Oral History of Richard Berreth and Tom Murnan

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Tom Gardner: Good morning. This is Tom Gardner, a volunteer with the Computer History Museum in Mountain View, California, talking to two CDC alumni in Bloomington, Minnesota, courtesy of Cisco Systems. Why don't you guys introduce yourself? Dick first.

Richard (Dick) Berreth: I'm Dick Berreth, former Vice President of the Normandale Division. I'm a mechanical engineer, with a Bachelor's in 1958 and a Master's in 1962. I then did another 30 credits toward a Ph.D. in operations research. I also got a PE [Professional Engineer] license and have almost 40 years of experience.

Tom Murnan: Tom, I started with Control Data in 1961. I'm a graduate of the University of Minnesota and hold a Bachelor of Mechanical Engineering degree. Control Data and later Seagate, which bought the CDC disk drive operation in 1989, were the only companies I worked for, totaling 46 years. I retired in 2007, about this time of the year.

Gardner: Great. I have to note that this facility is being provided to us courtesy of Cisco Systems. A number of Cisco employees have been very helpful in causing this to happen. It's an experiment for the museum to do an interview for an oral history remotely and hopefully, if this works out well, we can now talk to folks anyplace in the world. But, in particular, I'd like to thank Claudio DeSanti of Cisco in the San Jose area who set this up, and his colleague, Landon Noll, who is actually hosting us today. Craig Taylor from Cisco TV, a 15-year-old TV studio, is recording us in this session. In addition, a number of people in Bloomington have been very helpful in getting Dick and Tom to their room, particularly Anita Cooper.

So thanks Cisco very much for this opportunity. Dick, please tell us some of your background.

Berreth: Well before I came to Control Data in 1969, I worked for Collins Radio Company in Cedar Rapids, Iowa. I started there as a manufacturing engineer and then got into the materials area to design a paperwork system to handle engineering changes.

Gardner: We'll get into Collins in a second. Where did you grow up? How did you wind up as an engineer?

Berreth: Okay, well I grew up in South Dakota. I was born up in the northeast corner of the state and my dad was an old country preacher, so we moved around quite a bit. I graduated from high school down near Yankton, South Dakota, in a little town called Menno, a German Mennonite community. My intent was to go into the Army. I had an older brother, who was in the service. He was over in Germany, pushing a typewriter in a headquarters company and touring Europe on the weekends. That sounded like a great deal to me. The high school was 9th through 12th grade and had 100 kids, so it was a small school. About January of my senior year, the guy who taught math handed me some paperwork and said, "Why don't you fill this out? Maybe you'll get a scholarship. You're pretty good at math." So I filled it out, just because I liked the guy and he was a good teacher, and sent it in. The week of graduation I got a letter from South Dakota State saying, "Congratulations, you have won a Freshman Tuition Scholarship in Engineering." I thought gee, they're going to pay for it, so I'll go to school for a year and then I'll join the army. The draft was active, so you'd just as well join, because they were going to get you anyhow. So I went up to State and went to college, but had no idea what engineering was. I asked my dad and he

said, "I don't know. I think some of them work for the railroad and maybe the Highway Department." When I got up there they wanted to know what kind of an engineer I wanted to be: electrical, mechanical or civil? I knew I didn't know anything about electricity, and I figured the civils' had to work outside in the winter, which in South Dakota is cold. So I said, "I'll be a mechanical." But the tuition at South Dakota State in the fall of 1954 was only $28.00 a quarter. So what I had won was $84.00 and that $84.00 determined my career. After I got started in engineering and found out what it really was, I fell in love with it and said, "Boy, this is for me." I was writing my brother, who was going to get out in a year, and said, "Hey, you can't believe what they're paying these guys to start. Besides, this is really interesting stuff." So after he got out of the service, he then came to South Dakota State and was a year behind me. Of course he had the G.I. Bill and was getting $110.00 a month to go to school. Back then that was big money, so I made a deal with him that I would sell him my textbooks for what I'd paid for them and also give him my copies of the tests and my notes. He thought that was a heck of a good deal, so that's what I used to buy my textbooks for the next year. Tuition didn't go up until my senior year and then it went up to $125.00. So I was able to work my way through school and my brother really bought my books for me. That's how I became an engineer.

Gardner: Tom, its Thomas Murnan, right?

Murnan: Right. Nicknamed Tom though, and prefer Tom over Thomas.

Gardner: Your background?

Murnan: Somewhat similar, only my father wasn't a preacher. I was also raised on a farm, near a small town out in southwestern Minnesota called Fairfax. New Ulm is a nearby town that's a bit larger and has more recognition. Our farm is along the Minnesota River Valley and, as a matter of fact, I still own it. So farming has always been part of my background and I like to get back there from time to time. I went to grade school and high school in Fairfax and then on to the University of St. Thomas, where I took pre-engineering. Kind of like Dick, I wasn't so sure I wanted to be an engineer but I got into the science part of it and I enjoyed that. So I went on to the University of Minnesota to finish off my degree and got a Bachelor of Mechanical Engineering. I've also got a few additional credits, maybe another 100 quarter credits, of EE and Business Administration, all from the University of Minnesota. I actually majored in internal combustion engines and turbines. I ended up getting a job with Control Data in the computer industry, where I didn't apply any of that technology, except for the heat transfer piece of it. If you get the basics, however, you can pretty much carry it over into a different field, if need be. So that's basically how I got started at CDC in 1961.

Gardner: Neither of you guys served in the military. Both managed to avoid the draft in that era?

Berreth: Yes. Once I got to college and got into engineering I forgot about signing up for the service. Then I got married before I left college, so they weren't interested in me anymore.

Murnan: Actually I think we kind of fall in between the wars.

Berreth: Right.

Murnan: At least I did, age wise. I did go to work for Control Data in the Government Systems Division, which was doing business with the military, so I did have one deferment and they wanted to keep me. So that's why I never got really involved in the military. The Korean conflict was over and nobody knew where Vietnam was yet. So we were in between.

Gardner: I graduated from college in 1962, so I'm sort of in the same era as you guys. Tom, tell us what you did in the government part of CDC.

Murnan: I worked on the Polaris programs - the Mark 84 and Mark 88 fire control system. We developed the computer for the fire control system and were subcontractors to General Electric. Basically, we took the commercial Control Data 1604 computer and militarized it totally, transferring all of that hardware over into military packaging. I was very much involved with the design of the structures, where we had to meet fairly stringent requirements, considering shock, vibration, corrosion properties and the like. It was a good foundation for me to apply many of the things that I'd learned in school. So that's where I started. I think I worked three different programs, two Polaris and then a follow-on Poseidon program.

Gardner: And you were at Collins at that time Dick, correct?

Berreth: Yes. I was working as a manufacturing engineer, doing layouts, tooling, methods, time standards, whatever, in order to get what we were building into production. The line I was responsible for was Communication Navigation Identification (CNI) radios for the military. So everything was going to the government and, of course, we had government specifications, quality standards and inspections at the end. Because of that, the company was having trouble cutting in engineering change orders (ECOs) fast enough. It was taking five to six weeks to get an ECO cut into the factory after the engineers were through with the design change. And of course that was way too long. So they asked me to come over to the Materials Department and design a paperwork system to speed up that process. Our objective was to get all the ECOs cut in within three days (72 hours), after they were released. We ended up making it just 48 hours, as we got the new system designed and implemented. So it was design of a paperwork system, which obviously interfaced the computer system and all the rest, in order to get everything accomplished that needed to be done and still satisfy all the military requirements, including knowing the serial number of each change. From there I then was asked to become the inventory control manager, because they'd had a change in management in the Materials Department. The man who took over as materials director had come from the factory as the production control manger and they had moved the inventory control manager out to the factory to be the new production control manager. So he called me into his office and said, "Hey, you know anything about inventory control?" I said, "Don, I'm not even sure I know how to spell it. I have no idea what those folks do, except there's quite a few of them over there and they seem to be busy." Well the job really was to keep the material requirement planning (MRP) system clean and operational. In other words, taking care of all the exception reports: negative stock balances, excess and obsolete inventory, anything that didn't work right. Bad input would kick out a schedule and you had to get that fixed. So the key was being able to learn how the total MRP system operated. Once I understood that, I tried to find somebody to teach me how this whole computer system worked and, much to my surprise, there was no system expert. There were only experts on each part of the system, so I talked to each of them. After about six months, much to my surprise again, I found out I

was the computer systems expert on the MRP system, because I was the only one who had really been studying the whole thing. The guys who had originally architected it were off doing something else and a lot of them were no longer with the company. But that served me in good stead, in terms of running the Inventory Control Department, because like any large computer system, four or five years after it had been implemented we were still finding an occasional program problem. If there was a bug in there, but nothing went wrong until everything lined up exactly right, then you would get a bunch of errors and you'd have to go find what was wrong and get it fixed. I enjoyed that a lot for about 20 months and then the guy who was the materials manager left and went with Control Data. I was offered his job as the materials manager, which included inventory control, all of the stockrooms, and issuing the parts, plus the wire cutting department and the shipping department.

