had to actually sit down and make a decision whether I was going to go with Finis or with Terry. And I was in Terry's guesthouse, and Terry and I had known each other, and were friends, and I'd been with him for four years at MiniScribe, and I ended up picking Finis! <laughs> And I think part of that decision, I spoke with the employees, and they said, you know, "We gotta make a call here." It really came down to we'd been with Terry at MiniScribe. I kind of knew his style and how things worked, and Finis was sort of an unknown. But I figured if we'd go with Finis, it was the space shuttle had recently blown up, I think on launch, and it was about that time. So it was going to be like the space shuttle. It was either going get into space, or it was going be this huge explosion. And it would not be a long, protracted, slow demise if we-- so we went with Finis, and of course, Finis, for me, represented the quintessential marketing archetype, I suppose, stereotype, and flew in his Learjet one day, and landed, and you know, visited the team in Longmont. And I remember him complaining about the fact it was four degrees in Colorado at that day. <laughs> He was in his Palm Springs T-shirt. He and I left-- there's a short little side story here. We left-- he wanted me to go to Phoenix to see about sitting up a manufacturing plant there. And as we left Jeffco , which is nearby here, the airport where his plane had landed, we were flying out at night in this storm. And Learjets are just this incredibly unreliable scary plane. They had wings, you know, about as long as your arm, and fuel pods that are as big as the fuselage on the tips. And we're getting buffeted around, and thrown, and Finis is as calm as a cucumber. And he says, "Well, what do you want

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out of this company, John?" And I said, "No, what do you want, Finis?" And Finis says, "I'd like to make a lot of money." I said, "I just want to build a lot of disk drives." So, we had a combination of two people that, you know, knew what they wanted, and we were-- we both needed to do both of those things in order to make it successful. So we did go to Phoenix, and you know, just 'cause Finis had an acquaintance there that was in manufacturing, you know, it was a possibility. We did not follow that path. Finis did have a relationship with Compaq; he had licensed the Seagate product to Compaq at one point. And that was, you know, Compaq was not able to successfully going to make production. But they did have disk drive engineers, so probably the most well-known one is a man called Ralph Perry, who was in charge of the procurement for hard drives, notably at that time. And we had a SCSI interface, as you know. I mean, one thing led to another. Rod Canion was involved, who was the founder of Compaq. And Ralph came in, an ex-disk drive engineer, knew our product, and you know, liked what he saw, obviously. Even though we were relatively new and green in the industry.

Gardner: So when was this in terms of time?

Squires: This would have been in the Spring of '86. We merged companies.

Gardner: In February.

Squires: Right, we had CoData, and Finis had a shell company, Conner Peripherals. And we went with his name. Well, you know, a) he liked it. <laughs> And, b) he did have a reputation, and still does. Less so now, but at that time, he was well-known in the industry. So that was obviously the way to go. Plus there was already a CoData already existing somewhere in California. I was not attached to the name at all.

Gardner: Yes, there are a few names in the storage industry that are known by their first name, Al, Finis, Jesse and Juan.

Squires: Exactly.

Gardner: And I can't think of a fifth.

Squires: Well, actually, in my circle Ralph is one.

Gardner: Ralph Perry?

Squires: Perry, yes! He had so much influence on the industry. Because those guys, they were leading, you know, the smaller little computers, and they were speaking with Rodime, and they were influencing decisions in many, many companies. They were clearly going to be a winner. Even in the early days you could see that. And when they spoke, people listened, so to speak. So Ralph spoke for the hard drive needs. So Compaq did say, "We want a cheaper interface."

Gardner: Compaq invested in June of that year.

Squires: Okay, yes. I think it was $6 million or something, you know.

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Gardner: I don't have the number here -- I assume the conversation with Ralph and Rod were sometime between the merger of the two companies, and the investment.

Squires: Yeah, let's say April or May.

Gardner: Okay, -- we're Spring of '86 now and you have a SCSI drive.

Squires: Yes.

Gardner: And is that the earliest you hear of the cheaper interface?

Squires: Yes, it was. My thrust as architect was an intelligent interface. And really the only one that was practical at that time was the SCSI. And so I actually didn't care too much about the actual interface, just what was behind it in terms of-- between it and the read-write heads. So we were-- we had actually architected everything so that the interface was relatively modular, and so you could change a SCSI interface to an AT interface without deeply wounding the rest of the machine. So anyway, but, Compaq did work with us on the AT interface. And probably before the investment event. Finis is famous for his, you know, bar napkin deals and handshake agreements. And I'm sure there was a handshake agreement prior to the actual June date of the investment. Because both companies were small, and I think one of the advantages of being small is a) you can take bigger risks, and move quite quickly, and change direction quickly, you know, if you need to. So and we were doing all of those. So, you know, that's your advantage against a larger company. Which you need, because you don't have the infrastructure, and you don't have the experience base, and you don't have the relationships with both customers and the suppliers established at that-- when you're starting. So, anyway, Compaq did work with us on the AT interface. Obviously, it had to be modified. It was a floppy interface, essentially. Floppy disk interface, but they had to modify it somewhat. But it was largely a floppy interface.

Gardner: Did they tell you about a CDC version on the Wren 5-1/4"?

Squires: On an AT interface?

Gardner: Yes.

Squires: I don't have recollection of that. They may have. Because I know they were involved with CDC and I know CDC did have a SCSI product. And they may have had the AT interface, too, but I actually was not intimate with the details of the interface. Don Clay at Conner was the lead-- the key point for the interface.

Gardner: How's it spelled?

