Oral History of Dave Gordon

Interviewed by:
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Tom Gardner: Good morning, I'm Tom Gardner. I'm a member of the storage committee of the Computer History Museum here in Mountain View, California. And I'm here today with David W. Gordon to talk about the transition of the storage industry from just a bunch of large dumb disk drives to smart intelligent arrays. Dave was there at the crux of this transition. We will explore with him what it was to be like at that time period. In the interest of full disclosure, Dave and I worked together in the '70s. We were both at Memorex. And we both worked on the storage control units, an area that was in many ways a precursor to what we have today, arrays of intelligent drives. Dave, why don't you briefly summarize your career for us, and then we'll move to a slightly different orientation for the rest of the discussion.

Dave Gordon: As Tom mentioned, we worked together at Memorex. And that was really the origin of my both interest and experience in storage systems. I had gone through the air force and worked at another installation for a while. And when I went to Memorex, it was the first time that I found people that were excited about what they were doing, challenged with what they were doing, interested. And it had a concrete objective. And so that's really what started my whole career. And after ten years at Memorex, I moved on to a number of different places, ending up starting a company, starting a couple of companies. But the largest one was Array Technology. And it came from a series of discussions and ideas that the industry has taken hold of and really run with. So a number of storage companies. Most of my career has been in storage, and it's been an exciting, exciting trip.

Gardner: I notice from your resume that you really don't have an engineering degree, but you rose up through engineering ranks to found a key company. Would you care to comment on challenges of being a non-engineer in an engineering environment?

Gordon: As I commented, when I joined Memorex, it was to a group of young people as I characterize it these days. There were two or three seasoned managers, and everyone else had a master's from either Berkeley or Stanford. And it was a very, very exciting time for me in that these people were excited about what they were doing. They were excited about applying what they learned. I came from the air force. And one of the interesting times that I remember, the gentleman that interviewed me was a guy named Walt Hillblom and I'll never forget the interview. It was just he and I in his office, and he was asking about my experience. And he said, "Well, have you ever worked with TTL?" And I said, "T what?" And he said, "Okay. How about truth tables?" I drew him a bunch of truth tables on his whiteboard or blackboard. And he hired me into the group. But it was so exciting. I had worked previously with 3,000 amps and 10,000 volts. And to be able to touch what I was working on was interesting. But anyway, the engineers were very bright and they would design things. And we would prototype them, you know, do wire wrap. But I was never happy to just build it and let the engineer do it. So I would build the products for them, and then, you know, we would work together for series of hours. And they'd go back to their office to do some design corrections. And I'd continue working and found the task of chasing logic just extremely interesting and challenging. And it came to the point fairly quickly where the engineer would design it. I would build it.
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He would kind of give me an overview of what it was doing. And I would do the debug on it and come back to him and say, "This doesn't seem to work." And occasionally it was something I didn't understand. But just asking how and why and continuing to do that and never saying no to a challenge. There was a period there when an engineer had designed a product that, or, a series of boards, channel interface, that didn't work. Or I should say he kept telling me to take logic off this board, put it on that board, take it off here, put it over there. And I went to the manager. I said, "You ought to look at this guy. I'm not sure he knows what he's doing." And so two weeks later, this engineer left. And, you know, I hadn't heard

anything in the meantime. The manager called me in and said, “Can you finish what he started?” “A channel interface? No. How am I supposed to do that?” And he says, “All right. All right.” So he drew a little two or three chip, you know. “Can you design that?” “Oh, yeah, that’s easy.” And so my manager took a C-size drawing and put 50 small diagrams. And from that I went and built the channel interface that lasted through at least three generations of storage control units there at Memorex.

Gardner: This, by the way, was an IBM System/370 Block-Multiplexer Channel…

Gordon: Correct. It was exciting. In thinking through all of the logic, there was only one engineering change done to that basic set of boards from the time I released it, other than, you know, future features and changes. But it really gave me the challenge and interest. So to anyone that’s going after it now, use all of their God given talents and learn and challenge themselves. Some years after that, I was promoted to a junior engineer and then an engineer. And then the manager of the department was going back home, and, you know, there was a obvious need for a manager. And there were two of us in the group that kind of were obvious choices. And they ended up picking me as opposed to the guy with the master’s in engineering, which was quite a challenge to me. But, again, speaking of challenges, I remember the first engineer that I hired as a manager was a guy with a master’s from Rice. And in working with the people in the department, even when I was promoted to the manager, I’d worked with these people for so long I knew what their strengths, weaknesses were. And I didn’t feel less than any of them. And yet when I interviewed this guy, he knew more than I knew about error-correction codes. He knew more than I knew about channel interface. He knew more than I knew about software diagnostics. And I agonized. How can I hire a guy that knows more than I do about everything?

Gardner: Best way to get promoted.

Gordon: Ended up I did hire him. And he worked out very well. And I’ve never turned back from that, always have hired people who were the best that I could find. And even at that point in my career at Memorex, it wasn’t explicit. But if you give people a challenge and give them the ability to go do it kind of on their own, you’ll get the best result out of people. So growing people is really what it’s all about.

Gardner: That was the 370 Block-Multiplexer Channel. It sounds like you’re doing the channel interface with what became the equivalent of a 3830 control unit?

Gordon: Yes, it was a 3671 at Memorex.

Gardner: And to give him his credit, I bet the guy who promoted you was Ron Singleton.

Gordon: It was.

Gardner: **You** worked on a lot of things at Memorex. The one I’d like to get your recollections about is the Memorex 3770 disk cache. I believe you were in the middle of that. Didn’t start it, didn’t finish it. But what would you like to tell us about the Memorex 3770?

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Gordon: It was a product that was designed at another group. And when the manager of that group left to start another company, I was given the hardware, the product and the people that were in that department.

Gardner: And that manager was…

Gordon: …Dick Reiser.

Gardner: And the other group was headed by…

Gordon: …Ward Ellis. So the product was given to me, and it was said to be ready for beta. At the time, a group of CCDs were used as cache, which later became unavailable. So we switched to dynamic RAM memory. But we shipped the product to a beta site.

Gardner: Did it have CCD when you shipped it to the beta site?

Gordon: No, it didn't.

Gardner: It already switched to DRAMs?

Gordon: Yes, they were just unavailable. So we shipped the product, and it had problems at the client's site. So I was sent down to try and figure out what the problems were. And so it was kind of confusing the first day. Different suggestions of what was wrong. So I disabled the product, went back to the hotel. And sometime in the wee hours, I got a phone call from the site that, "The product is screwing up the channel again." Said, "It can't be. It's offline." And, well, it turned out that that first prototype had not had a worst case analysis done. So the processor was going at a speed that it wasn't reliable. So we later proved that putting it in a wait loop it wouldn't stay there more than an hour or two before it wandered off into the other code. So we brought it back. At that time, there were a lot of simulations being done by our firmware guys on performance. And I understand later it was sent out again. But I left the company at about that point. So it was an interesting product, but I didn't connect with it more than probably six months.

Gardner: Memorex, of course, in your area, primarily was making plug compatible storage systems to IBM channels. Any wisdom, after ten years of doing that, that you'd like to share with us?

Gordon: It was interesting occasionally to discover an error in IBM's either software or hardware that we had corrected only to later have to go back and break the way they had broken it, because being compatible meant being exactly compatible, not better than. So that was a learning process for me.

Gardner: Could you give us any examples?

Gordon: There was one hardware, and I can't remember the specifics of it.

Gardner: So you left Memorex in 1980 and went to a subsidiary of Exxon called Star Systems Division. I couldn't find out much about Star in my research. What was Star?

Gordon: Exxon, at the time, had more money than they knew what to do with and decided that electronics was really the future. So they started eight or ten electronic subsidiaries one example being word processing. This particular one in Star Systems was an optical disk product. So they had a 14-inch optical disk project. And I was hired explicitly to attach it to the IBM 370 channel. They had the technology, but they didn't have anything to attach it to, no interface, no subsystem. So I joined them with that purpose in mind. And one of the first things I asked was, you know, they didn't have a product. It was a disk spinner, you know, a metal table with lasers, mirrors. And so they wrote a pattern on the disk and put it in read mode overnight, came in, in the morning. Well, it had read it enough that it had totally erased the pattern that was there.

Gardner: The act of reading erased it.

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Gordon: The act of reading erased the data. So from that, it became instantly obvious that the product wasn't quite ready to make into a box, into a retail product. But they still had confidence. So when I joined them, I had plans to go to India for a month with a good friend of mine, Obaid Khan. And so I spent a couple months doing a schedule and a budget, a number of people, etcetera, to attach to the IBM channel. And I sent that in and went off on my vacation for a month, came back, went to New York and talked about the budget and schedule.

Gardner: This was at Exxon corporate?

Gordon: Exxon corporate. And they announced that I was now director of product planning, because they didn't want to spend that much money or take that much time. The Exxon concept was you pour money into a hole and all of a sudden it gushes. And electronics were not like that. So as product planning, I visited a number of the other Exxon electronics enterprises talking about what could we do with this optical product that would enhance their product. And there wasn't a lot of synergy with any of their groups.

Gardner: Who were some of the key people at Star? Who hired you?

Gordon: I don't remember the name of the general manager of the organization, but it was interesting in that he hired me-- I should say he called me for an interview and had me interview with a young Indian guy. And I still remember the interview, although I don't remember his name. Ten minutes into the interview, I thought I'm never going to work for this guy, maybe he can work for me, but I'm not even sure he knows that much. So at the end of that interview, I never saw this gentleman again. I did get a call from the headhunter that had initiated the contact. And I had a job offer, but I worked for the GM who

was an economist by training and had been with Exxon for a while and just was given one of their electronic enterprises as a perk for his career.

Gardner: Not a technology led company.

Gordon: Not at all, not at all. And he was very hands off;- to my recollection he never had a meeting with the managers of the different specialties and said, you know, "What's going on?" or "Where are we?" It was all a peer led group kind of thing.

Gardner: That's a pretty early recordable optical storage device. Do you recall anything about the technology? Was it magneto-optical, phase-change, some other? You did say you could write it and then read it back. It was a recordable device as opposed to write once?

Gordon: That's correct. It was a rewritable device.

Gardner: Do you recall what the technology was?

Gordon: No, I don't.

Gardner: Do you recall any of the other folks there?

Gordon: There was a Exxon guy, Leonard Laub, who was a visiting guru I guess. I never really knew what his connection with the organization was, but he would come in and pontificate and leave. There were three other managers in the group. Eric Moe was a mechanical guy. Ron Whaley was a servo guy, and Joe App was a read/write manager. And they each had a couple of engineers working for them. But I didn't stay there a long time. It was interesting. After I was put into the product planning role, one of these gentlemen came into my office, closed the door behind him and said, "What are you doing here?" I kind of smiled at him. I didn't know him that well. "What do you mean? What are you after?" And he says, "This outfit isn't going anywhere." He says, "I know a couple of guys who are starting a disk company, and I think you'd do great over there." So that was my awareness of a company that later became ibis.

Gardner: You went to Exxon corporate I guess and made your presentation. They decided that channel attaching would be too expensive. And it was a expense decision, not a technology decision. Then you became director of product planning. What interface did you then decide to do for the Star product? Was it going to be IBM channel? If it ever became a product, how were you going to sell it?

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Gordon: I don't think I ever came to that conclusion. As I commented, I visited, let's see the names that come up, Qwip, Videx, a number of other electronic subsidiaries or Exxon subsidiaries. And there wasn't any uniform kind of interface that they were using. This was before the days of SCSI. So there wasn't a

small disk interface that was a given if you will. But because the technology really wasn't there for the optical disk itself to be productized that wasn't really a concern.

Gardner: Star was acquired by StorageTek of all things in August of '81. So I take it you left before the acquisition?

Gordon: That's correct.

Gardner: So it'd be sometime in '81 you left Star and went to ibis.

Gordon: Correct.

Gardner: Ibis is a crane, isn't it?

Gordon: Ibis is a crane, Egyptian.

Gardner: What is an ibis?

Gordon: I heard that the president, at the time, Jack Jones, described ibis as an ugly bird. But it was supposedly the sidekick of Thoth, one of the Egyptian gods, and it was a bird that Jack and his wife saw at a zoo. And Jack had never heard of a company called ibis before. So that was the name. The only unique thing was that we always spelled it lowercase. We never capitalized ibis.

But, yeah, I was hired in a Denny's by one of the four founders before we had any facility or anything else. We met in a hotel room a couple of times. But it was an exciting company. The initial product was targeted for Cray Research. One of the members of the board had a connection at Cray and had already talked to them before the company was even founded. And Cray was willing to take a look at the product. And they didn't have any next generation if you will storage product for their supercomputers. So one of the first assignments that I had was to contact Cray and work out what kind of a product they would like. So I was assigned as the main interface with Cray Research from ibis. So I was back in Chippewa Falls regularly, even including the wintertime, you know, when the minus temperatures were the rule. But Cray was a very interesting company. Whatever technology they were looking at Seymour would typically build a lab and do it. When they went from SSI to MSI, Medium Scale Integration, they created their own lab in the basement of one of the buildings to create MSI chips so they would understand the foibles of the technology. So when we discussed the product with their IO guy, guy named Bob Halford, and his manager, gentleman named Dick Morris, we quickly decided that an interface with a lot of overhead didn't make a lot of sense. You know, Cray's cycle time measured in the single digit nanoseconds. You couldn't afford a lot of overhead in the interface. So Bob Halford, who had a background in CDC, myself, with a background of IBM compatible, and a gentleman, that I had hired, with a background at Century Data and some of the smaller disk products, the three of us created an interface for Cray. So we sat down and decided how wide the bus would be, what the sequencing would be and totally defined a custom interface. From that, we went off and built a 20-inch big board that was

our host for test purposes. Would've been a little expensive to get a Cray system for a test box. So anyway, we built that, built, or, used a RISC processor in the architecture of the box of the disk product [0:25:05]
and did a lot of testing on it and took it back to Cray for beta site. One of the slightly comical points that I remember, our test board would do, you know, sequential seeks, random seeks. And you could hear the product seeking, you know. It was <makes pththththth sound>. And so we thought that was pretty good. The first time we hung it on a Cray channel the sound will never leave me. Instead of this <makes pththththth sound>, it was <makes EEEEEEEEE sound>. It was, I don't know, 100 or 1,000 to 1 speed change kind of thing. And instead of hearing the seeks, all you heard was a very high-pitched squeal. And Cray was happy with the product. It performed as we said it would, both access time, transfer rates. You know, our product was a four-head parallel. We had speed matching buffer to synchronize the four heads' data streams.