Gardner: Now that led to your being recruited to CDC in 1969.

Berreth: Yes. The man who had been the materials manager at Collins went up to be the materials manager at Control Data. He would call me about every six months and offer me a job but I was having too much fun to leave. Finally he caught me on a down day and I said, "Well at least I'll come up and look." He wanted me to replace him, which I had done previously. It is unusual that you get to replace the same guy twice. So I knew how he'd have things organized. He was going to go off and design a new material requirements planning system for Control Data. So I took the job in 1969 as Director of Materials at CDC's Normandale facility, which was in the disk drive business.

Gardner: And in 1969 Tom, that's when you also started in the disk business at Normandale.

Murnan: That's correct, yes.

Gardner: Tell us about Normandale in1969, both of you, without stepping on each other. I'd like to hear about CDC and Normandale.

Berreth: Yes, well in 1969 Normandale was under 2,000 employees. They were still building tape drives and tape certifiers in the factory, but that was in the process of being transferred to Valley Forge, Pennsylvania, which had been set up as the tape drive plant. In particular, the tape certifiers were there for two or three years after the tape transports themselves left. Otherwise, we were building 14-inch removable pack disk drives and also still had the large 26-inch fixed disk file, with hydraulic actuators and 75 millionths of an inch of flying heights. This was the world's first 600-megabyte disk drive and it was huge. One power supply on that was three foot by three foot by five foot tall and that was just the power supply to drive the hydraulics for the actuators. It had huge motors and was really a Rube Goldberg, but it worked.

[**Editor's note:** Berreth and Murnan are referring to the CDC 8xx series of disk drives which included the original 100MB Model 808, the 200MB Model 814 and the 600MB Model 817. All models had 72 disks.]

Gardner: Now Tom, you were at Normandale and changed divisions or did you just move?

Murnan: I changed from the Government System division to the Peripherals division. As a matter of fact the large disk file that Dick is just talking about is where I cut my teeth on disk drive technology. There had already been a couple of generations, when I transferred, and I helped finish off the development of that large disk file product line. I believe it reached 800 megabytes and weighed 4000 pounds. Dick spoke of the size of the power supply, but the disk file itself was like four foot wide by six high and must have been eight feet long.

Berreth: Yes.

Murnan: So these things were huge. One particular version of that used 16 heads in parallel and those systems were sold to the Livermore operation of the Atomic Energy Commission out in California, because they needed the fast data rate. This particular product had four disk stacks on two parallel spindles with two independent, dual-opposing positioners, where the heads went out to both spindles at the same time, so there was no reaction and it was very smooth. Because there were two of these dual positioners, accessing the four stacks, you could ping pong between them. So you could transfer data serially until you actually dumped a file, without any interruptions. It was quite a marvel and anything I had ever learned in college I think you could apply, and then some, on that particular product. Like Dick said, we had hydraulics, plus we had pneumatics, heat transfer**,** kinematics, vibration, dynamics - you name it. For the electricals it was the same thing: a mix of analog, power, digital. It was a marvel from an engineering perspective to work on. So that's where I cut my teeth. And then I eventually moved over to the micro drum project, which had fixed heads, with no moving actuator. After that I then started the SMD development in the early '70s.

Gardner: In the early '70s there was a lot of discussion, as I understand it, on the tradeoffs between fixed media and removable media disk drives. Could you elaborate on that, who was talking about what and why?

Murnan: Yes, we wanted to get into the minicomputer market, or at least the low end of the large computer system market, and knew that we needed to make drives smaller in size and also lower in cost. Because IBM was rumored to soon announce the Winchester technology, we certainly looked very hard at fixed media at that point in time. It became a question of how soon you had to really convert from removable media to fixed media. In other words, what track densities could we really get to on removable media and still have that interchangeability feature, which was still relatively important, because it allowed the user to maybe buy up to ten packs to store data and still use that same device. When you're working in a batch environment, that was pretty much a good feature to have. We finally decided to go with the removable media pack, because we went through an analysis and concluded we could achieve 400 TPI, although the first SMD product, the 9760, was at 200 TPI. We also knew we wanted to increase the performance, so we went to 3600 RPM and an average seek time of 30 milliseconds. In addition, we wanted to make it small in size, so it could be adapted by our customers quite readily, and certainly lower in cost than anything being offered at that point in time.

Berreth: Also, the industry had started with mainframes and tape drives, so everything was still batch processed on business systems. Having removable packs, where you put the payroll pack on to run payroll and you put the human resources pack on to run human resources, made it possible to use the

same basic batch-oriented software, until new software could be developed that could actually make use of fixed disks.

Gardner: Actually I have a note here which says sometime around December 1970 there was a memory module kickoff and at that point it was a rack mounted, fixed media program that evolved …

Murnan: That evolved eventually back to the removable media concept. Yes, I remember that.

Gardner: How did that concept originally come about? I'm talking about December 1970 initial concepts.

Murnan: Obviously IBM had the leadership in the rotating disk business and also in technology, and you always have to pay attention to what your competitors are doing, so we looked very hard at being able to use fixed media in the user environment that Dick just spoke of, the batch environment. That was more or less a concern for us, because we looked at the concept of removing both the heads and the disks, and that was very expensive. So we eventually came to terms of continuing, at least for the first couple of generations, with removable media, because the pack would be a lot cheaper without the heads in it.

We also believed very strongly that the user could use removable packs and their system would be lower in cost with the removability, rather than buying x-number more drives to really serve that same function, say using fixed media. So it was discussed a lot, as I remember, and we eventually evolved to removable media for the SMD. Of course, we followed on with fixed media drives later on.

Berreth: I think Tom's being a little too kind on some of that. The truth of the matter is, since IBM dominated the disk business, they set the standard. So if you were going to be in the disk business, you had to do what they did but you didn't always know what they were developing for their next product. Yet you still had to be ready, from a technology standpoint. If they went fixed disk, you were going to go fixed disk; if they stayed removable, you were going to go removable, because there was no way at that point in time that you could survive if you weren't IBM compatible. They set the standard. That was the rules in that market and if you were going to be in that game, those were the rules you had to follow. So from a technology standpoint you always had this problem, because you knew that every two years you were going to have to double the bits per square inch on the disk. That was a given or you were going to be out of business. You knew that you had to accomplish that but you didn't know how they were going to package it. So you had to be developing disks and heads, plus working on different ways of packaging it, all at the same time. When they came out, you better get there in six months or you were going to be late, and you would not capture as much of that market as you want.

Murnan: That's a key point but with Dick and I coming from other parts of the world into the Normandale part of Control Data, we were not constrained so much with that IBM compatibility. The issue with IBM compatibility, as Dick touched on, is you had to see what they did before you can develop anything, and by the time you get it developed, you would be a generation late. So it was very clear in our mind at that point in time we had to strike out on our own, at least in the minicomputer market. Whether it was fixed media or removable media, it was going to be a Control Data design from day one, without the need to be compatible with IBM, at least on this particular product. That didn't mean we got out of the high end

system OEM business, where we also developed drives to be IBM plug compatible. But over time that made it very difficult to compete if you wanted to be compatible. We just didn't have time to respond to IBM and get out, and then be one-upped by the next generation. So I think it was kind of a wise decision at that time and that prevailed pretty much within the company. We got a lot of support to go off on our own, even though there were some non-believers who said that we weren't going to make it, because we were not IBM compatible. That turned out to not be the case.

Berreth: Yes, there were always the naysayers that would say, "Boy, if you don't do exactly what IBM does, you're dead." But the truth of the matter was there was really a big market demand if you could do the right thing. There was an unfulfilled market demand out there, particularly as the minicomputers were coming out. Now a war story. The rumors of IBM's Winchester development were all over the marketplace, but nobody knew, at least that we talked to, what Winchester really was, until they shipped the first one. There was some belief that Winchester referred to a rifle. So what kind of a rifle? Well the most popular Winchester rifle was a 30-30 and that was 30 calibers, of course. So Winchester was interpreted to mean 30 megabytes of capacity and 30-millioniths of an inch flying height. That was sort of the rumor. So we knew we had to at least be able to do that, if that rumor was true. In the meantime, these guys were working hard to figure out what they could get done. If we could do better than that, praise the Lord, but if we couldn't we had to at least do that, if the rumor was true.