Squires: C-L-A-Y. And Compaq also had an engineer who was the focal point for that interface. So those two guys, you know, architected, or just sort of made it work, and things like that. So.

Gardner: It's about a two-guy job, one on either side.

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Squires: Exactly, you know, well, that was, yeah. It was rough. Not today, but then we were less sophisticated, you know? So and then things went well. And I think we shipped, by the end of the year, we had shipped over 100 million dollars worth of product to them. Which, I think I'm in '86, right? And that's...

Gardner: I think in '86, there was very little shipped. But in '87 there was like 100 million dollars in revenue?

Squires: Yeah, right.

Gardner: The company went from a few million to a hundred million.

Squires: I think Finis likes to count '87 as the first year of production, maybe, okay, maybe yes. You're right. I'm way off. The development continued through the year. Production facilities were being established and a learning curve was being <laughs> felt out. So...

Gardner: At this point, you're the VP of Engineering?

Squires: Yes.. Although titles were just titles.

Gardner: Who was running operations? That's a huge accomplishment to go from nothing to 100 million.

Squires: It is. The main guy was in Singapore, H.P. Chan . He ran operations in Singapore, which allowed us to really ramp up.

Gardner: So you went right into production in Singapore?

Squires: Yes. We had, you know, pilot lines in Colorado, but it was clean bench set-ups, and you know, it was obviously good for prototypes, but not production. You know, and since in later years we did move some pilot lines back to San Jose, just to get larger numbers before full production. But in the early days -- we went directly to Singapore.

Gardner: By the way, my cheat sheet here says that in fiscal year '87, which is calendar, Compaq was 90 percent of a 102 million dollar full year sales. And I think the prior year sales were a few million. And that was probably all in the fourth quarter.

Squires: Probably, yes. Yeah, and Lyn Crawford was sort of-- out of San Jose-- was probably the focal point from the US operations side. So Lyn had assembled a team in San Jose. Part of the strategy was to kind of not get the Colorado development team too bogged down into the production side. So if there was one thing we did differently from most companies is that the-- we did keep-- I won't call it arm's length, but at least, the development team was sort of a little difficult to reach from Singapore. And Lyn was the buffer, and he, you know, he assembled a team, and could deal with most of the issues, and obviously dealt with supplier issues, and things like that. And so the team in Colorado was actually able to continue development. And we did have a fair-- we set, you know, fairly high pace of development for subsequent

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products. So even as, you know, one product was going to production, we were well along the road of the next.

Gardner: Well, actually as I look at it, that seems to have accelerated, right?

Squires: It did! Yeah, we developed a generation concept, where a generation was defined by a combination of heads and disks and electronics. You know, basically clock speeds, and electronics architecture. And then-- well, that's not true. First generation, second generation, and subsequent generations, you know, we were able to sort of plug in different HDAs and different, you know, form factors, different numbers of heads and disks, different mechanics, relatively easily into this generational, you know, using the head disk technology, and the electronics technology and the code technology. Because much about technology reside in the code. We had a very intensive code product, more so than had been done before by a lot. And so, but that code was independent of whether the product had four disks or one, or whether it was 3-1/2 or 2-1/2.

Gardner: Well, it sort of depends. Was the format in code, or was the format in hardware, or pico-code, perhaps?

Squires: Well, the format was the same. Are you saying the number of sectors for...

Gardner: The format or de-format hardware -- when you up the aerial density it has to run at a higher speed. And typically that hardware breaks at higher speed, unless you pre-designed it ahead of time to run ten times faster than the first one.

Squires: The aerial density was associated with the generation. So all products in the same generation had the same aerial density, basically.

Gardner: Oh, I see. So when I said head/disk combination, I meant that the track width and the TPI and the FCI, so that the aerial density. So that was a generation.

Squires: And so the next generation, you know, sort of bumped all those numbers, and had to bump the speed of the processor, and the speed of, you know, their channels and things like that, and deal with the different issues. But within a generation, we were able to plug in a different HDA, or a different mechanical configuration.

Gardner: Thick and thin HDA's, for example?

Squires: Thick, thin and diameter independence. That was what really allowed us to do what seems like a lot of products. You know, there really were mirrors here. <laughs> <phone rings> So, we've just sort of launched the first product, which was different, so different from other drives that it got everybody's-- a lot of people's attention, and I mean, a little anecdote. We did not have a servo engineer for the first product, or the second generation.

Gardner: Really?

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Squires: Yes, we didn't have one -- first of all we had a very good read-write engineer by name of Lou Shrinkle. Interestingly enough, I was going to hire another engineer, and Terry said, "I'll invest more money if you hire Lou." So <laughs>I took that as an indication that he had a lot of respect for Lou, and Lou did go on to be a star performer in the company.

Gardner: His name?

Squires: L-O-U S-H-R-I-N-K-L-E. That's all I knew him was Lou. He's one of sort of the old-timers that really made a difference in the early days in the read-write area.

Gardner: He apparently did your servo too?

Squires: No, since we were doing code, you know, the code was transitioning. I mean, the servo function was going away from hardware -- it was an embedded servo. It was going away from hardware to microcode. And so even though that had been done before, it was sort of like embedded on the fly. I mean, the thing with the spin control, made a very good spin control, but there was-- in subsequent years, we had servo engineers try to model the spin control system, and they said it defied modeling. <laughs> But it was all in code, I mean, which can happen easily, but it was quite good. So I did the initial servo code, and I had zero experience -- and it was a poor performing servo in today's terms. Very poor performing. However, with the level of intelligence between the head and the interface, and the environment, which was personal computer, that was really transparent. It was not obvious that it was a poor performer -- that if there was a little bit of vibration, it went off-track, and you needed to retry and that's just the way it worked. And of course those ideas were extended in later years to the whole level of intelligence and data recovery to-- but where people were coming from was, you know, prior to that, I said, you know, drives had been spec'd at a soft error rate of ten to the minus tenth errors per, you know. So soft errors. So that was totally a radical change. I mean, we're sitting way down-- well below that, and so but we did get a lot of attention with the drive, because it looked so different.