One other interesting thing that I remember in the design of that product, in the IBM world, when you have questionable data, your hardware fails, double-bit parity errors, that kind of thing, you freeze the machine so that, you know, you can recover it and not make things worse. And I remember a discussion I was having with Bob one time. And I said, "What do you want us to do when, you know, we have a uncorrectable data stream or a double-bit parody error or something, you know, in our product?" I said, "Right now we freeze." And Bob had this look of horror on his face, and he says, "You never freeze. I don't care what you're doing. You never freeze." He says, "Our products, we shoot missiles in the sky. We drop bombs." He says, "When we're shooting a missile in the sky, we don't want our computer to stop. You make your best guess and go." So it was an interesting change in market.

Gardner: Not unlike video today, right? You get an error; if it's data, maybe you could live with an error. If it's an error in your program that you're loading, you probably want to freeze.

Gordon: There was no acceptable freeze reason for that product. So, you know, that certainly changed our way of thinking and some of the ways we were designing things. But the product worked. We manufactured a number of them and shipped them to Cray. Over the entire time, I was the contact with Cray Research.

Gardner: You said the product did have a number, a model? Was it the 5800 or something else?

Gordon: 1250 is what we called it. It was a two- actuator, but it was the same capacity as an IBM 3380 product. There were concepts of putting multiple HDAs in single boxes, but at least until the time I left that never happened.

Gardner: So it was a 1250. It was a two-actuator. Each actuator had two heads in parallel. So it's a four-head parallel. I believe you told me the actuators never really operated independently.

Gordon: That's correct. We treated it as a single actuator.

Gardner: So you could've saved a bunch of money.

Gordon: I never, for some reason, never questioned it. I was the system guy, and there were people doing HDA and the read/write servo channel in a separate department. So I never questioned why that was. It was unique to me or interesting that we had designed totally the HDA ourselves. It was not-- bowing to my experience with Memorex, we would take an IBM product and break it apart and look at the HDA and how had they designed it and where were the lands and mounting points. At ibis, there was no such reverse engineering. We didn't have anyone's HDA to take apart. So the people that did the design, similar to what I did in the interface, their background in designing products, they just started off with a clean piece of paper.

Gardner: Were the disks vertical?

Gordon: No, they were horizontal.

Gardner: Were the actuators side by side or opposing?

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Gordon: Over one another.

Gardner: So one on top of the other.

Gordon: Yes.

Gardner: I don't know of any other dual actuator horizontally stacked actuator. That may be unique.

Gordon: One of the things that was fun at ibis was the president was a marketing guy. And so there were a lot of, how do I say it, vaporware, what we would call it today. You asked what we called it. The ibis 5000 was-- I've seen datasheets on that, but we never had a 5,000 megabyte drive. So one of the reasons that Cray liked me so much was that I told them the way it was. And there was a gentleman named Tom Patel who joined the company about two-and-a-half years into the company. And I worked for this guy. And he came to one of the meetings with Cray in Duarte, Southern California. And Mr. Patel joined us in the meeting. And so I went over what had happened since our last meeting. And afterwards Tom said, "You don't have to tell them everything!" He says, "I could just picture you there with a white collar!" He said, "You were letting everything out! You don't have to do that!" But in my frame of reference, you know, a major OEM, the company that would make or break our company, either had to know what's going on-- but I was chastised for telling them what's going on. And I liked Tom. It wasn't like he was shorting anything. Was just a style thing, I think, more than anything else.

Gardner: Who was the visionary president, marketing guy?

Gordon: Jack Jones was an ex-Memorex, Floppy disk division. And the finance guy was also a Memorex auditor, finance guy. Dick Weir and Jack Toronto were the other two founders, and they were Burroughs folks.

Gardner: Did the interface you worked out with Cray have a name? Did it become a standard? I think later on Cray adopted HIPPI as its standard. Could this have been a precursor to HIPPI or related to HIPPI?

Gordon: Yes, High Performance Peripheral Interface was HIPPI. It was not directly connected that I'm aware of. Cray certainly had a big hand in defining the HIPPI interface, but I've never actually compared the two or thought about it that way.

Gardner: We've moved from proprietary. Every computer system designed its own interfaces to industry standards. And I wonder if this ibis product may have been a precursor to HIPPI, which then sort of is a, well, for a while at least, was a standard on the supercomputer product lines, may even be to this day.

Gordon: One of the interesting things at ibis was when they were, the company was, all wrapped up in Thin Film technology. That was the gee whiz. And we were attaching to Cray.

Gardner: That was thin-film head or thin-film media?

Gordon: Thin-film media. We had our own plating shop. So that was the concentration of the company. And the concept of a system or what the product looked like was of no interest to anyone but me really. And so in defining the product, I had to say how many heads were going to be in this thing and how many disks were going to be in this thing. It was IBM's 3380 product that was announced and started to ship at that point. So to me, whose most of his world was the IBM compatible market-- I decided that even if we sold them to Cray another option would be to sell it into the IBM compatible market.
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So I defined the product size as compatible with 3380 with the idea of attaching it to an IBM channel. And I started talking about that.

Dick Weir was the VP of engineering. And I'm sure Dick talked to Jack Jones, others about the idea. So Dick was excited about the idea of attaching it to the IBM channel. And we started talking about how long it was going to take, how many people they'd need to get started. And so we continued that discussion, Dick and I, to the point of contacting a local real estate person. Because I had told him that to attempt to do it in the same shop as the Cray emphasis was going to be counterproductive. We'd keep peeling people off in concentration. So we were going to have a separate site to do the IBM compatible product. Dick agreed. So we had an appointment with a real estate person to look at other industrial space within a couple of miles of the Duarte office. And I don't remember the date any longer. But the morning that Dick and I were supposed to go look at space to rent for the IBM compatible product that I was going to lead there was a company meeting in which Bob Hancock was announced as joining the company to run the IBM attachment, which was quite a shock to me since we'd been having these discussions for six months to a year about me doing that. So anyway, long and the short of it is the company hired a number of people from StorageTek, 11, 12, something like that. Jessie Aweida the president at the time didn't appreciate that. So he sued ibis. And they came to a mutual understanding that we wouldn't hire anymore directly from StorageTek. If they'd been white washed for six months then we could hire them, you know, gone to some other company for a little while. But we couldn't hire anyone directly. If there was any money exchanged I'm not aware of it. But we started a division, in Boulder, Colorado, to do the IBM compatible product.

Gardner: And that's how you wound up in Colorado?

Gordon: That's how I wound up in Colorado. I talked to Bob and told him that-- he'd heard of me, and I'd heard of him. And I told him, you know, that that day literally was when we were supposed to go look at a site for me to open. And so Bob says, "The only job I got left is manufacturing. I didn't know you were even with the company." And so I took over as his director of manufacturing in Boulder.

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Gardner: Okay, so now were in Colorado, I understand a product that that group came out with was called the 5800 Control Unit. Did it ever ship?

Gordon: Purchase ship, no, it did go to beta, successful beta, but the company had never designed an IBM specific interface for the disk drive itself, so it beta-ed with IBM disk drives.

Gardner: Beta-ed with IBM disk drives?

Gordon: The Storage Control Group, was very efficient, and created the controller and it was a very reliable, good product, it was the same group that had created the storage controller for StorageTek. So they were doing it for the second time, if you will, so they created the product, tested it, again internally with IBM drives, but that was what went to, as far as I know, our first and only beta site. I left the company shortly after that, but the Colorado division was also shut down, rumor was that the concept of, or the cost of hiring or creating an end-user support organization was too much for the venture capitalists. After going to the expense of creating a storage controller, one would seem it was a little late to make that decision, but the division was shut down and most of the people went to a local company called IntelliStore in Colorado.

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Gardner: Some very interesting follow-ups in that area.

Gordon: <laughs>

Gardner: So it went to beta with the IBM drives, the internal architecture must've been very much like IBM's then?

Gordon: I believe we could IPL the IBM floppy disk. **-** Initial Program Load.

Gardner: So you could take a floppy disk out of an IBM, the 3880 control unit, drop it into this 5800, and it would boot and run?

Gordon: Correct.

Gardner: That's compatibility isn't it?

Gordon: That's really compatible. For me it was a unique situation, because at Memorex we had rolled our own, if you will, there was no-- it was compatible at the plug but anything inside was designed from the ground up. So it was an interesting comparison.

Gardner: Your comment about the cost of an end-user organization was sort of interesting, did you ever hear how much they were thinking it would've cost?

Gordon: No I didn't, it was astounding to me that an organization would go to the point of spending the money to develop a controller, and then just totally kill it, so.

Gardner: I mean the information was public if you read some of the Memorex annual reports in the Seventies, I think Memorex spent three hundred million dollars to establish an end-users sale and service organization.

Gordon: Really?

Gardner: And that was in the Seventies, so by the Eighties it might've been a five hundred million dollar bill to actually enter that business, shocking, I mean I'm really surprised that they would miss that fundamental marketing, the cost of that fundamental sales and marketing issue.

Gordon: That would've turned off the financiers quite a bit, they had done roughly seventy million into IBIS, and--

Gardner: Order of magnitude more.

Gordon: To look at that much more when they hadn't seen any return on the first seventy would've been very daunting.

Gardner: Now some of the IBIS senior management were ex Memorex too.

Gordon: Ah yes, but they were from the floppy disk division, so any comparison between there and a real end-user mainframe organization's coincidental.

Gardner: And I guess they never read the annual reports either.

Gordon: <laughs>

Gardner: There's a great chart in one of them which shows the cost of establishing, you have to be in all twenty-six metropolitan areas and fifteen countries and you have to have servicemen within two hours, and it's an enormous cost.

Gordon: Multiple levels of service.

Gardner: Yeah, just an enormous cost, you can do it and it can be very profitable, but the investment is huge, I mean half a billion dollars would be a budgetary number then and for somebody to miss that is incredible in my-- but we're here to talk about you, not me.

Gordon: <laughs> That's all right.

Gardner: And not my opinions.

Gordon: Back to Cray for a minute, we shipped them a number of drives, I don't know how many total drives they had, but I did see a machine or two with all Cray drives or all IBIS drives on it. I left the company, what, in ’83.

Gardner: It says you went to NBI in ’84.

Gordon: Yes, so it would've been ’83 when I left IBIS, <clears throat> and I was still very interested in it, well why did I leave IBIS, I guess, let's go back to there. I'd commented already that my expectations weren't met with the starting of the PCM thing. We also had a revolving door in the president’s chair, so at the time I left we were on our third president, which was again, a StorageTek guy, and I'll remember his name here again, <clears throat> he was the StorageTek marketing executive VP. But anyway, the company’s literature kept getting wilder and wilder, you’ve commented that there was an IBIS 5000, at least at the time I left there was no internal concept of that other than in the marketing brain.

Gardner: I have a data sheet, data sheets are cheap.

Gordon: Right, right. So were on multiple presidents, I had, at the last I was VP of engineering, still living in Colorado, flying out to Duarte every week, to run Engineering,
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and it was still the company didn't have a success mentality from a technological perspective, it was marketing, it was show, it was great for the VC’s, build a prototype, show them it works, make a milestone that ships a beta site, but the reliability turned out to be so horrible that later on when Cray would ship the contingent a machine with IBIS drives on it Cray would literally give the client an extra IBIS drive, because one of them’s going to fail, and it's going to fail pretty quickly. Our boards were roughly fourteen inch square, our printed circuit boards, with two or three of them full of analog parts for the servo and read channel, and there was never any attempt at improving reliability. I would talk about MTBF to the

management and kind of deaf ears, “Don’t worry about it, we're making it work first.” And that was the Achilles heel of the product as far as Cray was concerned.

Gardner: A redundant array of expensive disks?

Gordon: <laughs>

Gardner: Well, actually IBM did force the customers to take one spare with the original 2314 right?

Gordon: Did they?

Gardner: The only thing you could buy from IBM was nine drives of which eight were online and the ninth was a spare, and they unbundled that in ’69. So shipping a spare with a product is not unknown but it is rare--

Gordon: Interesting. It was ’70 when I joined Memorex, so that was kind of the origin of my IBM awareness.

After I left IBIS I spent, I don't know, six or eight months trying to decide what I wanted to do, and presented a few super computer conferences and at one of them I bumped into some of the Cray guys again and they said “Please come back to IBIS, we don’t believe anything they tell us, and we'd like you to go back to the company and become our connection again.” I'd had enough at that point, my thirty thousand founder shares were reverse split twice, and they were worth less when I left the company than they were when I was the second employee <laughs> in the company after seventy million dollars of investment by the capitalists <clears throat>.