Gardner: Yes, I'd like to focus in on a time period from December 1970, when I think you were considering fixed media or fixed disk, whatever that means, and then I think it's November or September of 1972 when what becomes the SMD is approved. There was a lot of discussion and Winchester wasn't even announced until the following year.

Berreth: Correct.

Gardner: Although people were certainly aware of it. Who was advocating what?

Murnan: In terms of people, I worked for a man by the name of Larry Matthews, who had been in the industry for a few years, and had recognized many of the issues. He was an advocate of the removable media drive. Now the large file, if we can drop back to that, was sort of a combination. It had fixed media but the heads were unloaded when you spun the drive down. The idea of being able to start and stop with the heads in contact with the media was something that would have been high risk for us and probably would have taken additional development time, so we wouldn't have been able to get the SMD out in time.

Berreth: On schedule, yes.

Murnan: Some other people like Bill Morgan, who was on the planning staff at the time, were very concerned about diverting away from that rumored new IBM concept of the Winchester technology. People like Tom Kamp and Dick Berreth, however, were fairly strong advocates of trying to strike out on our own and do the job with removable media, as we did. Internally there were many engineers, that said, "Hey, you got to be IBM compatible." Most of them, of course, had worked on those products previously, so they were a little bit biased, but to name names wouldn't be fair. Tom Burniece had

already started development of the 400TPI (3330-11 equivalent) HPD removable media drive in 1972. He later developed our version of the 3340 removable Winchester drive, the DMD, when IBM came out, and then developed the 3350 x2 equivalent FMD drive, which was our first fixed media drive, using CDC's version of Winchester technology. So Tom understood those tradeoffs as well. We all knew in the long run contact start/stop, with enclosed heads and fixed media, was going to be the way to go, because you could get to higher densities; no question about that. But for that period in time, removable media was the right choice for SMD.

[**Editor's note** (per Tom Burniece): CDC didn't actually start development on the Winchester technology until after IBM shipped the 3340 Winchester and CDC saw what it was. CDC then developed the DMD, which was identical to the 3340; the CDC Model 33401 was an IBM Plug Compatible version and CDC Model 9770 was an OEM version. Only a few were sold to CDC's IBM Plug Compatible business unit and to NCR. In that time frame, every other OEM went to the SMD instead.]

Gardner: Plus I think the market proved SMD was a good choice.

Berreth: Yes.

Gardner: I'm really interested in how the decision was being made. Was that early fixed media memory module contact start/stop or were the heads retracted, as say in the CDC large file?

Murnan: That was one of the key questions with the memory module. We really were torn between trying to start in contact or whether we would pull the heads off the disk before we spun it down. Because of the cost and complications of both, we steered away from fixed media and went to the removable media SMD. I don't think it was an overnight decision; it was sort of an evolution that occurred. What it really came down to it was what we could do with the technology we had in hand to meet the desired schedule and what we could do to meet the cost. Certainly when you looked at it, as long as we could hit that track density on removable media, it became a pretty obvious choice for us, at that point in time, with the technology we had.

Berreth: The decision really evolved. It didn't just happen, it evolved.

Gardner: Was it made by November 1972?

Berreth: Yes

Gardner: That's really what I'm trying to capture. You had done a double density 2314 and a 3330, so you had demonstrated 200 tracks per inch

Murnan: Yes.

Gardner: On a 14 inch disk with removable media?

Berreth: Yes on the HPD

Gardner: That existed?

Murnan: Yes. We were vertically integrated at that time, so keep in mind that we had our own ferrite head technology. We knew how to load heads and unload heads off a disk. What we were short of at that time was the contact start/stop technology. We hadn't developed that far enough along. We had good test equipment and servo writers, with the ability to write servo tracks on disks accurately, plus create the alignment packs that you needed to align all of the heads up, so that you could get the interchangeability. So we were very confident that we could do 400TPI, as well. Of course during that period of time, where we were trying to make the decision, we were still doing some of that development work to demonstrate that we could pull it off. So that was a big piece of it as well.

Gardner: In that same time period did you guys do the IBM 5440 cartridge type product that came out I believe in 1971? Was that done in Normandale?

Murnan: That was done in Hawthorne, California, by the former NCR disk drive people who had just joined CDC, as a result of the CPI joint venture. Later, part of that team went to Oklahoma City, as part of the MPI joint venture in 1975, and developed the CMD there. The earlier 5440 cartridge product was called the 9425 Hawk and was our first entry into the minicomputer market

Gardner: Was there a set of feasibility studies before the decision was made to go with removable media on the SMD?

Murnan: Yes.

Gardner: Can you tell me about that, who was involved?

Murnan: In the feasibility stage, we studied several significant things. I spoke of servo track writer technology. There were folks like Dick Yonke and Bill Rowling, who were strong in that field and had developed these writers for some time before that, so we knew we had that capability. It became a question of hitting a certain physical size for the SMD. Up until that time most of the disk drives were kind of the size of washing machines in height and so forth. We wanted to go to a rack mounted device so that we could get at least two of them in a rack, and maybe as many as four. We also wanted a standalone unit, where we would supply a drive in a stand with a cabinet below it

Berreth: The cabinet was empty.

Murnan: Yes, but we also had a version where we put another drive below in that cabinet. The top one was fixed in place but the bottom one could pull out, so you could change both packs. Obviously, fixing the top one helped the weight situation, so it wouldn't tip over. That was kind of unique. But getting back to the technology, one of the big challenges was hitting that physical size: 10½ inches high, 17 inches wide, and roughly 30 inches deep. One of the mechanical engineers, Noel Allen, designed the deck, the actuator system and the spindle system. Up until that point in time you had decks that probably weighed in the neighborhood of a couple of hundred pounds.

Berreth: They were huge and cast aluminum

Murnan: Right. The belief was you could keep the resonant frequencies under control much easier with a bigger deck but we had to go to something that was much lighter than that. I forget the actual weight, but it was 15 to 20 pounds, at most. We also needed to get all of the other components into that physical space and that was a significant challenge. Noel Allen also undertook that. He had the ability to do all of the modeling of the dynamics of the structure and so forth. He downsized the actuator itself and got the weight down so we could move faster. He also went from an eight-variant bearing system to a six-variant system that used 45 degree rails. That was sort of a risk but it turned out it wasn't all that big a risk. We wanted to use the same spindle capturing mechanism that had been used successfully in the past, so the SMD pack hub was no different than what was on the bigger 14-inch drives. What we had to do was make sure we could design the spindle, which had a much shorter bearing spacing, yet still be stable enough to work with the very small and light-weight (I don't want to say flimsy) deck; but it did the job. So that whole combination was one of the biggest challenges of the design.

Berreth: Right.

Murnan: Obviously the head and media technology was important, because we took the bit density up to 6,000 bpi, so we had to fly a bit closer. So there was a risk there but one of our engineers, Harold Beecroft, came up with a unique head design called a Unipad. Rather than having one ramp to unload the head, it actually had two ramps, because he thought that was more stable. We ran many load / unload cycles, hundreds of thousands, to prove or disprove that. Also in that whole physical space we had to get a filter system, so we brought air in the front where it had to go through a coarse filter, HEPA filter, cool the drive and exit the rear of the drive. We also had start motor capacitors, so we had to find places for them, plus we offered a 2400 RPM option, where we needed a different spindle drive arrangement. I can remember we had trouble on the 2400 RPM option because it threw the belts all the time while going through a resonance during start up. I think we solved that problem with a domed spindle hub or pulley. Then there were other components, like harnesses and so forth, plus we had to squeeze in all the electronics.

Berreth: And the power supply.

Murnan: The electronics were on one side and the power supply was on the other.

Berreth: The power supply had its own ferro-resonant transformer, which was a big chunk of iron.

Murnan: I think our original goal was to be somewhere around 60 to 70 pounds. It turned out to be 160 pounds but it worked in the long run. So it was a rather unique challenge. For the electronics, we used existing packaging, but we had to design the circuits to meet our requirements.

Berreth: Yes, and there were 22 circuit cards, which were about five inches by seven inches

Murnan: Five by six maybe.

Berreth: We also had a servo head and five data heads.

Gardner: One of the structural elements was that the heads were in line. That enabled the double ramping. Whose idea was that?

[**Editor's note** (per Tom Burniece): The CDC 844 fixed disk file (HPD) which first shipped in 1972 had an in-line head stack. It was a 100MB single-spindle, removable disk pack disk drive (IBM 3330 equivalent) used on CDC computers.]

Murnan: Harold Beecroft. When you look at the alignment issues, you can take a tolerance out. What you want to do is get those head gaps lined up relative to each other. Otherwise, when you move off track, that creates another alignment error, which is eliminated by the in-line design.