Gardner: Your performance was pretty good since most of your competition had open loop stepper systems.

Squires: Right.

Gardner: Your performance was probably better than them.

Squires: Sure.

Gardner: But you didn't probably perform as well as the Maxtor with dedicated servos.

Squires: Right.

Gardner: But they were not embedded servos.

Squires: Right.

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Gardner: So they had other sets of problems.

Squires: They did.

Gardner: There were people before you with embedded servo, but Conner was the first such product in a volume application.

Squires: Right.

Gardner: You can argue about Quantum with their Q200.

Squires: Right, I think they had a correct-- servo correction burst once per rev, I think.

Gardner: No, that was their first Q2000. Their first product was once per revolution, thermal correction.

Squires: Yes, right.

Gardner: Quantum began with the Q200[3], a SCSI only product, 5-1/4 inch with an embedded servo. They sold a bunch to Apple.

Squires: Okay.

Gardner: But they were the only ones who did it, and Apple was the only one who bought it in any volume.

Squires: Yeah. Interestingly, we didn't do a lot of competitive analysis, or you know, comparison. Again, you know, we were isolated from the center of the universe in San Jose. So we sort of made things up, and it just so happens, it was-- it worked relatively well, and it was different enough that it had different perspectives. And again, you know, sometimes you need to have somebody who doesn't know what they're doing to make, you know, in which case that was me in this case, to make, you know, changes that no one else would do. We did so many changes that, I think we were one of the first companies to remove the, oh, spindle grounding strap, for example. Because I said, "You know, they're nothing but trouble." And I did a little investigation and concluded that most of the spindle straps-- I'm sure you remember how they used to sing on the early Seagate drives? But they were mostly folklore, that you know, you really didn't need them. And did that, 'cause they came from the big drives. I mean, the big drives did need them, because the static electricity. The velocities were so much higher. But in these smaller drives. And of course, you never know until you're in production whether <laughs> you should have put it on. But we took it off, and then I took out the Hall switches of the motors without knowing how we were going to spin the motor. Because I said, a) there's no room for them; b) they're typically unreliable. And there's a cost issue. They cost money. We went through a couple different-- I went through a couple of different ways, you know, to treating this spindle motor like a stepper motor to get it up to speed. And that worked, but it was not very reliable. It didn't-- and it was-- you had to sort of build a

[3] Editor's Note: See: "Quantum Set To Introduce New Series Of Half- Height Drives," Computer Systems News, April 15, 1985

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profile, and you know, taking into account momentum and time and things like that, to try and step it up, before you could get the heads to fly, and then lock onto the data on the disk for the spin control.

Gardner: So you used back EMF control to commutate, which is the way people do it today.

Squires: No, I have a patent on the technique we did use, -- at very low velocities, there is no back EMF. So I used a technique, which we don't have to go into it, but to get it up to like 15 percent speed before there was a little back EMF to generate commutation information.

Gardner: And then you detected the back EMF, and then used it for commutation.

Squires: Yes, right.

Gardner: So you may have been one of the first companies to do that in the disk drive industry.

Squires: I believe we were the first people to take Hall-less motors

Gardner: OK

Squires: Yeah. And then people saw that, and then they went-- somebody went off and generated a chip that would do that, and everybody used the chip. At Conner, when I was there, we'd never used a spin chip. We always used microcode to spin it up.

Gardner: So you A to D converted the back EMF, and decided in microcode when you had a commutation?

Squires: Effectively, yes.

Gardner: I take you did the same thing with the servo signal. You took the differential analog signal and A to D converted it?

Squires: We had peak detectors for the bursts. And we had our A to D. And just read those numbers and then did some calculations.

Gardner: Did the differencing with the microprocessor rather than analog?

Squires: Oh, absolutely. Well, it's even worse than that. When I say worse, I mean a much lower level. The microprocessor in the CP340, which was a 6801, actually had timers in it, that were fairly clever. They could-- you could set a timer to make a signal go up, and then another time it would make the same signal go down. We actually used those timers to generate the gates for the servo burst information. The 6801 also had a built-in A/D converter with 4 inputs that converted serially and except for the CP340, we used quadrature bursts, so there were 4 peak detectors and our servo hardware was 4 capacitors, 4 diodes and a few resistors. So everything was code.

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There was one little small 600 gate array that did the gray code separation. You needed to detect an address mark, which was just the absence of transitions for a certain amount of time, and then actually the gray code cylinder information followed immediately. So you had a little piece of hardware, but it was just some counters and shift registers, and it was under 600 gates. And Motorola was very cooperative in doing that for us at very low cost, and it was very inexpensive. We were fortunate to have a very friendly rep from Motorola, whose-- turns out was Australian-- don't know if that helped or hurt, but Jim Wiggins , and he was an advocate for a startup company. You know, we were a startup, and the larger suppliers, you had to do a-- you had to sell suppliers as much as a customer. Because they were effectively taking a risk in dealing with you.

Gardner: The Conner Annual Report surprised me by saying that the first Compaq product was used actually the CP340, the SCSI product, not the ATA, or the IDE interface.

Squires: Right, right.