Gardner: IBIS was a disk pioneer with plated media.

Gordon: Correct.

Gardner: Plated media has a horrible reputation in the disk industry, any interesting recollections about the plated disks in the IBIS, did you ever hear about white worms on their disks?

Gordon: White worms, no, I did see a demonstration fairly early on of taking one of our fourteen inch plated disks, I don't know how much they weigh, a pound or two, something like that, <clears throat> laying a head on the disk and taking a pair of pliers and grabbing the head and waving the disk around in the air. One would think it was a term we called “stiction” and so in fact when the head is perfectly flat and the disk is perfectly flat there's a great atmospheric pressure holding the two together. So that was an ongoing problem.

Gardner: Stiction?

Gordon: Stiction, we talked about shrapnel, when you would have too much stiction, not enough wax or whatever inside a HDA, you could hear the arms being shredded inside an HDA <laughs>.

Gardner: Head disk interference is the euphemism for what we call head crashes

Gordon: Is the polite term for it, yes.

Gardner: Part of the reliability issues were head crashes?

Gordon: Head crashes and scored disks, yeah.

Gardner: Alar, a lubricated, plated media was tried by Ampex. Alar was the huge right about that time. Alar was shipping into the low end of the disk marketplace and got some success but then head crashes turned out to be the fatal problem they never solved, and I was just curious as to whether IBIS solved the problem in their own way. But who would we ask about that, who would have been the media technologist?

[0:50:03]
Gordon: Jack Toranto.

Dennis Morton was also the technologist, they said there was another guy hired before I was hired in IBIS, it was Dennis Morton, and he was from Burroughs also, he had worked on the production stuff at Burroughs. So we, at least until after I left, we had never solved the problem of head crashes, we did reduce the frequency, but early, when we were trying to do early system testing, by system testing our little board to drive it, our board host, we would typically have four or five HDA's before we'd have one that would work, or would last. We had our own clean rooms to build the HDA's, but it wasn't unique to have four or five or six before we had one that would work for us.

Gardner: And the principal failure would be heads crash, heads that ceased to work because they either crashed or wore out?

Gordon: Right, or didn't fly at all.

Gardner: Scored the media then?

Gordon: Yes.

Gardner: So it was head disk interference that was the problem until the industry went to carbon overcoated sputtered media.

Gordon: Yes.

Gardner: Data Disk shipped a bunch of plated lubricated disks for small applications, but no-one ever really made plated a reliable media. You said the folks in Colorado then went to IntelliStore.

Gordon: Yes.

Gardner: That's an optical disk company isn't it?

Gordon: I didn't know a whole lot about IntelliStore, it was I believe founded by some StorageTek guys, and they knew most of the people that were at IBIS there in Boulder anyway. I visited IntelliStore once or twice but don't really know much about them.

Gardner: The literature about the 5000 and 5800 says that the 5800 had a RS232 port in it, so the drive could quote, "phone home" as we'd say today. Did the 1250 have such a feature?

Gordon: The 1250 did have-- it had an intelligent processor in it, and we did diagnostics through a serial port. So the Cray attachment, Cray had their own system level software diagnostics, but in manufacturing the product we did not use any of our system boards, if you will, they were all manufactured using the serial interface diagnostics.

Gardner: Did you ever hook up to a modem and phone home?

Gordon: Not that product, no. Later on when we get to Array Technology we absolutely did.

Gardner: Yeah, phone home becomes another interesting aspect, I was just curious.

Gordon: Right, right.

Gardner: Anything else you want to tell us about IBIS before we press on?

Gordon: One of the interesting points, I commented earlier that as a manager I believe in giving people a challenge and then kind of getting out of the way. IBIS for the most part was micro managed and their big ways of motivating people, Jack Jones gathered us all together and gave us gold card cases with a folded up hundred dollar bill inside, that was Jack's way of motivating engineering.

Gardner: Did he want you to spend it on stock so the stock would then be worth, a hundred dollars would be worth ten million.

Gordon: He was again coming from a marketing sales kind of background, and that was a great “gee whiz” for him. Most of us shrugged it off and said “What am I going to do with a gold plated card case?”

Gardner: You still have it?

Gordon: I still have it.

Gardner: Still have the hundred dollar bill?

Gordon: I spent the hundred dollar bill <laughs>.

Gardner: So you spent six months sort of deciding what you're going to do with yourself, and then in ’94, I'm sorry, in ’84, you joined NBI, Nothing But Initials.

[0:54:53]
Gordon: Nothing But Initials, actually founded by a guy named Binx Selby, and I asked him one time what NBI really meant, and he whipped out this little business card, and I can't duplicate it but it was Ne Blung [ph?] something or other, he was a sci-fi guy, and so he had written a science fiction story and this was one of the characters.

Gardner: What was that founder’s name?

Gordon: Binx Selby, B-I-N-X, S-E-L-B-Y. Tom Cavanaugh was the CEO and president when I joined, and the inside story in engineering was NBI stood for “Never Buy Intel.” We had Motorola processors, and there were a number of relationships between executives and people working in the company, so another not so frequently expressed was “Nothing But Incest.”

But NBI was a fun company, their main product was word processing boxes, and their main market was attorneys. So they had a great presence in law firms, storing, retrieving canned paragraphs, depositions, all that kind of thing. But Tom Cavanaugh, the president, did not believe in PC’s, they were never going to do anything, we developed our own hardware, our own operating systems, and sold complete systems. As the company eventually tapered off it became nothing but a software company selling a little word processor, but even that died after a while. But at NBI I was hired to run the hardware engineering group and had, I don't know, sixty, seventy people in that group, and one of the first challenges they had a Unix system that they were just prototyping that had a five and a quarter inch full height disk drive, of the blinding capacity of five megabytes. And this was the ST506 interface at the time, which was the Seagate standard, I don’t remember if the disks were Seagate, probably, but anyway. In their Unix system they had this problem, they couldn't figure out why their system kept erasing the data, they'd load

the operating system and start running the Unix and a couple of days or a week later it would start having trash on the disk.

Gardner: They had their own controller, they weren't buying something from somebody like a DTC. They had their own controller that attached to their internal bus?

Gordon: Correct, correct. Yeah, they designed everything, they didn't buy much of anything outside. So that was one of the things, since I had a disk background, they called me and said “Tell us what's going on.” So one of the first things I did was hang a probe on the Servo system and watching it track follow and looking at Write Gate at the same time, so Write Gate would go up while this Servo was still doing this, trying to find the track. So it was clear that they were writing off track, so I said “For a temporary thing let's just synchronize to Index before you start writing anything, always look for Index.” And ‘pop’ the problem went away.

Gardner: I think you'd look for Ready too, maybe Index is gated by Ready.

Gordon: That could be.

Gardner: That's not a very sophisticated controller design.

Gordon: No, no, it was, engineering-wise it was not a very sophisticated company. And it was fun, Tom Cavanaugh at one point said that I was the most professional manager he'd ever hired, and I kind of was never sure if that was a compliment or a slap in the face, because most of the managers in the company were the creative, let's go roll our own, let's build a big system, kind of thing. But when I joined they were getting fined by Canada for shipping product that didn't conform, thrown out of Europe, [etc.] and by the time I left the company we had our own lab and did all of our own UL, all of our FCC, all of our stuff and we were allowed to put the label on it without even going to an outside lab, we were blessed.

Gardner: That's a long ways from parallel transfer five gigabyte disk drives down to a five megabyte ST506.

[1:00:00]
Gordon: It is, but I commented that I enjoyed starting at Memorex being able to touch logic, 5 volt logic, as opposed to the three kiloamp stuff that I used to work with. And it was a similar kind of feeling playing with five and a quarter inch disk drives, instead of a cabinet that was shoulder high containing a single disk drive, I could hold this little thing in my hand and it was like these things are now in PC’s, and I believed, even though our company management didn't, that PC’s were going to be big, and if PC’s were big they all needed one of these things, and so developing something, or using something created by the millions instead of by the ten thousands, had to be a cost benefit. So I was interested in what to do with this. So after being at NBI for a couple of years I started, you know, this thing kind of bothered me, what to do with this, and so I asked one of the engineers that worked for me, a guy named Bill Brant, who was doing our power supply and any analog stuff we had to do as well as processor design, I said “Bill, is it possible to take a couple of these drives and somehow play with the motor speed or whatever, such that

you can get the indexes popping up at the same time?" So Bill looked at it and he says "Yeah, that'd be pretty straightforward, pretty simple."

Gardner: Why'd you want to do that?

Gordon: Well, again, in the IBIS experience, we had four heads reading in parallel, and just the mechanical vibration, there's always some lack of identical positioning, so you had to have a speed matching buffer to essentially cache the data coming off, short-term cache, and we could run multiple drives but then you would have to have a buffer of a full track. And so the idea of synchronizing them to the extent where Index at least came up within a millisecond or two of each other, was a way to keep a much smaller buffer between the heads and the host system. So Bill said "Yeah, it's easily doable, we just have to tap into this circuit," and I wanted to have him actually do it but we never got around to doing that.

Gardner: This was at NBI?

Gordon: This was at NBI.

Gardner: So you were still thinking IBIS - wide, parallel transfer.

Gordon: Still thinking that parallel transfer or solutions for big systems using this inexpensive disk.

Gardner: Today we'd call that RAID 0.

Gordon: Today we'd call it RAID 0. So, while I was there I kept worrying this problem, and gathered Bill and another guy that worked for me, Warren Connor, and we started meeting at my place, my house, after work and weekends, just kind of talking about what could we do, what would we need. And when we did the Cray Research contract at IBIS the attorney that IBIS had hired to negotiate the contract was a gentleman named Bill Nikkel, William Nikkel. And so I knew Bill, I had worked with him in negotiating the Cray contract to some extent, I wasn't there through the full contract negotiations, but a good part of it. So I called Bill and I said "Hey, you've done some startup kind of companies and I've got this idea, don't really know what to do with it yet, but how about coming over and talking about it?" So Bill came over a couple of times and then he suggested a marketing guy, and I'll pull his name up here in a minute too--

Gardner: Ingles?

Gordon: Phil Ingles, yes, Bill had worked at StorageTek, was their chief counsel for a while, and Phil Ingles was a marketing guy at StorageTek.

Gardner: Which led to the proposal to form a company whose name neither Dave nor I can pronounce, spelt V-I-T-E, or pronounced possibly Vee-tah or Vite or Vi-tah.

Gordon: Vite.

[1:04:58]
Gardner: V-I-T-E, the document's dated July 13th, 1986, and I picked Phil Ingles' name off of a list of people who are going to get together on a Saturday and Sunday to talk about forming a company.

Gordon: Right. It's the fact that we had a document or two indicates that it was more than just a talk over a beer, but so there was an organizational meeting, what else, the company, current status, near term objectives, long-term.

Gardner: We don't need to read, because people will read it in the future, but sort of like the list of names there on the second or third page, if you'd walk, you know, you've talked a bit about each of them.

Gordon: The one I haven't mentioned was Larry King, Larry is an excellent engineer, one of the best hardware guys I've ever known. As it turned out Larry was doing consulting at the time, and I was unable to get him in the company when the time came, but he was one of the people that was in the early discussions with us.

Gardner: So, actually I'm curious as to which of those folks then went on with you to form Vite and then its history.

Gordon: Yes.

Gardner: I'm also interested in some of the market concepts, competitive concepts, technical concepts that existed in 1986 when you guys met on that Saturday. And maybe we'll take a break now and then after the break we can go into it.

Gordon: Okay.

Gardner: Okay, so it's the summer of 1986, I guess July 13th, and you're gathering a team to do a new product. I'd like you to go back again through each of the people who met with you that Saturday and Sunday, and make sure you tell us whether they went with you to what ultimately became Array, what they did as part of that, and anything else you'd like to tell us about them.

Gordon: Larry King was the engineering manager, and I had worked with him at IBIS for a short time, he was one of the guys in the controller group, and Larry's just a very solid, grounded, thoughtful kind of designer. And Larry was a consultant at the time, and when it came time to start the company Larry wasn't available.

Warren Connor was the next name as a manufacturing engineer, but Warren was actually the hardware, or mechanical designer. Warren is a interesting guy in that he worked for me six different times, so he

was with me at NBI, was one of my managers, and then he went with me and would leave to go do a startup, he was going to get rich, and then he'd come back, and then he would leave to go do another startup and he'd call and he'd say “You give me “that’a boy’s” all the time, all this guy does is chew me out.” So Warren was an excellent strong guy.

Gardner: Did he wind up at Array?

Gordon: He wound up at Array, yes, for quite a while. Bill Nikkel was the attorney that I had worked with on the IBIS contract with Cray, and I called Bill and he helped both advise me of how to create the company, and was instrumental in the StorageTek contract. So when we were independent Bill was our secretary and on the board. Phil Ingles was the marketing buy that Bill had recommended. And so those were the guys that were meeting at my home.

Gardner: You said Nikkel was the corporate attorney for Array.

Gordon: Yes.

Gardner: Do you know if he still has Array files in his files, or did he wind up passing them on to Tandem or?

Gordon: No, he was never part of Tandem, in fact Tandem didn't appreciate him because Bill was too independent minded. He might have.

Gardner: Does he still live in the Boulder area, or still in the Boulder area?

Gordon: On and off, yeah, he was writing a book and he commented that my company and I were going to be in it, but I never got a copy of it, I don't know if he finished it or not <laughs>.

Gardner: Okay.

Gordon: But I'll give Bill a call and find out if he's got any documentation, he very well might have.

Gardner: He has attorney-client issues but because it's history maybe the museum can acquire them.