I believe we stayed at the same standard disk spacing that we had previously, so that was a difficult job of being able to sandwich those two heads in between the two disks. But we thought that was kind of critical, in order to get us to that next higher track density, 400 tpi, which we eventually met.

Gardner: Yes, particularly in an unloading arrangement. To then be able to unload them and not interfere was critical

Murnan: They had to be very shallow, as you're kind of gesturing to us there, to be able to pull that off.

Gardner: But they can't come up too fast because they'll hit each other.

Murnan: That's right. As a matter of fact, there was a certain velocity range that you wanted to hit, both loading and unloading, when you came down on the disk. We took high speed pictures of that to make sure we weren't going to damage the disk. For that head pad to settle out properly, you didn't want to come down too slow or too fast, so you had to hit kind of the sweet spot. The same thing goes for the unload. You want to pull away off the disk and avoid any interaction between the two heads. So we had speed control circuits to handle that for us. Obviously there is also the one situation, where if you lost power, you had to do an emergency retract. We had to be able to go through a few of them, because you're coming off the disk very hard, especially if you were at the inner track, and you had to slam back. So those are the kind of tests that we ran. Obviously the recording guys (we called them circuit design)

were already working on those kind of track densities and bit densities, during the period of time that you were speaking about. So we were already working on that technology in the background.

Berreth: One of the risks, of course, was with the much lighter deck to not hit any critical frequencies as you're loading and unloading.

Murnan: Or when operating an actuator; the same thing.

Gardner: Let's step back to pre-SMD features decision, to make sure it's clear, because I'm still a little confused. Were there four choices being considered: fixed media with unloading heads, fixed media with contact start/stop, a conventional disk pack, and then a Winchester type data module? Were you juggling all four choices?

Murnan: I think we were but my memory is not so sharp on that. I believe we talked about all of those but we decided to remove the heads off the disk because we just didn't have the contact start-stop technology that we could risk at that point in time. We did talk about all of those and some of the advantages and disadvantages of each. Obviously one big advantage you have with Winchester is you can put the landing zone on the inner diameter, so you save that valuable area out at the outer diameter. When I left Seagate in 2007, we were almost recording on the outside edge of the disk, because that's prime real estate for speed and also for capacity. So, all of those things were talked about. I think we understood them but it came down to what technology you had and the risks that you were willing to take in these kind of trade-offs. Eventually, we went to the removable media but I think we probably covered every one of those combinations you mentioned,

Gardner: Of course, the actual Winchester technology wasn't known at that time. I think the only contact start/stop technology that was generally known at the time was Data Disc. They had a very lightweight head. What were you guys considering in terms of contact start/stop?

Murnan: I'm not so sure we had that all totally figured out. I do know that we were a little bit concerned with oxide media, whether we could get it durable enough to be able to take the contact start/stop. We knew that eventually, because of track density limitations, we had to do something in the fixed media area but the ability to start and stop in contact was, in our minds, high risk, although not undoable in the long term. It's just a matter of timing and being able to get that technology developed but we certainly talked about all of that during that period of time. I can remember that there were some systems where they talked about a fluid over the disk and I forget who developed that system, but it got contaminated, so it never really worked out. The ability to really do a good contact start/stop I think came with thin film media. It just gave us more robustness and we understood the tribology much better. Back in those days, we didn't have the metrology to look at disks and heads close enough that we could understand the physics of what's really causing the friction and the wear. We just didn't have it, so you had to be very careful. We had schemes to detect whether we were hitting the disk but we didn't exactly understand the failure mechanism. The advent of scanning electronic microscopes, obviously, gave us new insight at what things looked like.

Berreth: One of the things that made the disk drive business so interesting is you had to be able to develop your own testers and techniques. You had to move up the state of the art in measurement at the same time that you were waiting for the new scopes from HP to be able to handle the faster electronics, and you were trying to fly closer to the media. So you had to do all of this at the same time or you couldn't get there, because there was something you still didn't know.

Gardner: SMD is the first really different removable disk pack in the disk drive industry. CDC had done a double density 2314, which IBM never did, but this was really different; related to other removable media but really different.

Murnan: Yes, it was

Gardner: That was a huge risk. Didn't that worry you guys?

Berreth: Well, it really comes back to the issue that we didn't know what IBM was going to do next, and when that shoe was going to drop, but we had to be ready. At the same time, the minicomputer market was developing rapidly. They were a whole bunch of new minicomputer system players just coming out of the woodwork, it seemed. People that you'd never heard of before. All of a sudden, they were big companies and were potential customers. From a systems standpoint, they were not very interested in what IBM did, since they were doing the total system. Thus, they really weren't locked into it had to be IBM compatible. So that opened the door. Yes, we were worried, but talking to those potential customers really alleviated a lot of our fears. They really weren't all that concerned about IBM, as long as they could beat them, from a systems standpoint. The disk drive, of course, was a critical part of that system for them, so they had to have better capacity, higher transfer rate, anything you could do to help them beat Big Blue, because IBM was really the guy who was dominating everything up until then.

Gardner: Are you talking about the mainframe systems or the minicomputer systems?

Berreth: IBM dominated the mainframe market but the minicomputer guys were doing things that IBM was only doing on their big systems. Companies like DEC, Data General, Datapoint, Interdata - I can't even remember all the customers any more...

Murnan: Also Nixdorf.

Berreth: Yes. Some of them were process control people, some did word processing, and some were specialized in different niches in the market. IBM had a solution in almost every one of those areas of the market but on more expensive machines. The minicomputers guys had different solutions and were looking to pick off the customers that IBM thought were theirs.

Murnan: To just kind of reinforce a few things. From the technical side, at that point in time, we were comfortable with the recording density that we could hit. We were also comfortable with doing the mechanical design, so then it became a matter of the SMD interface. When you looked at our potential

minicomputer customers, we wanted to make sure that we had an interface that would be somewhat simple but robust. So we went to differential transmitters and receivers and were able to transmit up to 50 to 100 feet - I forget what the number was. We also wanted to do the data recovery inside the electronics, providing our customers with a shorter integration time within their subsystem. That interface was maybe one of the higher risks, in my way of thinking. Although the mechanical was certainly a tough job, don't get me wrong, I think doing our own interface was the biggest risk. We had to go out and really do a good job of convincing those customers that this interface would work. I think they were willing to accept that. Then our competitors, like Memorex and maybe even DEC, plus a few other companies that developed disk drives, kind of caught on. Even though they were competitive, it more or less supported our strategy in the long run that not only Control Data but some of the other disk drive manufacturers could be successful in the market and not be IBM compatible. So, just to summarize, I think the risk probably was getting an interface that was easily integrated by our users. That was the key thing, in my mind.

Berreth: A war story, if you will, that goes along with that and the marketplace. Once the SMD was announced and we started in production, we were running at five units a day on the production line. Based on that, I had six months of finished goods inventory unsold sitting in the warehouse. Of course, I'm getting very nervous, as the guy that's responsible for the business, because I don't dare get to the year end with that kind of finished goods inventory unsold or I'm history. So I got with our OEM marketing crew, because we had all these forecasts that said “man, we were going to sell them like hotcakes” but we didn't have orders. Forecasts are nice but what you live on is orders. So I said, "What are we going to do? We have got to get this thing going because we're going to all be killed at year end if we can't get this product off the ground."

Gardner: When would this be? Dick, what time period?

Berreth: This had to be late 1974, because we delivered the first one, I think, to Nixdorf in December of 1973.

Murnan: Yes.

Berreth: So we were running five a day and even had contracts from quite a few of the customers in the minicomputer market but no orders. We kept getting the same story, "their controller isn't finished yet." So we came up with a special sales spiff for all the OEM salesmen, double on the bump or something, I don't remember what it was. Anyhow, they could make more money, both long and short, if they'd get orders. I was the hero by the year end because, we were approaching 100 a day and the OEM salesmen were making so much money, they could hardly find time to go to a BMW dealer to get their new car <laughter>.. All of a sudden, the OEM customers had finished their controllers. Now they wanted drives and we were inundated with orders, so we went from five a day, with six months of finished goods, to 125 a day, with a backlog of orders and no finished goods.

Gardner: And this is 1975?

Berreth: Correct. When it broke loose, it just took off like a rocket. So the real issue was everybody getting their controller and software finished so they could really utilize the capability of the drive.

Gardner: Backing up a second, what was the round cable SMD?

Murnan: We initially came out with the round cable design because we thought we would have better signal integrity. That round cable had been used on previous programs so we knew what its characteristics were and knew that it was a design that would work. However, it tended to be bulky and our users wanted us to go to a flat cable for more flexible routing. Eventually, we evolved to that and it worked okay for us. I'm not so sure all of the terminations were as easy to do on that flat cable, at least to have the insurance that the integrity was there for the data signal. Now, I can't even remember whether we could transmit at the same lengths on flat cable or whether we also retained the round cable for longer runs.