Gardner: And then the first IDE announcement comes in '87, July '87, there's an announcement of a Conner CP342, which is what we now call the ATA interface.

Squires: I'm sure that announcement was well after the fact that we were shipping, we'd been shipping to Compaq. I don't recall details, but I believe we had sort of an exclusive or a certain amount of time with Compaq on this interface. You know, and again, I'm fuzzy on the exact nature of that, but so it's very reasonable that we would not have announced that product when it actually started shipping. So the very first SCSI interface product, I think, was minimal. If, you know-- I don't know how many shipped-- but I don't think it was very many.

Gardner: So you think Compaq may have changed the model number?

Squires: Absolutely. I think they changed it. They were doing a cost reduction. I think their product was called a Portable III.

Gardner: It's the Portable III.

Squires: They were trying to make it lighter, because it was a beast. <laughs> And they were, obviously, trying to reduce cost, so that was really the motivation for the AT interface.

Gardner: I'm surprised, in retrospect that Compaq didn't keep it proprietary.

Squires: While I wasn't involved in that, and I don't recall the details, I'm sure they may have wanted to, and maybe that was part of Finis' skill. And the other-- I think Compaq was, you know, it's a little bit of the Apple/IBM story, where when you go proprietary, you know, you actually limit yourself. And so they were-- I think they were forward-looking, and they wanted to make this a standard in the industry as well. And ultimately Compaq was interested in low-cost disk drives. And how you do that is you get everybody to make, you know, these things., so, you know, so I think it may not that been surprising in a way that they-- it wasn't proprietary. I mean, CDC had proprietary interfaces, and as did a number of people, and it never really took off in the way that these drives did.

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Gardner: Well, I've read and have been told that the IDE interface first shipped on a proprietary Wren 5-1/4 to Compaq[4]. And at least it was never announced publicly as a product, and was only sold by CDC to Compaq.

Squires: And I guarantee it was not the exact same interface. You know, it was just close.

Gardner: I'll bet you a cup of coffee on that.

Squires: Okay, because I think Compaq had to develop things for-- had to change things when they worked with us a little bit. Because they had been code as opposed to hardware, because it was a floppy disk. I remember WD was involved as the controller chip.

Gardner: Actually, I think you're mistaken on that. It wasn't a floppy interface. It was the PC-AT interface to ST-506 type of hard disk drives[5] but with a reduced number of address bits. Instead of the full 16 bits, it was reduced to a three-bit subset for the PC-AT register stack, which was a WD controller, then replacing the Xebec XT controller. So it was very much like the AT bus interface, but it was basically the WD command set. I think the term we engineers use is the register stack, or task file -- that's why I was saying, "I'll bet you a cup of coffee."

Squires: Well, I defer to you. As I said, I actually was way less intimate with the interface protocols and details than the rest of the product.

END OF TAPE 5

START OF TAPE 6

Gardner: Tape six, the John Squires interview. I think we've talked about the genesis of IDE. It was a huge success. What do you think of IDE?

Squires: I think it's a horrible interface. It was a carryover from floppy disk. And so, you know, it was an extension of floppy. Whenever you do that, you always bring along things that don't quite fit. Only later was it able to accommodate logical block approaches, which were very important for the zone bit recording technology, things like that. But initially it was a cylinder-head-sector addressing. From a disk drive point of view, it was too closely tied to computer. I mean, there was a lot of what I call open-loop timing on the interface, which was, you know, the host would pulse a line. And, you know, the data better be there. There was no handshake as SCSI, you know, SCSI had a handshake, which was much better for long cables and, you know, just for flexibility. So there were a lot of timing considerations that had to be solved and things like that. So that's why I feel it was-- but it did have the advantage of the lower cost. And, of course, it worked. I mean, it was made to work. And so I suppose, in some sense, that really defines a good interface.

[4] Editor's note: Subsequently it has been learned that the first IDE drive was a MiniScribe drive assembled to a Western Digital controller by Compaq for the Portable II.

[5] Editor's note: The ST-506 interface was similar to a floppy disk drive interface differing mainly in having a much higher data rate.

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Gardner: And you can't deny market success. I think 80 percent of the drives shipped today are derived from IDE.

Squires: Right. You know, and I come from times when, you know, there were cables, in the big computer rooms, with the 360, 370, that, you know, were 20, 30, 40 feet long, that went between the CPU and the hard drive.

Gardner: Two inches in diameter.

Squires: Exactly. And so now we're looking at, you know, cables that are, you know, three inches long or something. And that's what they had to be to achieve the transfers.

Gardner: Very quickly Conner comes out with two new products, a higher capacity 100 megabyte and I think the world's first one inch high?

Squires: Yes. Well, I think, yes, we did-- following the Rodime example, Finis concluded we should try and patent the one inch high. He actually never did tell me how we settled the Rodime suit, because they sued everybody. IBM settled for no money[6] in order to facilitate everyone else-- Rodime getting money from everyone else I think. So, like, if the big guy settles, then everybody else has to pony up. I know Finis wanted to establish credibility for "form factor patents", because we had the one inch high product in the works. We did get a patent on the one-inch architecture, but it wasn't so much the one inch height. We had an unusual sloped baseplate that facilitated manufacturing process. Today, things are just sort of flat baseplate. But ours had a slope to it, and internal name was Lowrider after that.

Gardner: Slope enabled a bigger motor or something?