[1:10:00]
Gordon: Well, yeah, and I was always the one who paid him, he was never hired by Tandem, so he was--

Gardner: But Tandem probably acquired all the rights to Array.

Gordon: Yes.

Gardner: So technically there's a privilege there.

Gordon: Could very well be a big connection, yeah.

Gardner: And then that's now Hewlett Packard, right?

Gordon: Yes.

Gardner: The chain, we'll get to the chain. Ingles, did he--

Gordon: Phil went with us, stayed with us at Array Tech, and did a good job.

Gardner: There is a discussion of the market in this plan, what was your recollection of your view of who needed what and who was doing what?

Gordon: At the time I was still in the super computer mentality, so it was Cray Research, and <laughs> it's called in here Crayettes, there were a number of companies that were also getting into various levels of super computer kinds of things.

Gardner: These are customers?

Gordon: Customers.

Gardner: Customers from the markets.

Gordon: Cray, ETA, Alexi, Convex, Saxby, MCC, Data General, Gould and Harris, the last two are kind of spook outfits. One memory flies back to IBIS, we had one of the spook outfits as a prospective client, we'd shipped them a beta site, and they came in and had a meeting with the then president of IBIS and myself, and we're sitting there discussing the product and he says “You know where we're going to put these,” and he says “We can't tell you, but they're going to be out in the Israeli desert in a bombproof outfit or installation that doesn't exist. And when you ship them to us they're going to an address that doesn't exist, and you'll never get back an HDA with the media inside, we're going to grind that up before we send it back to you.” And part of the discussion was about shipping schedules and the president made the comment “Well, you're not our only client, you're not our only customer,” and the guy got quiet, and he looked at the president and he said “You don’t understand, until you meet my quota I have the ability to station marines around your business and you're not going to ship to anybody.” <laughs> It was an interesting eye-opening for me, into the current world.

Gardner: Any competitors, I mean IBIS was clearly a competitor?

Gordon: Fujitsu, Fujitsu still made a parallel head HDA, and IBIS.

Gardner: How about Control Data, were they in?

Gordon: Control Data was the historic supplier to Cray Research, so those were pretty much the only competitors at the time.

Gardner: But those were big dumb drives.

Gordon: That's correct.

Gardner: Not arrays, you're contemplating an array here.

Gordon: That's correct, and at this point the concept was using these little cheap drives in place of this big cabinet, and one of the things I was concerned about is the mentality of the super computer user. So I called up Lawrence Livermore and made an appointment, went out and visited the guys who managed the super computer installation, did the same thing at NCAR in Boulder, the National Center for Atmospheric Research, and a couple of other outfits, one down in L.A. But anyway, I talked to a number of the super computer manufacturers, or managers, users, and I said “These little drives that people are putting in PC’s now, do you have an objection to those connected to your mainframe, your super computer? Do they work, do they store data, are they fast and reliable, that's all I care about, I don't care what you put in the box.” And that was the general concept. So that was encouraging. So I was still in contact with Cray on and off, this gentleman, Bob Halford, that I've mentioned, and I remember during this time calling Bob and saying “I talked to your end-users and they're happy with little drives, so I can put parity on them, but I'm still, I don’t understand how to keep reliability if the parity drive dies. So parity across the span of drives is easy to conceive of, but if my parity drive dies I don’t have any redundancy at all.”

Gardner: Now is this before or after this meeting?

[1:15:00]
Gordon: It would've been probably roughly the same time, I don’t mention in here the redundancy, so it was probably just after this meeting.

Gardner: I think you do mention redundancy, you just don’t describe it.

Gordon: Yes, I do talk about parity redundancy in here.-

Gardner: So that would be at least a parity drive--

Gordon: Correct.

Gardner: Yes, we call that today RAID Three.

Gordon: Right.

Gardner: But so you do recall talking to Bob Halford?

Gordon: Halford, right.

Gardner: About the bottleneck that a parity drive could cause?--

Gordon: Correct, correct, that was part of my architectural problem.

Gardner: And you think it's about this time?

Gordon: It was about this time, I was still at NBI, and talking to these guys about starting a company, and kind of playing with the architecture in my head, and so I called Bob one day and just, you know, shooting the breeze with him, but I don't really understand, you know, I don't know how to do it, and I don't want to have this single problem. And Bob very casually, he'd be a perfect guy in the Lake Woebegone area, very quiet and soft spoken, but I remember Bob saying "Well, all the parity doesn't have to be on the same drive." And it was like a big light bulb went off in my head, "Why didn't I think of that, we're distributing data, why can't we distribute parity at the same place across all of the drives." So it was in this same timeframe when I was finally getting the freedom to allow myself to believe that the host or the end-user didn't need to know exactly what head and what track the data was on. So from my Memorex IBM days you couldn't move data around so the end-user didn't know where it is, but I'd finally come to that conclusion that as long as we could find it, it didn't matter where it was. And so we could spread the data across different physical drives as long as we would address it in some fashion that he could recognize. So, that was when it became easy to understand how to improve I/O's per second, not just bandwidth, but I/O's per second.

Gardner: Did you actually have that meeting on Saturday and Sunday?

Gordon: We had a couple of meetings, I think there was a later, yeah, document in August, the same year, '86, August 22nd, in which we talked about it a little bit more. So, I don't remember exactly why this didn't go, whether it was a funding question, or what, but I still liked the idea, but I started calling companies to do it inside a company, rather than start my own organization.

Gardner: This is probably a good time to take a break.

Gordon: Okay.

END OF TAPE 2

[1:18:20]
Gardner: So in July and August of '86, you and a bunch of your colleagues from Boulder and from NBI and Storage Tech came up with this concept of a company called Vite -- swift, fast, Vite?

Gordon: Yeah, don't know where I came up with it, but it was the idea of life and excitement and fast.

Gardner: But it didn't happen?

Gordon: But it didn't happen. And I honestly don't remember why. The product was right. I don't remember if we decided we couldn't raise the money or what happened. But at some point while I was there at NBI after these meetings had taken place, and I had pretty much-- well, I had totally convinced myself that the concept was right, I decided that the disk drive manufacturers were the correct place to make it happen, as well as to get the slight modifications required to make the drives synchronize. So I started with the company that made the biggest disk drive in the 5-1/4 form factor at that time was Maxtor. And I also called Seagate, which was the largest manufacturer of small drives at the time. I had worked for Al Shugart at Memorex. And while I didn't know him well, I knew him. And so I called Seagate and talked to Al on the phone.
[1:20:00]
And he gave me Dave Wheeler's name. And so I flew out to Scott's Valley and interviewed with Dave Wheeler. And then I went to Maxtor and interviewed with Jim McCoy and the VP of engineering at Maxtor…

Gardner: Mike Warner?

Gordon: Mike Warner, yes. Thank you. And Mike-- it was kind of an interesting day. I was sitting in a conference room, and Mike had a conflict so he had a meeting he had to attend. So I'm sitting in a conference room, kind of, twiddling my thumbs. And this guy in slacks and a sweater walks by and comes in and says, "Hi, what are you doing?" And I said, "Well, I'm here to meet Mike Warner for an interview." "Oh, okay. What's it all about?" And so I just started talking to this guy and explained to him what I had as a concept of putting small drives together for mainframes. And so we must have talked half-an-hour or forty-five minutes-- just a casual conversation. It wasn't until after I was hired by the company that I discovered that was Jim McCoy, the president of the company. So I interviewed both Seagate and Maxtor, went back to Boulder.

Gardner: Can you date those interviews at all?

Gordon: Probably two months before I left Maxtor, so it would have been-- when did I leave Maxtor?

Gardner: Two months before you left NBI?

Gordon: Or NBI, yes. Sorry. So, I went back to Boulder and didn't hear anything-- didn't hear anything from either one of them. And weeks went by. And I finally got a call from Dave Wheeler saying he wanted to talk more. And I said, "Well, I'm waiting for a response from Maxtor." They made the larger drive at the time. And Dave Wheeler was running some skunk-works for Seagate. And while I didn't have any problem with Dave, I liked the attitude at Maxtor. And so I waited a little longer and it went on, like, six weeks. And I finally got a call back from Mike Warner, "Sorry, I've been busy. When can you come join us?" So, within a couple of weeks, I'd resigned from NBI and started at Maxtor.

Gardner: Can you date the resignation at NBI? Your resume unfortunately is annual doesn't give more precise dates.

Gordon: Okay, got you. I can. I will get that for you. I don't have it offhand.

Gardner: I appreciate it. We'll add it to the record. That's a very interesting date, because we know about the August meeting. Then there's the next milestone.

Gordon: So, I started working at Maxtor as an employee, working directly for Mike Warner. And just had a little cube and started spending full-time conceptualizing what the array would be-- how it would operate.

Gardner: Maxtor in California or Colorado?

Gordon: This was Maxtor in California-- in San Jose. So, I don't know. I probably sat there a month, something like that-- and would wander around, talk to the servo guys or talk to the interface guys or, you know, just other people in the company, product planning, about the capacities that they were looking at. And then Jim McCoy held an all-managers meeting. And Jim said, "I'm going for a trip to Europe and I'll be back in about six weeks. And here's George Scalise, the new president CEO. And I'm going to Europe because I don't want to get in George's hair. I don't want you all bugging me and taking George away. So, you know, it's his business.

Gardner: That was announced July 7, 1987, which was about six weeks after you joined?

Gordon: Yeah. And so, I, you know, went to George's secretary and I said, "I'd like an appointment with George." And so well, "Okay, I'll let you know." So it was, like, a week, a week-and-a-half later that I got an appointment with George Scalise. And I went in and he said, "Well, what do you want? What do you want to talk about?" And I said, "Well, I'm here to do an array of disks to attach your disk drives to mainframes." And so he listened politely. And after, I don't know, 20 minutes,
[1:25:00]

he said, "That's really neat. It's too bad we're not a systems company. Don't have any interest in that. So okay, thank you," end of meeting. So I went back to my office and that afternoon from Maxtor I called Dave Wheeler at Seagate and said, " Dave, is that job still open?" And he says, "Yeah, come on out. Let's do it." I said, "Got one change. I don't like living in California again, so I want to do it in Boulder." And Dave said, "I don't know about that. I'll have to check with Doug Mann or Al Shugart." And I said, "That's all right. Let me know." So, I stayed at Maxtor for another week or so. And Dave called me back and he said, "All right. We're starting a small disk operation back there anyway, so we decided we'll just make that facility a little larger and let you do it in Boulder." So I said, "All right. You're on."

Gardner: And this would be a week or two after Scalise joined Maxtor?

Gordon: Less than a month, certainly. So, Dave said, "Why don't you stop by and let's talk for a little bit." So I went out and visited Dave in Scott's Valley. And I wished I'd kept them, but I gave them a one-page schedule, a one-page budget, and a one-page product description. I gave him three pieces of paper. And I said, "This is what I want to do. And I'll have a prototype at COMDEX this year. So it was slightly less than a year, as I remember. So, that was the agreement.

[Editors note: Given Scalise joined Maxtor in July 1987, the conversation with Wheeler likely took place in August or September 1987, leading to a target product introduction at Comdex Fall 1988, not 1987 as implied above]

Gardner: So you had this one-page product description. Any differences from what you had in July?

Gordon: Progression, probably. Progression in that, going from-- I commented that the objective was to attach to mainframes. I had migrated, I suppose is the term, from strictly the super computer world to mainframes, in other words, adding transactions rather than just bandwidth. So, the super computer world, while interesting and they would like our product, is not the market to sell tens of thousands of systems into. It's a market to sell 150 or, maybe, 1,000 systems into. So, to broaden the market attractiveness to UNIX systems, to mainframe systems, to servers, takes you away from strictly 30 MB per second or 50 MB per second kind of world. So in separating the parity from a single-drive, it was now distributed from the idea of using not only all of the drives that were in the product for a single logical volume, if you will, but being able to have two drives that was a logical volume-- or four or six or seven-- a fully-configurable kind of concept at that point. So, it was-- to a great extent sitting at Maxtor, not having anything else to do, or my specific job being to define how to attach arrays, I was continuing my conceptualization of how to make things happen. So…

Gardner: So for sure at this point, if we had the document, you would have spread parity, because you're now worried about IOPS in addition to just pure bandwidth. Since you're now talking about other than super computers, how were going to make this box talk to the systems? Had you picked on a particular interface?

[1:30:00]
Gordon: We had picked-- to start with, we had picked VME. That was the, kind of, straightforward

backplane to plug into a Sun server or a MIPS server. As we progressed in our architecture at Array later on, we chose a MIPS processor. And so we used MIPS and Sun servers.

Gardner: So your controller would be on a VME board, plugging into a VME bus in the system.

Gordon: Yes.

Gardner: Then that would somehow connect to an array of drives.

Gordon: An array of drives. And those drives were SCSI drives.

Gardner: So this is '87, SCSI's been standardized.

Gordon: And it was the high-performance drives. And it had the first level of error-correction within it. So we didn't need to worry about any serialization, de-serialization or error-correction codes for the drive itself. It was strictly a matter, if the drive tells us it's bad, we believe it. And we recreate the data from that drive. So that was internal SCSI architecture-- our first product attached to, I believe, was a Sun server that we had.

Gardner: We're still talking about the three pieces of paper you gave to Dave Wheeler, where you were in the middle of 1987.