Berreth: I don't remember either but I think part of it was we were used to supplying mainframe manufacturers, where your disk drives were farther from the mainframe. I know one of the concerns was making sure you had this distance but with the minicomputer systems, you were close. You didn't have this huge mainframe so your distances were totally different than what we were used to. So that was part of this round cable/flat cable thing.

Murnan: Thank you. I think that's exactly it. Yes.

Gardner: Yes, because the spec I was looking at is a flat cable spec. I know from Bill Bayer that there was also a round cable product but I've never seen any documentation. There were really three cables, a power cable, a data cable, and a control cable.

Murnan: Yes.

Gardner: I think the power cable was always round**,** so the question is - were the data cable and the control cable both flat?

Berreth: I don't remember.

Murnan: I'd have to go check a spec or something to look at that. I just don't remember at this point in time but I will call a good friend of mine, Orville Dodd, and he'll be able to straighten that out. Bruce Johnson may also know that answer.

[**Editor's note:** The data cable (aka B cable) and control cable (aka A cable) of the same type were both the same shape, see e.g., Figures 1-18 and 1-19, CDC STORAGE MODULE DRIVE HARDWARE MAINTENANCE MANUAL, Volume 1 of 2, # 83322150, © 1985.

Gardner: Dick, your six months of inventory, were they the 40 megabyte 9760s or the 80 megabyte 9762s? Do you recall?

Berreth: I don't recall because I think it was just a one card change, wasn't it, from the 40 to the 80?

Murnan: One or two, plus obviously the servo track writing and heads were different. They had narrower gaps.

Berreth: At that point, it was mostly 40s with a mix of 80s in there. One of our big challenges, of course, was to get up to 100 units a day which, today, is nothing, But back then, with 22 circuit cards at 100 units a day, that's 2,200 cards, plus another 10% for spares or something, so you had to be running 2,400 cards a day At one time, we had 1,200 employees at our card plant out in Rapid City, South Dakota, working three shifts in order to produce all the cards that we needed, plus we had to make all the heads at our ferrite head operations. The big thing on heads was the winding, because those were all manually wound under a 20-power microscope through a very small orifice, with bifilar wire about the size of your hair. Thus the workers were all gals, because they had small enough fingers. Guys couldn't do it - their fingers were too big. So we had row upon row of gals looking through 20-power scopes winding heads.

Gardner: Actually, the 80 megabyte was announced in the middle of 1974 at NCC and probably didn't ship until later that year. So most of that inventory was probably 40s.

Berreth: Probably but most people were immediately going over to the 80.

Gardner: Now, the 80 megabyte was originally part of the plan, correct?

Murnan: Yes, we talked about two generations from the beginning - being able to get two generations out of it. The 80 came out a little faster than we figured. The demand was much better, because every time you double capacity you effectively cut that price almost in half for the customer, so it became very popular. We were also starting to displace some of the older technology standalone units that were certainly much more costly. So the demand was there for capacity and lower cost per megabyte, as we have talked about in my whole career, was probably the most important thing. You get that down by injecting technology.

Berreth: Yes.

Gardner: Who was the competition for the SMD in those first couple of years? Was there any?

Berreth: No. There wasn't any other disk drive that had that transfer rate and that capacity. There wasn't any head-on competition for it at all.

Murnan: Not that had that same configuration but there were some emulators later.

Gardner: I was heavily into the plug compatible space at that time but I have this recollection that Century Data and ISS announced a short stack product more or less at the same time as CDC, although I didn't pay any attention to that space - so I'm not sure, and I can't find any information.

Berreth: There was never any real competition at the beginning. It was only later on, as DEC started building their own, that we lost some business there. For the first couple, three years, it seemed like we were the only game in town in terms of the big volume. In fact, at one time, I can recall we had forecasts from three of our customers for around 800 units and we found out that these three customers were all bidding on the same contract with our drive. So there was really only an opportunity for 800 units but we had 2,400 units in our forecast. When we found out, we quickly got the forecast down to 800 units but we also scheduled 800 extra of the interface cards because we knew we could use them. That was for the Fireman's Fund contract. Only one of them got it but, fortunately, we were able to find out that kind of thing was going on in the marketplace, where our customers were all bidding on the same big contracts, using the SMD. We were constantly trying to find out who their customers were, so that we didn't have duplicate forecasts and were not committing for parts that we weren't going to use.

Gardner: Of course, at the systems level, IBM competed with the 3340 Winchester

Berreth: Yes.

Gardner: That was not much competition, was it?

Berreth: No.

Murnan: ISS and Century Data would have to speak for themselves but we initiated the activity to come up with a unique drive in the minicomputer domain. They may have concurrently had similar ideas but they really started to come around to our line of thinking when there was head-on competition. They may have even had a drive that was compatible with ours when the SMD interface was standardized by ANSI. What generally happens, when you go out and start marketing something unique, is your customers say, "Well, you've got the only drive with those kind of characteristics but I don't know if I feel comfortable to commit to only you. Let me go talk to Century Data and ISS and see what they've got." Of course, that information goes back and forth and if they want to be in the market, as well, ISS and Century Data would certainly want to fulfill that similar need. So how that all transpired, I'm not sure but farther down the road, they tried to emulate us, because we really had the lead. I really believe that.

Berreth: Our primary market up until then had really been the IBM plug compatible market, other than Control Data, which had unique, scientific computers, and the other large system OEMs So we always had plug compatible in our mind but we really didn't realize how big the minicomputer market could be until it happened. We were obviously very pleased at what happened but that was not the forecast at the beginning, that's for sure.

Gardner: I think, ultimately, Century Data offered a plug compatible SMD.

Berreth: I believe they eventually did.

Gardner: My recollection, and this could be age, <laughter> is that, early on, in 1973, 1974, or 1975, Century offered its own short stack version but you guys beat them out. I could be mistaken, but ISS may have also had a similar short stack product, which was unique and not interchangeable, but ISS got involved with the Itel and then Unisys, and they sort of left the market space. I've tried to find the information but I can't. In my view, CDC came out with a unique product and the IBM 3340 product was massively unsuitable for the market. For awhile there at least, you had no competition, except maybe Century Data and ISS, but for some reason they didn't succeed. That's my view.

Berreth: That's my view, also, but I can't guarantee it because it's foggy, too far back in my memory.

Gardner: Who was the marketing guy I should talk to? Who is out there?

Murnan: There was Phil Arenson, who was a big proponent and in planning, plus Amyl Ahola. They understood the market.

Berreth: Amyl worked for me and was our product planning director in charge of getting all the forecasts in, looking at what the customers really needed, looking at what the competition was doing, and trying to forecast where we ought to be going with our next version and so on. Amyl certainly had a good feel on the market and what was happening, that's for sure.

Murnan: Gordon Brown was the Regional Vice-President of Sales for Tom Kamp, right?

Berreth: Right.

Murnan: Gordon had the USA and then there was also a European VP but I don't remember the name

Berreth: Yes, they are gone from my memory, also. Amyl would know them, because he had to work with them, and Ray Crowder is another one who would know.

Murnan: Yes.

Gardner: I trust the product planning marketing guys more than I trust the sales guys.

Berreth: Oh, yes.

Gardner: You know the difference, right?

Berreth: Yes <laughter> In spades.

Gardner: Right. A marketing guy knows when he's lying.

Berreth: Yes <laughter>

Gardner: Right in the middle of this, you decide to do another version, the150-megabyte 9764 and the 300-megabyte 9766. How'd that come about?

Murnan: There were a couple of things. First of all, we already had the IBM 3330-11 compatible HPD that had 11 discs on the pack and was shipping at 400TPI. There were also some customers asking for more capacity per pack, because some of the new minicomputer applications needed more than 80 megabytes. So the idea was we could offer them a better cost per megabyte by putting the SMD heads, electronics, and interface in the HPD, giving 300 megabytes, so they could intermix with the 40 / 80 megabyte SMDs

Berreth: Oh, yes. That gave us 300s and 80s on the same system. It just didn't matter; you could just plug them in. As these minicomputer systems developed, they really weren't mini any more. That always happens. As the systems got larger, they needed more disk capacity, because solid state memory and chip prices were coming down. So the cost per byte also needed to come down on the disk and at 300 megabytes, they could get another level of cost effectiveness, which would keep their systems running longer in the marketplace.

Murnan: So it was sort of a natural, when you think of it. The HPD mechanical structure became an obvious choice for us to do that with a relatively easy conversion. The HPD also had the same disk spacing , so we could fit the heads between the disks with minimal design changes. .