Squires: Yes. Enabled the actuator assembly to swing in during assembly. Getting the actuator and the magnet structure in there, it's going to be a little tricky. It was a nice-- it was designed with manufacturing in mind, which manufacturing engineers didn't always accuse us of doing. So the 100 megabyte, you know, we put a strap on the top of the spindle motor to try and stabilize things a bit, put four disks and just pushed the TPI a little bit and did come out with, you know, relatively good product. Worked well. Actually was an extension, I think, of the 40 megabyte mechanical architecture, which you called a popsicle I think.

Gardner: I apologize for my term.

Squires: I had not heard it. It's a fine-- but just a little bit on that architecture, which essentially was—because you had to pack write. You needed access to the disks. But then you kind of wanted to seal that thing away without disturbing those disks and disturbing their relationship and twisting things. And so we sort of said we'll build it as an open product and then just put a little cover over it. And we'd had, you know, there's a huge-- there was what I call a huge carrot in the industry. If you could ever seal a disk drive, it would've been really great because you could extend the specifications considerably in terms of just temperature and humidity. Condensation was always an ongoing issue and there was always

[6] Editor's note: The specific IBM settlement amount in the Rodime matter is not public but there is public information that indicates it was in excess of $15 million.

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concern, especially with plated media, about condensation. And, you know, even in latter years, the big bonus was you could stabilize the flying height over-- altitude. You didn't have to budget the different flying heights. Because if you're going to operate at 10,000 feet of altitude, you have to-- your heads always will fly lower. And you had to make sure they didn't crash. So there's always this carrot of sealing in HDA, and no one has succeeded that I know of. But I did try several times. Being a microcoder I tried. I said, "Well, we should try this." So we tried several different ways to do it. We ultimately ended up sealing the contamination inside the drive. People opened it up, and the gaskets were stinking, smelling very badly.

Gardner: I think the PATTY was a helium-filled drive by NTT.

Squires: Is that right?

Gardner: And that was sealed, but it was sealed and filled with helium. Therefore, it had very precise flying height. It could fly at any altitude because it was sealed. But keeping helium in an HDA was not a trivial task.

Squires: Next to impossible.

Gardner: Everybody else uses breathing filters.

Squires: Yeah, we just have a side project. You know, just I'm diverting. Compaq called me up. Ralph called me up one day and said, "I have met the future of disk drives." And it was Jim Lemke out of San Diego who had invented this liquid that, very small distances, lost its viscosity somewhat and, therefore, gave you very stable flying height, smooth and all that stuff. And so that involves sealing the drive as well. That was ultimately-- did not come to fruition. But we did put a lot of money into it.

Gardner: Conner did buy ViSqUS Corporation in July 1991, right?

Squires: Yes, we did. We put money into it. That was, you know, a little story there. And we worked on it, and we had a team down there. And IBM had actually previously gone down that same route, we learned later, and spent a lot of money trying to make liquid interface work. But, you know, it was ultimately not the winning path.

Gardner: So in '88, we have the one-inch product, the 100 megabyte. The one inch is a new platform. 100 megabyte's extension from the original platform.

Squires: Right. one generation - two products.

Gardner: Engineering's growing like a weed now?

Squires: Not too much, no. In the eight years I was with Conner, engineering didn't grow, in Colorado, did not grow beyond 80 people. So that included pilot-line production. Still, again, following this generation concept, you could, you know, do a lot with a little type of thing and, you know, use mirrors. It was not growing like a weed. The company was growing like a weed. We had more engineers in San

Jose trying to fix the problems that were created in Colorado, in some sense, that we had in Colorado. But the core engineering team was actually relatively stable. And, you know, 80 people included, you know, the payroll person, something.

Gardner: In '89, your third generation's announced, Hopi, Stubby and Kato. Would you like to tell us about that?

Squires: Okay. Well, again, the generation-- same aerial density in all three products, you know, in round numbers, same electronics, same performance numbers, different form factors. So the Hopi was a one-inch product that was just higher capacity, full size. Compaq asked us to do the Stubby, which they were trying to hedge their bets on the two and a half inch coming along. And they weren't comfort-- obviously their-- they made portable computers. And small was good and light was good. Stubby was a cutoff version of a-- I think it was maybe three-quarters of an inch thick or s-- it was a little thinner, little shorter, obviously the same width to accommodate the disk diameter, a three-and-a-half-inch disk. But we shipped quite a few of those, and Compaq built a laptop around it, made space inside a laptop for the product. And then, the other product, the two and a half, that was a product we just sort of did on our own. I know Terry spoke, in his interview, about PrairieTek. My recollection is Jim Morehouse, who had been with Amcodyne, the eight-inch company-- Amcodyne sort of slowed down, shut the doors there at some point. And Jim was looking around for something to do and was sort of interested in a job with us and came and looked at what we did. And then next thing I know there's a new start-up company called PrairieTek, you know, with Terry's name on it as well. And this is sort of surprise doing two and a half. They'd put together a strong team of individuals. We knew many of them. Lot of Hewlett-Packard talent in the initial company. And when we had time, we recognized that that was a very viable form factor and went off and did our own. And we executed pretty well.