Gordon: Right. And I gave those pieces to Dave. And he really didn't look at it, other than, you know, "When are you going to have something to show and what's the bottom line on your budget for that period of time?" In fact, as I remember, he said, "We don't understand what you're doing and I don't want to. Just go do it. Do what you think is right." And so I went back, rented an upstairs room from an insurance company, called Bill Brant, one of the names that was in my early Vite plan. And Bill came over. We then hired a diagnostic guy, I think he was, a micro-code guy. So there were three of us in this upstairs office of an insurance company when Seagate set up the facility for the drive development and our system development in a new industrial space. So at that point, we just started developing a product and conceptualizing what it would like. I hired an outside industrial designer. And the idea of little drives on a big system was new, and so I wanted to make it obvious. So we came up with a cubed design that had, at each of its four corners the disk drives mounted three vertically on each of four corners with one of those corners being used for power supplies. So it held a capacity of 11 physical drives. And the center of this box was an air chamber, air flow where the electronics were. So we conceptualized this, built a foam-core box, did some pictures, and then we proceeded to build a couple of prototypes. Built two.

Gardner: I suppose I can hand you this Seagate brochure from about a year later. If you hold it up, Yan may be able to zoom in on the picture in the lower right corner of the page. That's a product brochure from November '88, I believe, and it's being donated to the museum by David. I guess your mock-up became that product.

Gordon: Right. And we took two of those products to COMDEX that year, had our own private suite in the hotel downtown. Had a stream of companies through, including the then-existent Memorex folks from Europe. And they were very interested in the product. And I had a meeting set up with Doug Mann and myself and the Memorex folks. And Doug got busy, so he didn't show up.
[1:35:00]
And so Memorex felt snubbed, so I worked for quite awhile with an engineering manager from Memorex at that point. And I can't remember his name. He was again, an ex-storage tech guy-- ex-Memorex guy. Maybe his name will come to me.

Gardner: Would the Memorex folks who were snubbed be Marcelo Gumucio or Giorgio Ronchi?

Gordon: I believe he was an Italian, but not Giorgio.

Gardner: Reto Braun?

Gordon: No. I'll have to get a look. It might drive you nuts.

Gardner: Giorgio Ronchi was the Memorex Italy general manager, then he became head of Memorex Telex after Marcelo Gumucio.

Gordon: It seems like he was not living in Italy. He was living in Great Britain or, you know, somewhere in Europe.

Gardner: This was after Memorex had spun out of Unisys. And this was what became the Memorex Telex, I believe. Memorex was no longer part of Unisys. I think they spun out in '86, and then they acquired Telex.

Gordon: Yeah, it was going to be a marketing kind of thing. They were going to, you know, buy it from us,

Gardner: Well a $300 million investment in sales and service, if you're going to that business, Memorex had the infrastructure to move your product.

Gordon: Might as well use it, right.

Gardner: Right. But it would have to be an IBM channel-attach to serve as their market. Did you have that?

Gordon: We didn't have an IBM channel, no. And that-- the gentleman, that I mentioned that I worked with, was also experienced in the IBM-compatible world. I guess I'll see if I can come up with his name.

Gardner: Was he from the Memorex engineering organization?

Gordon: Seems like this guy was a field engineer at Memorex-- field specialist, and then was a developer at Storage Tech.

Gardner: They had an engineering organization in Fremont or in Milpitas when they spun out from Unisys. I personally did some consulting there, and I just don't remember the name of the folks. But maybe it'll come. At our age, it happens, right?

Gordon: <laughs> Yes, yes.

Gardner: So we're at COMDEX. You have a working prototype?

Gordon: We have two working prototypes, both attached to servers.

Gardner: Attached to?

Gordon: Doing I/Os to Sun servers.

Gardner: An 11-drive array?

Gordon: Eleven drives. We were demonstrating…

Gardner: Configurable?

Gordon: Pulling out an HDA and watching the data stream across the monitor continue.

Gardner: Spread parody?

Gordon: Spread parody. One or two levels of redundancy.

Gardner: You mean, you could pull two drives out?

Gordon: You could pull two drives, continue to operate. Multiple-- too much configurability. In retrospect, you could have a logical drive of two physical drives, or three or four, or the top 25 percent of four drives-- one logical and the other three-quarters a different logical…

Gardner: A different type of redundancy, too?

Gordon: It can be a different type of redundancy as well.

Gardner: So one layer could be, say, mirror and the next layer could be spread parity?

Gordon: We really didn't put any limitations on the flexibility. So, while in some cases, you could get yourself in a corner, we didn't limit the end-user from that in our architecture. So yeah, you could have-- well, any combination you could think of was acceptable in our software and set up at installation time. When we delivered product, we usually talked to them, be it MIPS or Group-Bull or whoever we were shipping a prototype to, what they wanted it configured as. So rather than having them face the initial concept of how to configure it, we would ship it to them the way they wanted it. And that was all done through a maintenance port that we had connected to. We had this similar architecture as Memorex, if you will, ahead-of-string concept, in which we had a multiple or redundant controllers in the first box. And you could attach additional boxes to that for additional capacity.
[1:40:00]
So the product had, at this point-- and it was a SCSI interface and we had dual-interfaces so you could have controllers going to different hosts. You could have one controller or two for redundancy. The power supply's at this point were small paddle board plug-in hot-plug power supplies that shared the load. So they were not end-user replaceable, but you pulled off a panel and idiot lights were on, telling you which power supply was bad. So you'd pull that and plug in a new one. At this level of the product, the only thing the end-user could do would be replace drives. So we even talked about, in some of our discussions, that you could use it as a back-up. If you wanted to back-up your data on a drive, you'd put a drive on, copy data to it, pull it off, put it on the shelf.

Gardner: So you went from the empty offices over an insurance company in early '87 to this working prototype?

Gordon: Yes.

Gardner: In COMDEX '88.

Gordon: Correct.

Gardner: Three guys in the empty room. How big was your organization about then? How many folks?

Gordon: We had about 18 folks-- 18 or 19. And at COMDEX, Seagate held a board meeting. And I heard it was, kind of, impromptu, but whatever. They held a board meeting and it seems like it must have been just before Thanksgiving, COMDEX. Because as I remember, Thanksgiving weekend, I got a call from Dave Wheeler, "Seagate's decided to shut your operation down. I want you to box it up, lay everybody off, and have it totally cleaned by the end of December." And I said, "Well, what are you going to do with it?" He said, "We don't even know what you're doing. We'll just put it in the warehouse." So,

"Okay, thank you." So, there I was with a team of folks that, you know, for the last, I don't know, 60 days or so, I had mandated a six-day work-week. And everybody was there for long days getting those two prototypes ready for COMDEX. So, they were very charged-up. They all believed in the product. So here I was. I still absolutely believed in the concept and all of a sudden I didn't have a company or any way to make it real.

Gardner: Backing up, we have August '86. Summer of '86, you're at NBI, you caught this idea and started shopping it. Then you thought it was pretty quickly that you wound up first at Maxtor, then Seagate. But it's pretty clear that the Seagate decision occurred in late '88, because Array was founded in January of '89, so you may have shown the product in COMDEX '88.

Gordon: Yes, it would be COMDEX of '88.

Gardner: I have a couple of articles here which show the public announcement occurring in late '88 and early '89, which would correspond to Thanksgiving '88. f Dave Wheeler, a guy at his level, not knowing what you were doing, I wonder what other things he had on his plate?

Gordon: He ran a number of skunk-works at the time. I don't think at the time I knew what else he was doing. I think he visited us once in Boulder in the year or so period. And no other Seagate person ever visited us.

Gardner: During this period at Seagate, from sometime in '87 through the end of '88, were you involved with the Berkley folks?

Gordon: My marketing guy, Phil Ingalls somehow got wind of the fact that Berkley was studying disk arrays. And so, I don't remember exactly who called, but I was invited to attend one of their meetings. And their meetings were, kind of, run by Dave Patterson and Randy Katz. And they had a storage architecture committee, mainly people working on their PhDs in storage, and their objective was to use these small drives for large systems, so a similar kind of thing that I was trying to do. So they had developed the concept that was later published in a RAID paper by the same group. But they met couple of times a year with industry, and the objective was for us in industry to comment on the research that the students were doing. And, you know, say, "Well, maybe you'd look a little bit more in this area that you skimmed over" or "We've tried that; you're going down a garden path." So, as the students would get up and present their papers and we would comment on them. And there was usually a social hour where you could talk one-on-one with the students and give them some private insights or whatever. And at one of those, they suggested that the students would like industry at the next meeting to present what they're doing in this arena. So Control Data, IBM, Prime, myself, Tandem, you know, there were probably eight or ten industry representative in the meeting. And the students wanted to know what we were doing or had done or prototypes we played with. So it was arranged at the next meeting, we would each get up and give a pitch. So we had this product again operating at that point. And so I stood up and gave a half-hour explanation of the product and talked about the I/Os per second, transfer rates, we were doing close to 30 MB per second transfer rate and at the time, a whopping 400 or 500 I/Os per second. But it was early, and so I sat down and Mark Walker, the engineering manager from Tandem that was there, came over, kneeled down beside me, and-- the next guy is up starting his presentation. Then Mark looks at me and looks at the papers in front of me, "Is that real?" I said, "Yeah, come on back to Boulder and

you could touch it and feel it and, you know, watch it run." "I'm writing a patent on that right now." I said, "Well, we've written a couple and they're running around the patent office somewhere, but come on back." So that was the beginning of, first of all, a technology license that we did with Tandem for an amount of money, and which later, six months later, ended up in us, as Jimmy would say, merging-- Jimmy Treybig, the president of Tandem. "Merging," he said, "I don't ever acquire people. We join." So, that was one of the fun things. I was in the office, I don't know, 7:30, 8:00 in the evening and the phone rang. And I picked it up, "Hey, Dave, this is Jimmy." "How you doing, Jimmy? What's up?" And he says, "Are you happy with us?" And I said, "Yeah." "Good. Talk to you later." And I sat there, "What was that all about?" And so I called the attorney, Bill Nikkel and I said, "Bill, I had the strangest conversation, you know? It was all of 30 seconds long." And Bill says, "Well, if I were you, I'd call him back and ask him what it was all about."
[1:45 Chapter 25]
So I called Tandem and got through to Jimmy's office. And his assistant said, "Well, they're in a meeting." And I said, "Well, you know, Jimmy called me from that meeting. Go ahead and put me in." So, I said, "Jimmy, this is Dave again. We just had a conversation, but I don't know what it was about." And he laughed. And you could hear other people laughing in the room. And he said, "You know, my guys told me that same thing." He says, "We're sitting here deciding whether it's time to merge with you or to bring you into Tandem. And I wanted to make sure that you were ready for that, so that's what that conversation was all about." I said, "All right. <laughs> Thanks, Jimmy. I appreciate that."

Gardner: You know you jumped forward about a year. You're now in the fall of '89. We were talking about your second or third meeting with the Berkley team and several of you were asked to make presentations. First, you mentioned a guy Mark something?

Gordon: Mark Walker.

Gardner: Walker?

Gordon: W-A-L-K-E-R. I know Mark went to DEC with the organization. I don't know where he went after that.

Gardner: Is there any way you can date this meeting?

Gordon: The Berkley paper was published at the end of '88, I believe, right?

Gardner: There were actually several papers published in different technical journals between, more or less, December '87 and June of '88. I think there were two or three versions of the same paper -- \the Redundant Array of Inexpensive Disk paper published by Patterson, Katz and Garth Gibson. I think the first version was published in December '87 and there were several others.

Gordon: I think it was '88 when I went to the meetings with the group. And so again, if COMDEX was '88 COMDEX, early November, it was after that. Because we were an independent company at that point, not part of Seagate, when I met Mark Walker. So it was probably '89 when I met Mark.

Gardner: Okay, because it was about November '89 that Tandem entered into the relationship.

Gordon: Okay, so we had this Disk Array product.

Gardner: Well, the big thing, of course, that happened was Thanksgiving '88. You got the call from Wheeler and all of a sudden, you've got to box it up and shut it down. But you didn't do that?

Gordon: I didn't do that.

Gardner: What'd you do?

Gordon: One of the conversations that I had after that was with the attorney, Bill Nikkel. And I said, "Bill, I still very much believe in this product." And he knew I did. And he said, "Well, why don't you make Seagate an offer?" And I said, "But I don't have any money to buy the technology from them." He says, "Well, all they're going to do is put it in a warehouse, so let's just go talk to them." So, I called Dave and asked, you know, if it would be-- who I would talk to about buying the technology. And his response was, "Doug Mann." So we set up an appointment with Doug, Bill Nikkel and I. We flew out to Scott's Valley and we sat in Doug's office. And I told him that, you know, this was a product I really believe in. I really believe in its future and I want to continue it. And Doug said, "Well, what do you need?" And I said, "Well, I don't need all the equipment that we've got. You know, I can take a couple of scopes and a logic analyzer. And I'd certainly like to take the prototypes and the software. But there's this equipment that I don't need. And he said, "Well, how about space?" And I said, "Well, I don't have any space right now." He said, "That's all right. We've got that place contracted for another year-and-a-half anyway." So, we ended up doing an agreement with Seagate, $350,000 in three even payments, 12-months apart, for the technology and the prototypes and a minimal set of equipment.
[1:50 Chapter 26]
So, I walked away from that, back to the group, and held a meeting. And I said, "Well, I have…" I had told them that Seagate wanted to shut us down. And so I said, "Well, we got good news and bad news. The first news is that we're going to start a company out of this, but I can't keep all of you." So in that meeting, we called names of people off, and they left the room, and talked to a Tandem HR-- no-- a Seagate HR person. And there were nine of us, or ten of us, including me, in the room. And I said, "Those of you that are left, I'd like to invite you to join Array Technology Corporation-- a independent company-- and, you know, doing the same jobs that you've been doing. And, you know, let's go forward. I'm going to call you all founders, since, you know, you're all here. So, let's go forward and make a company.