Berreth: Right. We didn't need new heads and most of the circuit cards were the same as the SMD.

Murnan: Absolutely.

Berreth: The power supply was obviously different, because the HPD was driving a bigger pack, so you needed more power. The HPD was 200 megabytes at a 6.45 megabits per second transfer rate, rather than the 9.67 mega bits per second of the SMD, so you needed the SMD interface and electronics to get the higher transfer rate and higher capacity.

Gardner: The original SMD at that data rate had one and a half times the number of servo bytes per revolution of the IBM 3330 drive, right?

Berreth: Right.

Gardner: So you took a 3330 servo and increased the byte density by 50%.

Berreth: Right.

Gardner: The magic number, from my days at Memorex, was13,440 bytes per revolution.

Berreth: Yes.

Gardner: And the SMD is 1.5 times that, giving you the 50% higher data rate. So essentially, the 300 megabyte SMD is a 200 megabyte, IBM 3330 mod-11 equivalent, at 50% higher data rate

Berreth: Correct

Gardner: In fact, that magic number is 20,160 servo bytes per revolution and that's ubiquitous across the entire SMD line: SMD, MMD, CMD. So that is why the controllers can mix them...

Murnan: Yes, it was a good strategy.

Gardner: It was brilliant.

Berreth: Yes. Depending upon their application, it gave the minicomputer guys a lot of flexibility with the same software and controllers to solve their customers' problems.

Gardner: For those who are not engineers, when we say 20,160, that's an integer number - precisely 20,160 bytes per revolution.

Berreth: That's correct.

Gardner: The prior number was 13,440 and if you were a half a byte off, you were incompatible.

Berreth: That's right.

Gardner: I have scars from that. I think Tom, when he talked about servo writer technology, has some of those scars, too.

Murnan: Nowadays, just to put things in perspective, because of the difficulty in manufacturing heads that are a total replication of each other, you do allow variations in track density and bit density. So there are features now within the drive firmware that allows you to go to variable TPI or variable BPI for a

particular head, as long as you come out with the capacity that you intend to sell in the market. So firmware is powerful nowadays. If we would have had that back then, we could have alleviated a few of those scars that you got. <laughter>

Gardner: That era was all hardware. I don't think we even had firmware on the serializer/deserializer or formatter. Today, it's all firmware; then it was all hardware.

Berreth: Yes.

Murnan: I don't believe there was any firmware of any type in the SMD. No programmable chips or anything like that.

Berreth: No.

Gardner: Or even in the controller. You had firmware for error correction and calculations but the physical control of the data was typically done in hardware, with a bunch of counters and decoders, not firmware.

Berreth: Right.

Gardner: Today, it's all firmware.

Berreth: A story from a customer standpoint of when the 300 went into production. When we serialized our units, the first production unit was always serial 101. Anything from 1 through 100 was preproduction, prototype, or engineering test units but the first production unit was always 101. I got a call one day from our salesman on the east coast that handled the Inter Data account. Tom Riley was his name and they had just landed a big contract with Citibank up on Wall Street. They were going to be putting their minicomputers in offices and not in a computer room. This was the unique thing about this installation and it was a first on Wall Street. So this one had to work, because it was the wave of the future to get the minicomputer out of the computer room for smaller applications. It was the stock transfer operation that recorded who were the owners of the stock at any point in time. What Citibank did was cancel certificates and issue new certificates, so that was our application for this system. I got a panic call one morning, where my secretary interrupted a meeting, said, "You got to take this call, it's really important." Our salesman and the materials director from Interdata, Inc. were on the phone. They said, "We've got a tremendous problem. We've got the Citibank contract and our engineers just realized that your 80 megabyte SMD does not hold 80 megabytes of user data" <laughter>, if you can believe that. We're talking back a few years, obviously, and they thought, when we said 80, we meant it would hold 80 megabytes of actual user data. We, of course, didn't know how they're going to format it or use it in their particular system, so we didn't know the actual user capacity. In this case, it only held 67 megabytes of user data. The rest was used for header and everything else but not data. As a result, they wouldn't be able to get enough disk drives in the offices, because the system wouldn't fit with just 67 megabytes per drive and have enough data storage to handle the stock transfer activity. They said, "What are we going to do? We have got to deliver these contracts." I said, "Well, guys, I don't know for sure but we've got

this 300 megabyte version that's just going into production." I asked "When do you have to have these units on Wall Street?" and they said "Well, we have to have 20 units there before the first of July." So we shipped 19 units from serial numbers 101 through 120 directly to Wall Street and the other one went to Interdata for them to integrate their software. Praise the lord, it all worked but that was the advantage of using proven technology, with the SMD heads and disks on the HPD mechanism. It all came together and 19 of the first 20 units of the 300 megabyte 9766 SMD were shipped right to the end user's site, without going through our OEM customer. They went to his customer directly, in order to make the schedule, and it all worked and was installed. The system was accepted and I got then invited up to Wall Street to see the installation. So I got to see the cartloads of stock certificates being wheeled around, millions of dollars in these laundry carts. I couldn't believe it, just going from office to office. This was my first introduction to the financial world. Then we went up on top of the World Trade Centers that are no longer there and had a drink and celebrated.

Gardner: And when was this?

Berreth: This was in the summer of 1976. Charlie Wolf was the materials manager at Interdata and they were right by Monmouth, New Jersey, race track.

Gardner: Just as an aside, companies I've worked in stopped using the same number system, because our competitors liked to know how many units we'd shipped by just getting a current serial number.

Berreth: Yes.

Gardner: So when you're 100,000th, you know, just take the current shipment, subtract 101, and you have the competitive analysis. Anything of particular interest in the 300 megabyte development that you guys think you did really well or not so well?

Berreth: Well, I would comment that we really had almost no field problems. Looking at the warranty and field customer complaints, they were really few and far between. There was occasional head crash in the field but hardly any and generally the head crashes could be traced to the computer operators storing the printer paper on top of the disc drive. <laughter> You know what paper dust does to disk packs and heads. So, there were a few of those kind of problems, but customer complaints and spares shipments were always below the forecast and the reliability and overall excellence of the design really came through when we got into mass production, because you can't make that many if you don't have margin. We had margin and so we did not have hanger queens. The ones you couldn't get out of test**.** We just didn't have hanger queens on the test floor and we didn't have field problems. So, as the business manager of the whole thing, I'll tell you, that design was solid. We had margin. We could make 125 a day and we did not have a lot of rework or units cycling around. We could make our cost targets and we could make our schedules. Because we had margin, we could look the customer in the eye and say, "You need how many when? We'll do it." And we could do it.

Gardner: That raises a question, was it the same base casting on the 300 megabyte as in the 80?

Murnan: No, it was the same as on the HPD. The 80 was the very lightweight deck. The HPD deck was much bigger, since it was a standalone unit, not a rack mount.

Gardner: Gotcha.

Berreth: There some modification to the HPD deck but it was basically same**.**

Murnan: The voice coil and the actuator were pretty much the same as the HPD but we had to adapt the double cam load/unload mechanism to it. The changes were relatively minor and straightforward, although nothing is ever minor. The biggest concern we always had was head crashing, because when you have removable media and if you happened to unknowingly have a head crash, with a damaged head or a damaged disk somewhere along the line, you could propagate that. You could take that pack out of that drive and put it into another machine and that would cause that one to crash. I think our users became very knowledgeable about the consequences of that and they watched that very closely. This was a concern with the larger 300 megabyte drive, because we obviously had more heads and more disks. You could get into an environment where you might have up to three packs or more per drive and these could be used across a string of different drives, so you would be a little bit concerned. Thus you needed to be knowledgeable and keep that within your vision of what could go wrong.

Berreth: Yes, and since a lot of these were being used in office environments, the printer might be sitting right beside the disc drive. It wasn't like a computer room where you get all the printers and other stuff off to the side or at least out of the disk drive area. No, you had your printer, disk drive, and computer all sitting in an office. That is why, as they were changing paper in the printer, they might lay it on top of the disk drive. They needed someplace to set it, right? So that was common.

Murnan: Let me tell you one little story about reliability and the head-disk loads and unloads. You always want to be able to test a device to failure, if you can. A good engineer should understand where his/her product or design fails. I took an 80 megabyte SMD down to our machine shop in Normandale and Dick knew what that was all about. I took out the HEPA filter but left the coarse filter in there. The technician did a couple of pack changes every day and it ran for six months without the HEPA filter, if you can believe that, in this oily kind of sticky environment.

Berreth: Yes, where they were using cutting oil on lathes and milling machines. So you had that stuff in the air and those molecules are big.

Murnan: To this day, I'm so sure why it ran but usually head crashes were propagated by something being damaged more so than by a marginal design, where they all wore out.

Berreth: Right.