In fact, we essentially had everybody doing a laptop pretty much buying from us. Because we came out there with Kato. And I think I've mentioned earlier, in separate conversation, the very first Kato that came out of the Colorado engineering team was plastic, all plastic. You know, at that point, Kaylok had just demonstrated you could make a disk drive with two screws and that had appeal. So I think we had just very few screws, maybe two, not many anyway. One grounded the flex lead to the actuator. So, you know, spindle motor was glued into the plastic. There was number of innovative features. And that worked quite well. We actually shipped it. I think Toshiba was one of the early adopters -- Toshiba came over and was intrigued. And we work with them closely as well with Compaq. I may have this incorrect, but Toshiba may have been more aggressive on the two and a half than Compaq, but I can't remember. But we ultimately abandoned the plastic just for EMI reasons. The drive was going into a very noisy environment, switch of power supplies and things like that. While we had hoped that the weight considerations would warrant the computer manufacturer, laptop manufacturer, providing the shielding, EMI shielding, while we just provided the mechanical structure. That did not turn out to be, and so we ended up going to a traditional casting with the Kato. And that's the product that really went into high volume. But we did ship quite a lot in the plastic version. We even had to glue on the mounting bracket things, which was, you know, did not fare that well in shock and vibration tests. But we did have a number of challenges. So the two and a half was a good product. It was fine.

Gardner: You did replace the plastics with metal.

Squires: Yes.

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Gardner: But that was not a new generation. That was just the same product came out in a big engineering change.

Squires: Yes, exactly, exactly.

Gardner: That sort of change gets your customers excited.

Squires: Yes, you have to re-qualify things. I don't recall terrible pain. But I'm sure there was pain involved. I guess, if you had to generalize from that whole experience, it's like trying new stuff. And, you know, it's like many of your ideas are not going to work. But, that doesn't mean you shouldn't try them. I tell my engineers it's like, you know, because we did this generation thing. And I'm strong believer the iterative design process is the most powerful design process. And you could summarize that as try crazy stuff but don't repeat the problems you had on your last product. And so you got to fix the problems in the old one, and it's okay to have new problems. So we did create new problems and tried to solve the problems from the previous generation.

Gardner: I take it Stubby was sold to Compaq before you designed it. Was Hopi sold to anybody before you designed it or Kato?

Squires: I don't think so. You're right about Stubby. That may have been even a Compaq-unique product. I'm sure we announced it at some point.

Gardner: It was publically announced, but who knows who bought it.

Squires: Right. But it was definitely in Compaq laptops. The other two products were sort of obvious, you know. And we may have had, you know, quote, partnerships. You know, that's the buzzword that is used. So partnerships sort of provide priority. I mean, because, at that time, still through today, everything was a horse race. People were very-- one of the ways to win the horse race was to somehow differentiate your product. And if you were working with one of the leading component manufacturers, in this case it was Conner making disk drives, and you could get that product before your competitor, you could differentiate your laptop. And so we did those types of things with various manufacturers, where they would get early production and hopefully some advantage over their competitors. But ultimately our goal was to sell to everybody. And, you know, timing that you could maybe manipulate a little bit.

Gardner: In '88, I think you go public. Conner, the fastest growing company in the history of commerce. Did you have any involvement in the going public?

Squires: I think I mentioned, in my MiniScribe days, I missed out on the public offering. Actually was not appropriate I go. I was interested in the selling of the company to investors.

Gardner: Were you on the road show?

Squires: I was on most of it. I have very vivid memories of flying into Chicago, in a little plane, when the winds were 120 miles, off the lake, miles an hour and having to evacuate Sears Tower because it was swaying too much. And the whole presentation of the Venture Capital Center was ruined because the

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conference room-- anyway, I may have gotten rescheduled or something. We went to Europe and, you know, learned something about, you know, the best place to sell things is far away from home. You know, because it's-- get investments. And we got a lot of interest in Europe, out of Edinburgh, Scotland, who had, you know, Edinburgh was basically the venture capital for the U.S. railway industry back in, you know, 100 years ago. And so they were interested in investing in the technology in the United States. And same when we went to Switzerland and France, Paris.

Gardner: Any advice to somebody starting out on a road show?

Squires: You know, it's, well, it's a heady time. The underwriters are managing. And, of course, they're trying to present a successful company, when lot of times, as Finis used to say, it really is smoke and mirrors. And you're trying to balance things. But I think ultimately comes down to personality and people. And I think people invest in people more than the products, and that was part of my interest in going was just to understand that cycle. Not many people have sort of been on a road show and actually seen how these things work in a public offering. It was a fascinating experience to see what do investors, you know, people that just literally manage money all day long, what's important to them and how do they think.

Gardner: Did you figure it out?

Squires: Yeah, they look you in the eye and ask you question. The way you respond is whether they invest. What you say is less important than how you say it. It's a people thing. From an engineer's point of view, it's like, oh, that's new, I thought you wanted to hear all about my fancy, you know, electronics and micro-code-- it's not that at all. It's people.

Gardner: You guys obviously convinced them you were people.

Squires: Well, and Finis is brilliant in that area. I learned awful lot from Finis. Again, very different from Terry. Terry and Finis are my major mentors in life. You know, and they each had-- I'd like to say about Terry-- Terry says ten things. Nine of them are really dumb, but you'd better be listening for the tenth. And Finis has such a different outlook, or, take on things. I was always listening and trying to understand his thinking.

Gardner: I actually didn't realize this until I started my research. But apparently you were on an annual schedule, a new generation. In October of '90, you come out with your fourth generation. In May of '91, your fifth generation comes out, Cougar, Summit, Jaguar and Poncho.

Squires: I guess Jaguar and Poncho were four, but I don't know. Just a little bit about that, starting with the fifth and beyond, we split the generations into performance characteristics. Because it was clear that this concept of generation would not work for high and low end. You couldn't have the same electronics in a two and a half as you were trying to win business from EMC, you know.

Gardner: In a SCSI three and a half.

Squires: Yes. So we did split the generations -- and so the fifth generation was the first high-performance specific generation. Again, the names and numbers are not very clear. But sixth generation

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was back in the desktop world, and then the seventh generation was the high-performance thing. So we did odd - even. And then also the team sort of split at that time.