Gardner: Doing the same job you were doing at no pay?

Gordon: I told them we have no financing opening, "I'm going to put whatever money I can. If any of you can invest in the company, that's fine." But we'll talk about that later. So, at that point, they all excitedly jumped in and said, "Okay, let's do it." And it was subsequent meeting with the attorney, who had dreamed up a share prospectus and price. And so one of the fun things-- every person invested to the point where the one secretary we had in the company, her brother invested 20 bucks, which our attorney acknowledged probably wasn't a sophisticated investor, but <laughs> he didn't make us not take it. The

interesting thing Anne Marie Hopf, one of our managers, convinced her church, Catholic minister or bishop, whatever he was, to invest. And so I never knew whether it was his personal money or church money, but we had $10,000 of blessed money. So I figure we were going to be a success.

Gardner: Probably a good time to break for lunch.

[1:57:00 Chapter 27]
Gardner: We were at the end of '88, talk about the founding of Array. I'd like to back up for a second, and in November, '88, while still at Seagate, four of you filed a patent application which became US Patent 5148432, Arrayed Disk Drive System and Method. I'd like you to tell me about each of the folks on it. I'll give you the cover in a second. I would note that, including my research, this patent has been cited in 251 subsequent patents as of about last year. Probably more by now; which is one of the largest citations I've seen. And I think the largest citation in this technical space, arrayed storage. I'd also note that the five of you in the same space filed a total of 28 patents at Array, and then at the subsequent companies, including a recent patent within the last couple years by one of you. So here's the cover sheet. And I know David W. Gordon, the first guy on the list. Who are the other guys? What'd they do? How'd they contribute to this invention?

Gordon: Sure, the other guys, the next name is Dave -- David C. Stallmo. Then David Warner. Just a short aside, we had six Daves at one point in the early day of the company, and when we were trying to name it, we even thought of Dave's Arrays. <laughs> We gave that up. Anyway, then Bill Brant, and lastly, Walt Hubis. I'd mentioned starting upstairs, above an insurance company, Bill Brant and Walt Hubis were the two other guys that were in that office with me. Dave Warner was a guy from Storage Tech, who was an experienced IBM microcode guy. And so he was the software manager in the company.

[2:00:00 Chapter 28]
An interesting aside - Dave Warner had had some bad experiences with startups. He was one of the ten people I'd invited to be founders of Array technology. And yet within a week, I had one of his people come tell me that Dave was telling his group in a department meeting not to trust me. And so he said, "You know, startup companies, the guy who starts it always makes money, and nobody else does. And that's just the way it is, so whatever he tells you, don't believe him." So that same afternoon I called Dave in and I said, "I was told blah-blah-blah. Is that correct?" "Yes, that's correct." "And I said well, I can't use you then. So clean out your office and go." So Dave Warner was part of Array Technology, but only for less than a week.

Dave Stallmo, other than Dave Warner, there was really no one in the company that came from the storage world. So Bill Brant came from NBI from a startup building telephone switches. Dave Stallmo was at the same startup doing telephone switches. And Dave Stallmo was a software guy, C programmer. And so Bill introduced me to Dave, Stallmo and I liked him, so I hired him as a software guy. And again, Dave and Bill had never come from storage before. So I had-- I don't know how many series of chalk talks with Dave Stallmo, in particular, and I'd, you know, draw on the board the concept of arrayed or spreading parody and spreading a second level. And they would, you know, I'd talk for half-an-hour and they would ask me an hour's worth of questions over what I was trying to tell them about.

Gardner: You could save yourself and us a lot of time if you say, "Dave Stallmo," instead of "Dave."

Gordon: That's true! <laughs>

Gardner: Because when we edit the transcripts we have to go and say, "Which Bill?" or "Which Dave?"

Gordon: Dave Stallmo was all of the above.

Gardner: I know it's hard-- but if you think about saying the whole name, or the last name, it'll make editing the transcripts for both of us a lot easier.

Gordon: Dave Stallmo grasped quickly the big picture of the product. And became kind of one of the go-to people for everyone else in the company about what we were trying to do. So after, I don't know, three months of Dave Stallmo being in the company, he was able to disseminate and distribute the technical requirements of the product. Dave Stallmo, when we became Array Tech, Dave Warner left, Dave Stallmo, I put him in as manager of the software department. So for the entire duration of when I was at the company, Dave Stallmo was the software manager there. Bill Brant was the hardware guy. He was manager of the logic department. And Bill was also a good analog designer. So he was in charge of power supply design redundancy. Walt Hubis was a diagnostic or firmware programmer. So he was writing all of our diagnostics. One of the rules was always that the diagnostic had to be ready before the hardware was. So the hardware guys had something to be able to test with. But those four guys were really the very front-end of the whole array concept. At the time I was worried about not having people from the storage industry, not understanding what the requirements are. And yet, I came to believe that it was a positive not to have people with pre-conceived notions. So they didn't know what couldn't be done, or had been tried and failed. So they just went off and did what had to be done. I remember working with the patent attorney, a guy named Larry Granatelli, who is an excellent patent attorney. And Larry struggled with this, 'cause he says there's a lot of papers out there, and some number of patents. And so Larry, you know, in working out the claims was trying to decide what was really unique in what we had.
[2:05:00 Chapter 29]
And the one thing that I remember is we defined that the differentiating part was that this product had the intelligence outboard to the mainframe. So it was the distribution of parody, the redundancy, the recreation of lost data was done outward from the host system. It was done at the control unit level. So whereas, Cray Research at IBM, a lot of other companies had parity, they distributed it from the channel level. Cray research, the same thing. So this was the first subsystem patent that allowed all of that to be done at the controller level. So that was the largest single differentiation of the product. And this diagram here at the bottom shows effectively what it was, a series of SCSI controllers talking to SCSI drives, parallelizing those SCSI controllers, filling into a large cache, and then do a host interface. So we had a MIPS RISC processor as our intelligence. And we didn't have a floppy, we used EE ROMS. They allowed us to a couple of things. Have a fairly instant boot up, as well as be able to update the software. So one of the things that we had in this product was a serial interface and the ability to upload software while the system is operating. Because we had a fully redundant product, we would take one controller offline, update its software, bring it back online, take the other controller offline and update it. And we did that from the Boulder office to the installations in the field as far away as Taiwan. So we didn't have any difficulty in doing software updates or bug corrections, that kind of thing. We also had all the statistics of reliability or any failures from drives or hardware was downloadable. So we'd dial into all the systems in the field, and download them, and for example, if Tandem's site down in Austin, Texas, where they had a couple of our products under test, we called them and told them to replace one of the drives, that it was

going bad. And they were quite impressed with the fact that we knew in Boulder that one of their drives was going bad.

Gardner: Looking at claim one, I think what you claimed which probably is of interest in all subsequent is the idea of multiple configurations in the subsystem. There was the Micropolis product out there, which was a subsystem mirror, and arguably was not configurable. And I look at your claim line with what you claim, because you're the owner, was this idea of multiple, the virtualization that's typical today. And I suspect anybody who's putting out a patent today looks back to you, and we've gotten very sophisticated in virtualization, but you know, your language is pretty broad about virtualization - multiple levels of multiple choices. So whose idea was that? A bunch of you were on the patent, but where'd that come from?

Gordon: Yeah, it all came out of my concept of how the product was going to operate, to the extent that I was prepared initially to-- and there wasn't anything preventing it-- but it didn't turn out to be a reason for it-- to support multiple size drives in the same product. So if you started with 300mb drives and you bought a couple of 760s you could plug those in and have a mixed system of different capacities. So but in trying to satisfy the market for I/Os and the whole spectrum of companies wanting-- some people wanted I/Os, but at a fairly high transfer rate.
[2:10:00 Chapter 30]
So you know, we might parallel four drives, and give them I/Os off of four drives simultaneously rather than 11 or 66. We could connect up to six of our boxes together for 66 drives. And it strictly becomes a performance per attached gigabyte at that point.

Gardner: Were you still contemplating synchronizing the spindles at this point?

Gordon: In all of the products, they were, in fact, synchronized. At this point to get an extra, both had a pin that would allow you to cross them and have them synchronized, so that the SCSI drives at this point were all synchronized within a couple of milliseconds of each other. So that was just part of the wiring of the back panel. One of the-- my objectives in creating the product was to design out any of the problems that I'd experienced in my previous 12 or 13 years of storage. More like 15 at that point. But be they power supply problems, I remember one field trip that I went on that the problem the machine was having trouble turned out to be whenever the freight elevator went up and down, we had problems. So you know, we had multiple levels of power supply that got rid of the problem of noise on the power lines.

Gardner: You're not thinking of the Memorex Konamatsu Bank Building problem, are you?

Gordon: <laughs> In fact that rings a bell.

Gardner: I have personal information about that.

Gordon: <laughs> There was another situation where, I believe this was in Dallas, where the machine only acted strangely in the evenings. And it turned out that when the janitor came in, he opened all the windows in the computer room and let the humidity in, and we had some early plastic ICs at that point

that loved to soak up the humidity. So those kind of war stories that I had in my head of cables that were put on backwards because they weren't clearly identified. All of those things we attempted to design out of this product, or prevent it. So you couldn't plug a board into another board slot. You couldn't plug a cable in the wrong place. Everything was-- like I talked about the idiot lights telling which drive or which controller is bad was designed for the lowest common denominator or maintenance person. So that the flexibility of the product once we started with you can have different capacity drives, you can have different size redundancy groups, and different levels of redundancy, one or two drive redundancy. We could have created a list of rules of configuration, but didn't see any reason to. So we kept it totally flexible. The drive-- the product today if we had one here, we could stick 100 gigabyte drives in it and it would operate happily. So there were no arbitrary limitations on drive size or speed, that kind of thing. As opposed to some of the sequential logic that I had designed back in the Memorex days, this was all asynchronous DMA kind of operations. So the software was totally independent from 99 percent of the hardware. The software kicked off something, and the hardware just made it happen. So as I told the venture capitalists a lot when I was out pitching it to over 70 of them across the nation, I called this a "creatively packaged software product". So you know, it's-- yeah, architecturally it's interesting, but where the interest really is in the software, how it operates. Almost any big VC in the high tech world that you named, I've been there.

Gardner: This was beginning January '89?

Gordon: January '89.

Gardner: And so there you were. You got a nice building. Got big debt.

Gordon: Nice building, big debt.

Gardner: Some cash.

Gordon: We raised about $100,000 from all employees, our board member, the church that I mentioned.

[2:15:00 Chapter 31]
Gardner: Who was the board member?

Gordon: Bill Nickkel, our attorney. So every employee invested, their families. My mother invested. So as it turned out they got about a 2.5 times return, so you know, it wasn't-- nobody was made a millionaire, but they were happy. A lot better than many startups do.

Gardner: A lot better than most startups do.

Gordon: <laughs>

Gardner: Actually that's a nice, particularly with the Catholic priest, and the gal's mother.

Gordon: Well, during that time, it was interesting, we ran out of money a couple of times, and one-- there was a company, East Coast Storage Company, that wanted to buy our software. And so I had talked to them for a while, and we finally decided to go ahead and sell it to them. So we licensed our software to-- and I don't remember the name of the company right now-- for $50,000, something like that. But I ran out of money before that closed, so I called nine people together and sat around the table and I said, "We're out of money. You know, I've got a hopeful kind of thing that's going to come down, but you know, there are no promises whether that'll close or not." And this was on a Friday afternoon, and I handed them their paycheck. And I said, "But, you know, Dave Stallmo and I will still be here. We've agreed to continue, and we still have the place, so you're welcome to come back, but no promises." Monday morning, every single one of them was there, continued working, and it was roughly two weeks before we closed that. And so I caught them up on their pay. The second time we ran out of money, I was discussing with Tandem the licensing agreement, and again, called them together and I said, "We're out of money. Dave Stallmo and I are going to take it to the basement to continue the product."

Gardner: I think we're actually in October '89. Well, that's when Tandem and you announced your agreement.

Gordon: Let me finish this one comment there. I said I ran out of money the second time when we were independent. And had Tandem interested, but not closed yet. And for the second time I told these same nine people that they didn't have a job. Weren't going to get any additional pay, and I didn't know whether there would be any more. And for the next two or three weeks everyone showed up every day, including most Saturdays. And I can tell you, if there's anything that a manager feels for his people when you have something like that happen, it just really-- I don't know, it makes you feel great as a manager.

Gardner: And to make sure they get their due, let's just back up a second. So in January '89 you took ten people in and fired one?

Gordon: Correct.

Gardner: So that's how you got the nine. And those nine were?

Gordon: Those nine were: Dave Gordon, Bill Brant, Warren Conner, [Judy Eggleston], [Dave Hagler], Jerry Hohenstein, Ann Marie Hopf, Walt Hubis, and Dave Stallmo

Gardner: That's great! So the nine of you are struggling without any money, and you're negotiating with Tandem. You got a deal!

Gordon: And we got a deal. We licensed the product to Tandem. They took a copy of the code, and a set of schematics. And one interesting thing there, before they gave us the check, they sent out an auditor from corporate to look at our records, the way we were spending money. They came out for a

two-day trip, and after four hours, he came in and he says, “I’m leaving tomorrow.” He says, “You guys are so squeaky clean, there’s no sense in me staying any longer.” So you know, we’d just done all our own thing. So he left. Later on, six months later when we were acquired by Tandem, the CFO sent the auditor again, or told him to come out, and he called me and he says, “You guys got the same system you had?” I said, “Yeah.” He said, “I’m not coming out.”
[2:30:00 Chapter 32]
Obviously, at that point anything on our books was on Tandem’s books, so there was some exposure there. But he had such faith in us as clean-living folks, they didn’t even come look.