Murnan: That was one of the concerns we had with the bigger drive but we already had the HPD field experience, so it was just a matter of tradeoffs, since we were flying a bit closer. The decision was go ahead and it worked out.

Gardner: In 1977, the CMD (Cartridge Module Drive) was added to the SMD product line. What can you tell me about the decision leading to do that?

Murnan: When MPI was formed, there was an opportunity that came along with that acquisition for me to be the technology interface between Minneapolis and Oklahoma City. At the time, they were working on a cartridge drive design, with one fixed disk and two removable disks. After discussion with the key engineering managers down there, Tony Maggio and Dean Bowman, I convinced them to upgrade their design to the higher bit densities that we had in the SMD and make a device that was physically the same size as an SMD, plus used the SMD interface. The idea was the minicomputer guys could put their operating system on the fixed disk and their customers could use the removable cartridge for swapping in application data, with only one or two drives needed per system. This became the CMD (Cartridge Module Drive) and it was a very successful member of the SMD family.

Berreth: Process control applications ate it up, since it gave them a cost advantage. Oklahoma City still had to do the cartridge development but there was no new head, disk or electronics development, so their development time could be shortened and they would have low cost, reliable components. Not low cost in terms of today's environment but low cost in terms of that day's environment.

Murnan: So they picked up a lot of the SMD technology from Minneapolis, including the power supply. It was kind of a growing experience for the Oklahoma City engineering, because they were not necessarily familiar what we had done on the SMD. So we had to transfer a lot of that technology down there, but they went ahead and implemented it with some of the uniqueness that was required for the cartridge drive. They already had the customer interface capability and structure in place, so it was a relatively easy thing to do, except for a pretty steep learning curve to pick up on our technology. Eventually they sold well over 100,000 of those CMD drives.

Berreth: You also have to remember the history. That was a Honeywell disk drive plant when MPI got it but prior to that it had been a GE systems plant. So they had very good engineers but they weren't familiar with our technology.

Murnan: They previously didn't have the head technology available to them that we offered up at the Control Data Normandale division, so that was key. I can't over emphasize the need for recording density. That is what kept the disk drive business going. I don't know many other products where you get more for your money as time goes on, other than the computer itself. During my career, we increased the reporting density in the industry over a million times and I've double-checked those numbers a couple of times.

Gardner: Actually I have a much larger number. My number is 50 billion.

Murnan: Tom, you may have another 10 years in front of me, so I'll believe you, but I'll take the million.

Gardner: To be fair, I'm measuring from the 1956 RAMAC to a 2005 drive and the aerial density increase is somewhere in the 10 to 50 billion range.

Berreth: As an old engineer, I know that if you plot it on semi-log paper against time, it is a straight line, even though to get to the next level we often thought we were at the end of technology, because the physics wouldn't let you.

Gardner: Actually, if I could disagree with my guest, there are a couple of interesting kinks in the line. One of them occurs around 1990, when all of a sudden the aerial density starts increasing at about 100% per year. Then it slows down again around the turn of this century. So there are definitely a few kinks but you would not be too inaccurate with saying it is essentially a straight line from 1956 to 2009. It's pretty close. There are some kinks which are worth discussing but not here, since we didn't cause those kinks.

Murnan: When you inject a new technology, like an MR head, what you tend to do is get sort of a boost, over a short period of time. That then tends to flatten out, until the next technology boost comes. So you kind of ride that a little bit in between and you get a few bumps in the road along the way, because of those technology injections.

Gardner: In transferring the SMD technology to Oklahoma City, were there any interesting stories or any not invented here?

Murnan: There always is a little NIH but they had test systems down there that they could use to evaluate the heads and disks. Their key engineer at the time was Hossein Mogadam and you have probably heard of him. When we convinced him that the technology was good, then it was a lot easier. They certainly were skeptical at first, on whether this was the right thing to do, but once they saw that it was working and they got leverage from the recording density, they became convinced. Then it was more a matter of why we couldn't get that stuff down there faster. Pretty soon we become their supplier and they were the buyer, so we had to respond. That was good and it was healthy. I made many trips to Oklahoma City, so I'm kind of familiar with the town.

Gardner: Now CMD was always a fixed / removable. Am I correct?

Murnan: As I recall, that is correct, yes.

Gardner: I think fixed / removable drives were first invented by IOMEC in the 2315 era but it sort of died. People stopped buying them, because they just bought two removables instead, but you guys made the CMD very successful, with 100,000 units. Any idea why people didn't do removable only and why you were able to resurrect the fixed / removable?

Murnan: We touched on the propagation of head crashes earlier. With fixed / removable, you have to make sure that, when you were doing cartridge exchanges, the fixed disk is properly shielded from any debris that could come in and out during that operation. That was always kind of critical in my mind, so we worried about that a lot. Oklahoma City did a pretty good job of getting that fixed disk sealed off properly and avoiding that issue but you always worried about an impending catastrophe that could happen. Since the customers had their operating system on that fixed disk, they needed to make sure it was backed up.

Berreth: The other thing was the amount of capacity that was available, needed to adequate for the applications. The CMD was being used in a lot of applications where the operating system needed to fit on the fixed disk and the removable cartridges had to have the capacity for running the applications. So it fit some niches in the marketplace.

Gardner: I'm interested in the different market dynamics that occurred than the earlier generation 5440 single-disk cartridge, which generated lots of suppliers. The fixed / removable combination had died and I'm just surprised that in the next generation nobody responded to the CMD with a removable only version. You guys also didn't do a removable only cartridge drive. Why were the markets different in the early '70s and the late '70s, if you know?

Berreth: Well, I think it's a lot like real estate, where they say location, location, location. It's timing, timing, timing for the capacity and performance, versus the application that it was going into. If the timing was right for that combination, with the characteristics that it had, it fit the market. So in that sense we were probably lucky in that, although we thought we understood the market, we really never understood all of the applications and how the product was really going to be used in the market.

Gardner: Marketing is not an exact science. But the next year, we're into 1978 now, you introduced another product in the SMD product line, the MMD. How did that come about?

Murnan: That was a result of the evaluation we did back in the early '70s and was sort of a precursor to what we were going to do long term in the fixed media area. We knew that long term this is the way we were going to build disk drives. They were going to be fixed media with contact start and stop in a relatively clean enclosure. There wasn't going to be any removability, because the risk with achieving the higher track densities and avoiding potential head crashes was too high. So we knew that we had to introduce fixed media at some point. We knew that the IBM System 32 had a fixed media disk drive that was smaller in size. We never lost sight of the fact that in order to grow the recording density, which was our key objective, we would need to get that fixed media technology. Now, I think the technology we put in the MMD was actually the same as the SMD, in terms of density, but I might be wrong on that.

Gardner: No, I think you're correct.

Murnan: We then migrated beyond that density when we went to the smaller diameter 9-inch disk on our next fixed media disk generation, the FSD, because what was also occurring about that time was downsizing of the disk drive form factor. As Dick pointed out, drives were going into offices areas, so you

needed to get more capacity in a smaller volume and make them quieter. As a result, we saw the end of the 14-inch disk pretty much coming about in that timeframe and needed to downsize.

Berreth: I would also add that as you downsized, your costs got better, because you had smaller disks, which required smaller motors with less starting torque, etc. In addition, integrated circuits reduced the electronics costs and also helped the reliability. So as the cost per megabyte got lower and the reliability got higher, rather than removing the media, you could afford to use more of the higher capacity fixed media drives. Why not? They were getting cheap.

Murnan: There were some constraints on getting enough capacity on smaller diameter disks but they also helped get higher recording densities. It is much easier to make smaller disks with greater homogeneity and fewer flaws across the disk and then fly heads closer to the disk. In addition, large scale integration allowed us to downsize the electronic components to fit into the smaller packages. With the FSD, we went to160 megabytes, so we got twice the capacity of the MMD in half the volume. That was very important.

Gardner: I thought the MMD was a 14-inch.

Murnan: The MMD was 14-inch. The 9-inch FSD wasn't quite conceived yet. We knew that downsizing was coming but we thought our first SMD family entry point in fixed media should be with a 14-inch disk, using the same contact start stop head-disk technology as on the FMD. So we decided to get our foot in the door with that strategy and make the MMD a bit cheaper than the SMD. We didn’t have the recording density capability to take that up another notch at the time, otherwise we would have done it. But it also was a good entry point from a reliability perspective, since it had higher reliability than the SMD.

Berreth: Thus it provided an entry with a product that had less risk than trying to get all the way to the 9-inch FSD in one step.

Gardner: So the MMD was basically a fixed media version of the SMD. It had the same aerial density and number of disks but it used Winchester heads. Is that correct?