Gardner: They were on different time schedules then?

Squires: Yeah, they sort of ran independently. So we sort of almost created two engineering groups. Obviously, you know, we tried to get as much synergy as possible. But they did diverge in their thinking approach, in the way they did things.

Gardner: Probably an IDE group doing desktop and mobile market and a SCSI group doing the enterprise products. And that's the way the customers split for many years.

Squires: Absolutely, yes, yes, right. But just, you know, higher frequencies, higher spin speeds, just higher performance, you know, bigger magnets, faster and shorter access times, that sort of thing.

Gardner: More power…

Squires: More power, exactly.

Gardner: …SCSI interface, more microcode.

Squires: Yes. We did have one interesting product in there, Chinook.

Gardner: I was going to ask you about Chinook, which doesn't seem to fit.

Squires: Well, Chinook, no, it actually fits exactly. We we're struggling. We'd done the generation four. Was Summit a generation-four product?

Gardner: Well, I show, in '91, an announcement of Cougar, Summit, those 210 and 540 megabyte.

Squires: Cougar was definitely fifth generation.

Gardner: I thought that was a fifth generation. And then Chinook comes later that year, in October. And then the following March, another generation comes out, which is Derringer, Sierra, Baja, Aegean, Montgomery.

Squires: Right, right. If you were to trace Conner, the product, the 100 megabyte, was high end for the times and the time. And then we did another higher-end product, which I think was Summit, which would've been generation four. At that point, it became clear-- and I may be wrong on that. But there was another high-- there was a clamshell. We did a clamshell. I was very intrigued with the Siemens mechanical architecture[7], where they did this clamshell thing, where the motor set in this little-- no, no, it was the other way. If you had placed this vertically, the baseplate was on the bottom. So it was a shell,

[7] Editor's note: Siemens MegaFile, Series 1000 and 2000, first introduced circa December 1985.

and you lowered the motor into this one half. And then the gaskets sort of went around a different way. And then you put the top on vertically. So for access during pack writing, we needed access to this, of course. Very stable, very, you know, just bulletproof German design. I mean, Germans always design things well.

Gardner: Actually, I think MiniScribe did a split shell type of design[8], where you capture both sets of bearings. You capture the motor bearings and the pivot bearings with a clamshell that comes together.

Squires: I was there when that happened. No, I call it a clamshell. Possibly that's misleading.

Gardner: That's what I call it.

Squires: Yeah, anyway, it became clear that, you know, we needed to architect in such a way to differentiate low end, high end. And we approached customers. And I remember one conversation with possibly Grant Saviers, at Digital Equipment, that time. We would go in, and we would talk about spindle speed and access time and data rate, TPI and FCI. And I think Grant said, "You know, we don't care about any of that stuff. We care about I/Os per second, and that's it." And he said, "Currently, the industry's at 15 I/Os per second and we want more." Because they were running multitasking multithreaded systems. And so I went off and I said, "Well, that's interesting." It just sort of reset me a little bit, even though was just a different perspective on the problem. I said, "Well, one way you could get more I/Os per second is to put a second actuator on there." So we did that. And I think it's probably the only drive ever built where both actuators can access the same data. And that was-- so it was not-- they had been-- even the IBM 3380 had dual actuators. But they were separate disks. So it just had the appearance of dual access.

Gardner: There was no overlap.

Squires: There was no overlap. I don't think there'd ever been overlap. But we, taking advantage of the embedded servo system, you know, the data was not laid out in cylinder format but on a surface format. We did talk about going spiral recording, at one point, which would've made a difference. But we achieved the double I/Os per second. And, of course, you know, there were all types of algorithms that were possible. And I had a guy, Steve Cornaby, whose brother used to run engineering at Iomega, architecting the SCSI code. Because, you know, you had Command Queuing in SCSI. It was a SCSI product. Command Queuing was perfect for this type of product. And, you know, you could take a, you know, you could take advantage of latency. You've got a little bit of reliability issues. You could do a number of crazy things if you had two different heads that could read and write the same data. The problems with embedded servo architecture were not terrible. So we did do that.

Gardner: Writing on one and track following on the other might be an interesting challenge.

Squires: No.

Gardner: No cross talk?

[8] Editor's note: MiniScribe 9000 Series, first introduced circa November 1987.

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Squires: No, no, because we were all embedded servo. No, no. It wasn't like the old dedicated servo, where, you know, the writing would always disturb the servo data, you know, the noise inside the HDA was not an issue. I don't know why. Maybe it should've been. Maybe there's some good grounding. I remember, when I hired Mike Workman, he said, "When Chinook came out, really got our attention." Then they went off and did a little mini array with their product to compete with us, because ultimately the product failed on cost basis. It was a five-and-a-quarter-inch form factor. But that was not the failure point. The failure point was just the cost of the heads, the additional cost of the heads.

Gardner: Grant wanted I/Os, but he wouldn't pay for them.

Squires: Exactly. Isn't that the way it goes? But it was an idea. There are people who get intrigued by this little crazy dual-actuator drive today.

Gardner: I actually got one donated to the museum.

Squires: Did you? Oh, really? Yeah, no, people love it just because it is different. I mean, we built, you know, 50, fewer, maybe 100, I don't know, not a lot.

Gardner: One of them got out because it wound up in a repair shop.

Squires: Oh, yeah, I've lost track of them. It was an experiment. And sometimes, you know, it's like they say, you throw spaghetti on the wall, see what sticks. And this was spaghetti. And I think that's an important aspect. You got to have the bandwidth and the courage and, you know, to do that, to try things that don't necessarily fit just a linear extrapolation of the last product.