Gardner: Tell me about the Tandem deal. Was it a cash plus royalty?

Gordon: It was a cash plus royalty basis. I don’t remember the royalty percentage right now, but it was enough that if we took off, and had a large revenue that we would all be more than adequately compensated. So there was up-front cash that was a little more than twice what we had paid for the stock initially. And probably, I don’t know, we ended up with another probably 50 percent of that in revenue or royalties over the time. We had products outstanding to Tandem, NCR, a couple of small distributors. I don’t remember who our Taiwan connection was, but we had a product in Taiwan. We had to eventually sign an OEM agreement with NCR.

Gardner: Actually, I think the next thing that happens according to my understanding is in August of ’90, you sign up with Storage Tech.

Gordon: Storage Tech was an interesting company, and early on, probably within six months of when I started for Seagate, I called Storage Tech, and went over and presented to their Senior VP of Advanced Products, or something like that. And I want to say his name was Bill Brown. Not the Bill Brown that you and I know, but another. And he listened to the presentation and said, “That’s all very interesting, but we’re not interested, thank you.” And so I left.

When we had a prototype running somebody called and said that Storage Tech would like to come talk. And this was after Seagate and before Tandem. So we were an independent company with nine people. And it turned out that Ryal Poppa and his board of directors showed up. So we had ten or twelve Storage Tech folks in our space looking at one of our prototypes. And one of the board members looked at me and he said, “And how many people do you have that developed this product?” And I said, “Nine.” And about three of the board members looked at each other. I didn’t know at the time that they were building an iceberg with hundreds of engineers assigned. But they stayed for an hour or so, a demo, and left. Specifically asked about power swapping. You know, “Does that work?” And we showed them. And later found out that they were having great difficulties with the hot plug power process.

So at some point after that visit, Don Swatick came out and we signed a contract. We spent a couple of months negotiating the contract. And the contract was for a product identical to what we were selling to NCR and Tandem, with the exception that it had an IPI3 interface. So it was our 19-inch rack product, but with an IPI3 interface in it. And Don and I agreed that that was where the future of storage was going, and away from the monolithic boxes of IBM. So that’s what we signed the contract based on. And then Don went away, was reassigned, and the product definition was given to the departments of Storage Tech, and they defined at IBM like box, six feet high, four feet wide, and 45 drives as I remember. You’ve

got the spec sheets, I think, Tom, so it says probably how many drives are in there. But it was a very expensive box. Had full redundancy, and everything, double power plugs. The full maintenance panel. Everything that a typical IBM subsystem has, and many times the price of what Don and I had agreed with up-front was going to be the product.

[2:25:00 Chapter 33]
So anyway, that was the product that we custom-designed for Storage Tech. Shipped a few hundred of them. In the contract we had things like guaranteed MTBF. We said what we would do for the product, and the number that's in the documentation was 23,000 hours MTBF for the electronics. Well, it turned out that we did better than 150,000 hours MTBF on the product. It was the most reliable product that Storage Tech had in the field. Fewer customer calls, fewer broken parts, or Field Replaceable units, we called FRUS, or CRUS, Customer Replaceable Units. At one meeting in Storage Tech, their field support manager got up, and he said, "This is the most successful BETA that we have ever had in any product at Storage Tech." It went in more smoothly, it has had fewer problems than any other product he'd been associated with. So while doing an IBM compatible interface was not easy-- never is-- one of the most difficult things turned out to be-- which you can equate to Memorex.

One of the points that I had mandated in the contract was that storage tech being the IBM compatible expert would have a diagnostic for us to test against, so that we could use that as a go/no-go performance basis. You know, are we compatible? So we'd attach to an AS400, run their diagnostic, and see if it was a good one or not. Good product. Well, Storage Tech never did develop that diagnostic. So when we started delivering product to them, all they had was the IBM software, and so there was no system level diagnostic at all, other than what we'd written for our own testing purposes. And that turned out to be one of the major problems in the litigation as it ended up. Because there was no acceptable, or acceptance test. They took-- because one of their managers had had a bad experience in buying an OEM product that was horribly unreliable, they didn't accept our product as being reliable. So they set up their own manufacturing line within Storage Tech. Every product we shipped to them, they took it all apart and rebuilt it in their factory. And for about a year they refused to even let us train the people that were doing this. And they had a lot of failures, sub-assembly failures, system failures. And so we finally convinced them to let us train their manufacturing people, and the reliability about tripled from what it had been. But you ask, Tom, what did they sue us over?

Gardner: I haven't asked that question yet.

Gordon: One of the claims that they made was they spent roughly $70 million in their own re-manufacturing process. I can't argue with the number other than they're horribly inefficient if that's the case. But they literally took every machine that we shipped them apart and put it back together again. So it was an interesting company process.

Gardner: Let me back up and understand the various machines that you actually built. Now for Tandem, they took a license, did they manufactured their OEM, did you ship them...

Gordon: They took a technology license just to understand and really to have something they could point at for this money.

Gardner: But then they bought product from you.

Gordon: Then they bought product from us.

Gardner: Was that the Seagate product?

Gordon: It was initially the Seagate product, but because Tandem has so much experience in customer replaceable units, they helped us redesign-- mechanically, mainly-- the replaceable items. So for instance, our printed circuit boards did not have just a couple of ears on them to lever them in and out. They literally had sheet metal on both sides of the board, so you could not touch the logic with your hands, even if you wanted to discharge static electricity into it. So the only thing that was visible was the connector out the back, and a couple of long pins to sequence power coming out of the board. Resister-- limit the power surge. So, you know, you'd plug in the board, and every unit was like that. The power supplies, the disk drives, the controllers, everything on the machine was in a metal box.

Gardner: This was the cross-shape unit with the drives in the four corners?

Gordon: No, that was the Seagate product.

Gardner: Okay.

Gordon: With Tandem, we redesigned all of the units to, yes, to this. So this is a standard 19-inch rack, and it also holds ten drives. And the two units at the top are fans pulling hot air up. The units at the bottom are power supplies. This also had battery back-up, so a couple of these units are batteries. There were two power plugs coming out of the box. One of Mark Walker's rules to me in designing this for Tandem-- and I remember in two different ways-- maybe one was more gentle than the other, but one was that you can't take a 30-aught-6, and shoot a single bullet into the product and have it fail. Okay? The other one was just a big screwdriver. You can't stick a big screwdriver in it anywhere and have it die.

Gardner: This is now your second design, essentially the same, identical electronics with improved software, and repackaged.

Gordon: Power supplies were from a different vendor, because we initially had just little paddleboards.

Gardner: And the firmware's on fifth or sixth generation.

Gordon: Yeah, continuing. 300,000 lines of code, something like that of...

Gardner: Now was this then the product you sold to NCR?

Gordon: Yes, this is the product we sold to NCR.

Gardner: And you sold it?

Gordon: We sold it.

Gardner: It was a license agreement also?

Gordon: No, it was just an OEM product. We were talking at lunch about JBODs. They actually purchased more JBODs from us than redundant systems.

Gardner: A single controller or two JBODs.

Gordon: True JBODs, no controller. And this was the systems division of NCR, and as you're aware, NCR got into the array game. I don't know how many we shipped them, 40/50 units, something like that, before they terminated the contract, put that GM in the penalty box, and built their own.

Gardner: By the way, JBOD is an acronym for Just a Bunch of Disks. Okay, so we now have the old product is the Seagate design.

Gordon: That kind of is dead end for that product.

Gardner: Okay, now you're building a more rack-mounted type product.

Gordon: Correct.

Gardner: STK did not want this product. They wanted yet another one.

Gordon: This was the product that we did the initial contract with Storage Tech up. After six or eight months of working with them, we sat down and did another contract that had a big development phase to create an IBM type box. So we would use the same CRU, technology, the same battery backup, but in a large six-foot high, three-by-four-foot cabinet.

Gardner: And that was the Alpine?

Gordon: That was the Alpine product.

Gardner: Storage Tech's name was Alpine.

Gordon: Storage Tech's product name, yes.

Gardner: Did you sell that product to others, or was that exclusive?

Gordon: That was only for Storage Tech. It was an exclusive product.

Gardner: And so it's more disk drives, more power supplies, same architecture, same software.

Gordon: Same architecture, software with the one exception that it was an IPI3 interface as opposed to either VME or SCSI kind of product.

Gardner: That was the product that you sold to Tandem and NCR?

Gordon: SCSI product host interface.

Gardner: What, probably a wide SCSI?

Gordon: Yep, yep.

Gardner: And so it then plugged into some wide SCSI host plus adapter, VMI or otherwise.

Gordon: Correct.

Gardner: Some where's along here you get acquired by Tandem. And I don't have that. You mentioned Jimmy Treybig calling you up. You know, it's not in my notes?

Gordon: It was almost exactly six months after the licensing agreement.

Gardner: All right so the licensing agreement would be in April '90. Tandem buys disk startup Array.

Gordon: That sounds about right. Yeah, there ought to be enough publications on that one.

Gardner: It was April of '90 you got acquired -- shortly thereafter you entered into Storage Tech agreement. You told us about Treybig's strange call. Most startups don't get to have that pleasurable experience. What would you like to tell us about it?

Gordon: It was very painless with the exception that they had nicknamed me “The Cowboy.” Tandem in the Bay area was, I don’t know, roughly a billion dollars in revenue. And had all of the corporate rules of such a size company, and they had fairly recently had a case where a number of desktops had walked out the door. So they had a corporate security rule where everything had to be bolted down or chained to the desk. They had security cameras on all the doors. And so they sent me a nice little letter saying that that was a requirement, and to let them know when I had done all of that for our stuff. And I wrote back and told them, “This is Boulder, Colorado, we don’t do that kind of thing. We trust our people.” And so I know that went up the flag out there to some level. And it came back down, “Leave them alone.” So HR tried two or things as well, and I don’t remember the details of what they were trying to get us to do, but after two or three episodes like that, most of Tandem organizations left us alone. Oh, I know their manufacturing at one point wanted us to use all of Tandem’s part numbers, and get into their release system. And I said, “Whoa! Wait a minute! We got to get the product working before we dive into your EC processing system, and all of your online approved parts list,” etcetera, etcetera, etcetera. So like I say, I became known as “The Cowboy,” because I didn’t do anything the way corporate did. So I had a board of directors consisting of Jerry Held, the technologist of Tandem; Don Fowler, kind of a subsidiary manager, EVP. Seems like there was one other name on the board, but I don’t remember what it was. We never had a board meeting. Don Fowler came out maybe two or three times to visit us. So it was an extremely painless acquisition.

Gardner: You hadn’t raised any VC money at all?

Gordon: No.

Gardner: Talked to 70 of them?

Gordon: John Hill, Carmen, Kirby in Boulder, talked to them most.

END OF TAPE 4

Gordon: I was talking about speaking to one of the venture capitalists, John Hill; Hill, Carman, Kirby of Boulder. And, I'd probably talked to John five or six times. He'd been out visiting our place, had talked to people in my background. He was seriously interested. A guy named Carl Carman was one of the associates, not a partner but an associate. And, Carl was very much behind our concept. But, I remember one of those meetings, one of the last meetings I had with John Hill, and he said, "Well, how about, you know, you're president of Array. What do you think your job should be?" And, I remember kind of sitting up straight, "Well, president." And, at that point, his interest closed. In retrospect, I was not prepared or ready for running a company, public company or private, from, you know, the marketing, all of the business aspects.

Gardner: What they probably wanted you to say was, make a lot of money for the VCs.

Gordon: Well, that could be, too. If I had told him I'd be, you know, I'd love to do the chief technology route or something like that, we might have had a different outcome.

Gardner: And, how much did Tandem pay?

Gordon: Tandem paid about $0.5 million for the company. And we tried to keep a percentage of the company for ourselves. And, they just made a flat statement, "We never allow acquisitions to retain any equity." So, that's when we did the licensing or royalty basis. So, the more we sold, we would still have some residual income from that.

Gardner: So, the employees got residuals on the product, even after it became part of Tandem?

Gordon: Yes, based on their share ownership at the acquisition. So, yeah, one of the comments that I made is that I would not make more than, I think it was twice was the number I said, I would not make, out of this company, more than twice what anybody in the outfit did. And, I've been told that that was dumb, but that's the way I did it. And, I stayed with that, even though the marketing guy and Phil Ingalls and our attorney Bill Nickel tried to convince me otherwise.

Gardner: In retrospect, if you guys had said you've gotten a tenth of a percent of revenue on your patent in perpetuity, that's big numbers these days.

Gordon: One interesting part of the Tandem contract, when we were doing the final negotiation for the Tandem license, Bill Nichol and I spent about three days in Cupertino discussing all the details with Tandem. And one night, I got a fax at my hotel room that I wish I'd kept, from Ryal Poppa. Storage Tek had wanted to acquire us, and both Bill Nichol and Phil Ingles said, "No, you'd be crazy to do that," from their time within Storage Tek, knowing the way the company operated. So they both strongly advised me not to even consider it. But, the FAX from Ryal promised me considerably more than I would make personally from any discussion with Tandem, no numbers, of course. But, he promised a great personal reward, and I didn't respond.

Gardner: Now, my understanding is the Tandem folks were not receptive to a hardware array company.