Gardner: So you were basically able, then, to execute this, now, in two parallel teams. I suppose you had grown larger. Then you had two teams, and they were operating those platforms. They had one aerial density, one set of electronics. They bring out multiple mechanical platforms, in both diameter and height, to meet the market needs.

Squires: Right.

Gardner: Sell any of them to customers before you designed them?

Squires: You're referring to Finis' sell design build quote, which I think has achieved notoriety from Fortune magazine or something. There's always a little bit of that. And it's always, you know, it's always overplayed. But I think we spoke earlier about how having customer participation is invaluable. Ultimately, you know, our success, in some ways, was directly correlated to having Compaq invest in us. And so not only did they, you know, were they a customer. We did a similar thing with Olivetti. Olivetti, we acquired their disk drive team, which is a problem in Italy. You can't lay people off. So they needed to do that, because they were struggling. They had an investment in that company, and they purchased our drives. So that was the brilliance of Finis, in a way, at least. And I think, I mean, if you have, you know, some engineering and a good strategist and marketing guy as we had in Finis, that sure helps.

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Gardner: I think he first used that phrase in the 1988 annual report. Then it got picked up and became very famous.

Squires: It has. I mean, I know that there's at least one, you know, thesis in Harvard based on the Conner strategy that people have written. It's been incorporated into several books on how to do things. Because we, you know, we did grow quickly. We achieved some significant milestones pretty quickly I think. We actually made it to Fortune 200 or something like that in the time I was there, which is unheard of. You could not do that today. It's, you know, amazing -- got bigger than Storage Tech.

Gardner: How about Google?

Squires: Google, yes, yes, right, they are not a hardware company.

Gardner: They don't build any factories, right?

Squires: No factories. Yeah, they're not a hardware company. We were pre-dot-com bubble, whatever. And, you know, we were sort of, in some sense, more real, maybe not. But, in some sense, there was at least something tangible.

Gardner: Was the sixth or seventh generation your last?

Squires: Yes, both. I was actually personally spending 50 percent of the time as an engineer, contributing to engineering as an engineer. In addition, I was a board member of the company. In addition, I had engineering groups in Italy, little bit in Scotland, in Malaysia, in Singapore and San Jose, and they all worked for me. And my interests, my personal interests, were not really in trying to run 500 engineers, which I think was about the number that dotted line reported to me.

Gardner: But only 80 or so in Boulder.

Squires: Yes.

Gardner: Because I think that's the number. I wrote those numbers down, at one point engineering got to 437 people.

Squires: Exactly, yeah, right. Okay. You know better than I.

Gardner: Was in the annual report. I just picked the number out.

Squires: Good. Yeah, 500, yeah, 100 or 80, something like that. It was very clear. I needed to sort of step back. And so I actually went out and hired Mike Workman, from IBM, who brought in the next level. Finis really led the way. We went through three presidents, in Conner, which was not necessarily a happy transition always. But Finis always thought big. And none of the presidents that, you know, were left behind, so to speak, ever missed a goal, ever, you know, performed anything less than brilliantly, Bill Schrader, Bill Almon. But Finis saw that, you know, that the strategies and the techniques and the

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processes that were needed for the next step, you know, needed to be brought in from the outside. I think I saw the same trend in engineering, and that's why I went after Workman. And Charlie Sander took over the Colorado group. Charlie's brilliant. He had been running the high-end generation, generation six and on. And then he took over the whole group. He subsequently ended up running engineering for the whole desktop division of Seagate. So he performed very well. Charlie and I remain friends today, socialize.

Gardner: You didn't mention Tom Mitchell.

Squires: Well, Tom came in towards the end, and I suppose he helped me leave in some sense. There are many, many Tom Mitchell stories, and I don't need to say any of them. But I think Tom was a brilliantly-flawed character. He was brilliant and flawed as are we all. But Tom and I did get crossways in the hatchway a few times but not seriously. Finis was good friends with Tom and recognized the disciplines that Tom could bring to the company he felt were needed. Ultimately, Tom and Finis got crossways in the hatchway, too. That didn't turn out as, you know, as well as it might've. And, again, I was-- I didn't overlap a lot with Tom. But it was probably a year or more, something like that.

Gardner: Six months, September to December.

Squires: Actually, you know, on paper, I worked for Finis and not Tom, which, Tom being president, Tom was not thrilled about that. That may have contributed something, maybe not.

Gardner: How about a one- or two-minute summary?

Squires: All right. Well, just the Conner experience is magical in some sense. People talk about it in awe a little bit. We were like the ducks on the pond, you know, calm on top but working hard underneath. My personal philosophy on how you succeed is you just have to work hard and you work harder. There's a book out, which I'll just briefly reference, called Outliers, by the guy that wrote Blink and Tipping Point. Those are more famous. But it actually talks about the success of Sun Group and Bill Gates, things like that. It basically is hard work. And, you know, there's always a sacrifice. Often it's your family. Often it's your, you know, your mental state or whatever. But we worked hard. I worked hard eight years at Conner, and we achieved extraordinary things. I made a lot of good friends and learned a lot. I mean, that's ultimately what it's about is expanding your experience and making a contribution leap. Provided, you know, food and sustenance for quite a few people. I think we had 10,000 people in the company at one point. So it was a magical experience is the only thing I can say.

Gardner: Well, I'd like to thank you very much, for the Computer History Museum, for giving us your time and sharing your thoughts about your career.

Squires: Thank you for the opportunity to put this down.

END OF TAPE 6

END OF INTERVIEW

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