Gordon: Hank Zoterrer was the storage manager at Tandem, and Mark Walker worked for Hank. And, they had a very tight department for many years, very few newcomers, very few people leaving. And, even though Mark was working on a similar architecture to ours, Tandem systems effectively connected all the disk drives directly to their system. They didn't have I/O subsystem, if you will. And so, our concept didn't match with the historic Tandem architecture. So, we were never seriously considered for attaching to the Tandem NonStop mainframes.
[0:05:00 from start of session 5]
However, their UNIX division down in Texas was very interested in our product. So, whether Mark's early investigation into disk arrays was for the Austin group, I don't know that I ever heard. But, the Austin Tandem UNIX group did take a number of our products and did quite a bit of testing with them and, I believe, sent them to beta sites, but I was never visiting their field. So, MIPS John Mashey, you may have bumped into somewhere.

Gardner: No.

Gordon: John was MIPS chief technologist, and he was interested in our product. I believe he's one of the advisors of this museum, according to the Web site. But anyway, MIPS took some number of our products. In fact, maybe that's where I got to Taiwan, was a MIPS connection.

Gardner: Yes. So, who were the competitors on the supply side in this time period? We're talking now we're into '90, '91. You're selling to NCR, Tandem, STK, other smaller companies, or you're a part of Tandem. Who did you consider your competitors?

Gordon: Very few. SF2 was another startup company founded by Tom Idelman, a guy that both you and I know., Tom, had worked with me for a number of years. Tom and I shared an office wall for probably five or six years. I forgot who the president of SF2 was. Met him a couple of times, but I don't remember. Anyway, they were doing a disk array product, and in all of our presentations, sales presentations, we talked to Prime and NCR and Data General, Amdahl, everybody you could think of, and, Micropolis, Maximum Strategies. So there were a number of companies doing high-performance groups of disks, RAID 3 kinds of things. But I'm not aware of anybody that was trying to market something like we had at the time.

Gardner: Yes. According to my research, Storage Tech shipped the AS/400 RAID system in December '92. Two years later, they sue you. Tell me about the two years in between. I think maybe you talked a little bit about some of the lack of, say, an acceptance test and the remanufacturing. Any other things you'd like to talk about in that period?

Gordon: Yes. It was interesting that the engineering group that Storage Tech assigned to the product was what I call a second string group. There were none of their people out of the main line development organization, which from a, you know, from their management perspective, I could understand not peeling off their top guys. And yet, as it turned out, the guy who was the lead technical representative from Storage Tech was a guy that I had interviewed for a position and not made an offer, because he wasn't strong enough. So, his attitude when we started was, "I don't like you and we'll go from there." So, the program manager that was assigned by Storage Tech after Don Swatick left, was the son-in-law of Storage Tech's chairman. And, I don't know what his background was, but it certainly wasn't technology or production. And, he would sit in meetings. We had weekly project meetings at our offices. And for the last, I don't know, eight or ten months of our delivery schedule, kept telling me to order more products, [0:10:00 from start of session 5]
that the product is selling so quickly and so wonderful that our planning people are going to increase our projections, our forecasts. And yet, they would never–- they didn't increase anything on paper.

Their beta sites and their sales, we sold them a couple of hundred units, were going very well. One of those experiences was at a customer, the AS/400, and our product was installed. And, the management of the company was doing a show-and-tell, and they sent one of their people off to talk to the end users and tell them that we were going to start playing with the storage and pull units off. And, the guy that was going to talk to them had been gone for so long, they just started pulling CRUs, Customer Replaceable Units. Everything was a CRU, our drive, our power supply, our battery. So, when this guy came back from pulling the users, on a table, there were a couple of disk drives, couple of power supplies, a controller. And, the guy came back and they say "The users who are saying, the system's working perfectly, don't touch it." So, this is with a large number of our pieces out of the product. Because of the

battery backup, there were a couple of these CRUs. You could literally walk up, pull both power plugs out of the wall, wave them around, and have the AS/400 just humming along happily. So, it was a very successful product in the marketplace. The customers were very happy with it.

But, Iceberg was still having problems. They couldn't get Iceberg out the door. That's their Storage Tek big system version of a disk array with, as far as I knew, much of the same virtualization that we had. But they say, they sold our product. They remanufactured it and shipped it. They would send all of the field returns back to us, and we had a closed-loop corrective action group of two engineers. Every CRU that came back, every failing unit was analyzed to understand what the cause was. And, we put it through the HALT process again, if we couldn't easily tell what went wrong. And, we'd typically find a broken trace, something that was a root cause. We kind of used the Japanese "ask five times why, and when you get down to the fifth why, you're pretty much at the bottom.

Gardner: HALT is Highly Accelerated Life Testing.

Gordon: And HAST, Highly Accelerates Stress Testing. And, when we say highly accelerated, we're going from a minus temperature, minus 20 or 30, to 70 degrees C, in just a minute or two, while the unit is under vibration, in a random access vibration. So, the devices were only specified to work at 50C, but we'd run them up to 70C. And, we found in the process, some design errors, some worse case problems. And, we got to the point where every single board that we shipped was run up through 70C, under constant vibration, before we'd ship it. So, the reliability of the product was some seven times what the contractual requirement was.

Gardner: But, STK ultimately won the lawsuit and was awarded $67.8 million in damages. What were the issues? Were you involved?

Gordon: No.

Gardner: Did you testify?

Gordon: I did testify for three days, but I was not allowed to participate in the preparation of the case, if you will. I spent, I don't know, a few weeks in the very front stages explaining some of the documentation and the product, to the attorneys out of Denver, that were hired. But, I was never part of the litigation, really.

Gardner: Did you recall what the complaint was? They alleged a breach of contract. I haven't seen the complaint to figure out what the alleged array did, but they obviously convinced a jury.

[0:15:00 from start of session 5]
Gordon: Yeah. And it was-- the rumors that I heard, because I never saw the actual complaint either. But what I was told was that they said we didn't meet the specifications. So, after a couple of hundred field units are installed with very happy customers, I didn't quite understand why it didn't meet those

specifications. Our reliability was seven times what they had asked for. Our field maintenance was such that we typically told their field service guys what was going on in the field. So, other than the price, when we configured the unit or specified it, the dollars per megabyte were roughly $25 to IBM's end users. When they stopped taking product, it was about $5 to $6 a megabyte, with the largest drive that HP was shipping at the time. So there was a lot of activity on cost. Towards the end they came in and did an audit on the cost of our controller, the cost of the detailed pieces, to try and get us to lower the price we charge them. And they accepted the fact. I think we were doing a 22 percent margin, or something like that, on hardware. And that barely covered, you know, the labor to put it together. So, they couldn't argue us down in price anymore. And, the drives were never purchased by us. They consigned them to us, and we put them in boxes, tested them, and shipped them a box ready to go.

Gardner: Hewlett Packard drives, did you say?

Gordon: Yeah, Hewlett Packard drives. That was their vendor of choice.

Gardner: Not necessarily a low-cost drive supplier.

Gordon: No, nor a real high volume supplier, but that was their choice. So, I'm not-- other than cost, I don't know what happened in that contract.

Gardner: Yes. Actually just about the time you left, or maybe because, EMC acquired Array from Tandem.

Gordon: Right. It was right at the time I left. They had, Unterberg Harris had come out and done an analysis, actually did two analyses of the company. One was before Storage Tech stopped the contract, and that was–- Tandem was what, feeling good about us, but realizing that we were not integral to Tandem. And then it made sense to spin us off. So, Unterberg Harris came out and did an evaluation and came up with roughly $100 million that we could go public, as an independent company. And so, Don Fowler and I were literally in discussions of, you know, well, how much of that can we reserve for the employees, and how much of it goes to Tandem? When Storage Tech started being late paying, and they didn't send the checks as promptly as they had before, and I finally had a discussion with Dave Reiss, their executive VP and ex-IBMer. And, Dave said, "I'm just the bearer of bad news. We're not going to accept anymore product, and we're not going to pay for the last 50 or 60 that you've shipped us. So, this is the end of the contract." And from there, it was some three years in preparing the litigation that went on for months. And a jury of non-technical people awarded Storage Tech the winning. Our attorneys were all-- it was interesting, they were all high tech, You know, you've been in more courts than I have. But, the attitudes of the attorneys to the jurors, and to the court, our guys were all techies. Everything was data-based. A couple of monitors, big monitor showing for the jury, accessing documents, pulling them up on the monitor. Storage Tech had foam-core boards for everything. Now, very hands on, they had a lady attorney. Didn't admit she knew anything about technology. And, our guys were just tech weanies. And so, whether that affected the jury, I'll never know. When I spent the three days on the stand, at the end of that time, the attorneys, you know, took me out to dinner and said
[0:20:00 from start of session 5]
"Wonderful, no problem." The senior guy said, "I've been in private industry a little bit, and I probably

would have done everything just the way you did it." And so, they were very upbeat and confident that we would win the suit.

Gardner: It's an interesting juxtaposition, if at one point Unterberg thought Array was worth $100 million, EMC paid less than $10 million to Tandem, which is a magnitude of difference. Now, did you leave before or after the EMC acquisition, do you recall?

Gordon: During the discussion, it was actually before. I went and interviewed at EMC, and was the president before the current guy. I don't remember his name.

Gardner: Dick Egan?

Gordon: Yes, long-standing guy. And I remember him trying to impress upon me the fact that EMCers work harder than any other company. And that, "When we send our people to the west coast, we expect them to take the red eye back, and we expect them here at the office at 8:00 in the morning. So, there's none of this, you know, sleep the night and take the 10:00 plane back and miss a day at work. Uh-uh. You know, we– you take the red eye, leaving at 11:00, you get in at 6:00, and you're back at the office at 8:00. And, that's the way our company operates." It was an interesting interview. I met a few of his Israeli engineering managers, but didn't hear from them after that trip.

Gardner: Yeah, but they went out and bought the company. I guess you don't know, because they then shut it down, ultimately in '96. They bought it, you know, early '94 and early '96. So, about two years it lasted within EMC. And actually, EMC sold one of these products as something called a ModARRAY, which I suspect is a variation.

Gordon: Yes, a variation but a very different variation. The ModARRAY was what a lot of people are selling today. Three-and-a-half inch drives in a three or four U, 19-inch rack mount product with, I don't remember, 10 or 11 drives, maybe nine or 10 drives across and a controller on the top and bottom of that rack, and additional racks with the same number of drives chained to it. So, it had, again, the full redundancy, and could be in a box with our CRUs, at the bottom, you know, holding the rack up, kind of thing. But, that was a three-and-a-half inch version of the same software as what we had.

Gardner: Using the same RAID SCSI controllers and software?

Gordon: Yes the same as the earlier products.

Gardner: The earlier product, which is new, smaller, higher capacity drives, and repackaged now to a rack product. Not unlike the STK version, or STK, I guess, was a little different than that.

Gordon: No, the STK was still CRUs, customer replaceable everything. And, this product was designed to be much more dense storage cell.

Gardner: There's been a lot of recent discussion of the conflict within EMC, between the big Symmetrix folks and the small modular Array folks. Like, do you know anything about it? Was the demise of AT part of that conflict?

Gordon: It was part of it, but I'd mentioned the cowboy mentality that I had or was anointed with from Tandem. The group in Boulder carried a similar independent attitude to EMC. And, EMC is a much more disciplined, military-type organization than Tandem is. In Tandem, it was not unusual for a manager to disagree with a command that came from the top, and literally to do something different. So, if they said you'll use a MIPS architecture, and he liked Sun's part better, he'd go use the Sun processor.
[0:25:00 from start of session 5]
And, EMC is you salute and click your heals together, and do exactly what you were told. So, even EMC, for a long time, had the disagreement of big systems or smaller systems, where is their emphasis, where do they want to be. In discussing with them products early on, it was, "We don't do the smaller system stuff." So, it was a bit of a surprise that they ended up doing it later. But, there was one product planning guy, Mark Lippitt, that I had, that went to EMC and I believe he actually moved back to the east coast for a while with EMC and, you know, helped them plan how to get into the midrange market. But I think Mark left after a year or so.

Gardner: Actually, I think Tandem, if I've got it right, wound up selling that Array product that was developed at EMC.

Gordon: Oh, really?

Gardner: It got licensed back to Tandem.

Gordon: Everything comes around.

Gardner: What comes around goes around. The industry has been characterized, it's different companies and always the same people, as opposed to say the optical storage industry, which is same companies but always different people.

Gordon: Yes. Well, the dinner you had last night, you know, there was six of us that had had wild, invariant experiences, but we all started at the same place and all stayed in the storage.

Gardner: Was there ever any discussion at Array Technology, about IBM channel connection for the product?

Gordon: Not really. Towards, what, I guess, in '93, I managed to get a gentleman named Randy Kearns from IntelliStore to join us, K-e-a-r-n-s. And Randy is one of the best I've found. I would have loved to have seen a technical battle between him and Tom Idelman, for example, or he and Jesse Stamnes. Randy Kearns was a former software guy, but he wrote whatever software we had, to test on the AS/400 for us. Randy was one of the guys at IBIS, doing the storage control unit, and was at Storage Tech,

obviously before that, doing their storage control unit. But Randy, the last time I saw his name on the Web, he's still doing consulting in the large systems area.

Gardner: So, 27 years experience in the storage industry right at the nexus when SLEDs, Slow Large Expensive Disks became Arrays of Disks. Any closing thoughts? Anything you'd like to share, looking back?

Gordon: It's been a wonderful ride. I wouldn't change much of any of it. No, it's been exciting. It's been an industry with a lot of great people and a lot of great challenges. And, I might do a few things differently in some of the companies, but I wouldn't change the career.

Gardner: Thank you. I enjoyed it.

END OF INTERVIEW

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