Murnan: Yes, the FMD Winchester-type ferrite heads with two heads per surface.

Gardner: So the heads were more expensive.

Murnan: Yes, but you definitely gained some performance, because you cut the seek time down, plus it had more cylinder capacity. When you use the two heads in a cylinder mode you have twice as much cylinder capacity as one head per surface. So, there were some advantages there that got us to higher performance and also got us started with fixed media in the minicomputer market

Berreth: The FMD really wasn't in the minicomputer market, so the MMD got us into that market and we felt it was certainly worthwhile to do that.

Gardner: You already dominated the minicomputer market with the SMD.

Murnan: Yes but we were fearful our competition would get out there and gain market share with fixed media. With the MMD, we could mix removable and fixed media drives all on an SMD interface, so you could get the removability you needed with the major part of the capacity on fixed media. There was a concern on our part that we would not have positioned ourselves well if all we had was removable media.

Gardner: IBM first tried to sell the 3340 into that space rather unsuccessfully. There was a debate within IBM as to whether their problems on the low end were caused by the low-end systems or by the 3340. They then took the Winchester technology to the 3350 and later came out with the 3370 and 3380, which had thin film heads

Murnan: The problem with the 3340 was it was a removable data module that was just too expensive.

Berreth: Because it had the heads and part of the actuator all inside the removable data module.

Murnan: It might have been all right for moving data between machines but certainly not for low cost data storage. It was too expensive for either removable or fixed storage and had less capacity than an SMD.

Berreth: You only had 70 megabyte with the 3340 data module, so your cost per megabyte was sky high.

Gardner: Did you make disk packs also?

Berreth: Yes, we built our packs in Omaha.

Gardner: Do you know how many disk packs you sold per SMD?

Murnan: You have asked me this question several times before, Tom. I'm pretty sure that on the 80 megabyte SMD there were an average of three to five packs per drive and I would say the majority of those packs came from Control Data Corporation. I would guess as high as 80%. I know there were people out there making similar packs but there was a risk with the user, around head crash propagation. If you come in with a bad pack and you mess things up, then it's kind of hard to get a foothold. Nevertheless, I think our customers always wanted to have a second source for pricing reasons. So I don't think we can ever get a handle on the exact total but I would guess we sold at least three Control Data packs for every drive we sold and maybe even a little higher

Berreth: Yes, I would think it would have to be in the 350,000 to 500,000 packs range but I don't know for sure.

Gardner: Is there a pack marketing manager in that time period who might actually have studied that stuff?

Berreth: Yes, but I don't know who it was. I just don't remember.

Murnan: I don't remember either, because that was a separate organization. Once we got the development done, they sold packs separately from the disk drive folks.

Berreth: The disk plant in Omaha was not part of MPI. It was part of the Control Data Business Products Group. So, even though we did the disk development at Normandale, as part of MPI, the disk production was never part of our operation. That's why it's a little hard to find somebody, because it was a different organization. We all ended up reporting to Tom Kamp of the CDC Peripheral Products Company but that was a long ways up to find out details.

Gardner: The reason I'm interested in this, of course, is the IBM justification for the 3340 data module was that small computer users did not want many disk packs, so therefore they could sell the expensive data module. I think CDC's success proves them wrong (bad planning) but I'd like to see if I can find a number. I suspect the number is more than 5 to 1 because I suspect CDC's market share was not as high as 80%, but I could be wrong.

Berreth: Well, over time people kept adding packs and some of those applications keep running for 10 years. So they could still be buying new packs and running that old iron in the back room of some place that you've never heard of. I ran into that on customer trips.

Murnan: I'll continue to try and see if I can round up a number for you and get the person to talk to. I think I can do it but I don't remember all the names. I'll see what I can do.

[**Editor's note:** Several former CDC people were contacted; most simply did not know but some think the final number may have been closer to 10 packs per drive]

Gardner: If you look at the history in the 2311 era, IBM had a monopoly and they were selling eight or 10 packs per drive, with those packs selling for $1,000 or $2,000 each. Then competition entered and by the time the 2314 came around, IBM was selling only a few packs per spindle, since Ampex, Memorex and I think the Control Data and BASF were also selling 2314 packs. The same thing happened in the 3330 era. So I think the total packs per spindle number is probably in the 10 to 12 range for almost every generation.

Berreth: You are probably right over the life of a drive - that's probably true.

Gardner: After you stop building drives, people still sell disk packs. It's an amazing number. Today, of course, that's gone. We do have CD-ROM, CDs, and DVDs but that's it. Probably 30 or 40 of those per

drive. Removable media consumes itself. So if MMD was only marginally improved over SMD and actually had a lot less capacity, how did MMD do in the market? Was it just a placeholder until FSD?

Murnan: I believe it to be more of a placeholder. Dick, correct me if I'm wrong, but I don't think we sold that many MMDs; the FSD was much higher volumes.

Berreth: MMD sort of bridged the gap. FSD was much more of a winner in the marketplace.

Gardner: FSD was not truly SMD compatible, right? It had a higher data rate and different format.

Murnan: Yes, it had higher transfer rate and a different format but the rest of the interface was the same, so they needed to upgrade their controller. What we tried to do, when we sized the next generation, was do it in 2x increments, so that you could map over quite readily, not give you something in between that didn't quite make the 2X capacity. We were very cognizant of that up until the year 2000, I think. It was always in the back of your mind, when you are going to talk your customer into taking one of your new drives, that data migration from the old to the new had to be made relatively transparent. That was important.

Berreth: Yes, because the number of legacy systems out there is huge and, if you aren't compatible with some easy way to migrate, then you're out there off singing solo.

Gardner: However, as you pointed out, an 80-megabyte SMD does not necessarily hold 80 megabytes of user data

Murnan: Eventually we went from unformatted capacity to formatted capacity, as we have it today, to solve that problem.

Berreth: What you see if what you get, right?

Murnan: Yes.

Gardner: It should be remembered that until the '80s, disk drives were sold with an unformatted capacity. It's really not until you see SCSI in the late '80s and then IDE in the '90s that all drives came with formatted capacities, except for the difference between binary numbers and digital numbers, but that's another story. That was part of the controller design issue. Depending upon the controller design, an 80 megabyte SMD might have 67 or 72 or 53 megabytes of user data, so it depended upon the skill of the controller designer.

Murnan: That’s correct. Certainly as time has gone on in the industry, we’ve always tried to make that format more efficient. If you can cut down the overhead, you get more capacity and that’s what the customer wants.

Berreth: You get more bang for the buck.

Gardner: My notes here say your 5,000th SMD went to Systems Industry

Berreth: Yes.

Gardner: Your 50,000th went to Philips and your 100,000th went to Datapoint. I'm pretty sure SMD is the first disk drive ever to exceed 100,000 spindles and you were there for most of that, Dick.

Berreth: Yes.

Gardner: Growth like that is usually not experienced by one person or one manager.

Berreth: As an operations guy it was a crazy ride. I have never had more fun in my life than when I was Vice President of the Normandale Division. It was like going to the moon. We were on a rocket and, no matter how hard you worked, you were always behind but you didn't mind the hard work, because it was so much fun. The more you could do, the more they wanted you to do it. It was insatiable and I tried to keep up with it by adding people and adding plants. We hit our peak in what had to be late 1980 or early 1981, with 7,200 people in the Normandale division. We had five plants here in the Minneapolis area. We also had plants in Bemidji, Minnesota, Redwood Falls, Minnesota, Aberdeen, South Dakota, and Rapid City, South Dakota. So we had 7,200 people, all domestic, and that doesn't include any of the media manufacturing in Omaha or anyone in Oklahoma City, which was a separate division from Normandale. We were totally a non-union shop and we worked very hard at keeping that. Employee relations are always difficult when you're hiring fast. Your old timers tend to think they're just a number – "you've got so many new people, nobody knows who I am." Employee communications was key to trying to keep good employee morale because if you don't have good employee morale you don't have good quality and you don't have good delivery performance. So that was essential from an operations standpoint and we worked very hard on employee communications. I personally communicated with every employee every three months, even when there were over 7,000 of them. These weren't one-on-ones, obviously, but we'd meet in the cafeteria quarterly, during working hours, and I'd have a presentation of about 30 or 40 minutes on how the business was going, what the orders were, if orders were still coming in at a good rate, what our forecast was, and whether we were going to be hiring more people, so they didn't have to worry about a lay off. Then we would just throw the meeting open to questions. Anybody could ask anything they wanted, so some might try to embarrass you or point out some problem that is going on in the shop that shouldn't be or even embarrass their supervisor. There was always a little of that. You just had to keep your cool and give them a straight answer and be honest with them. I always tried to do that and it was always a lot of fun, because you never knew when you threw it open to questions what the question was going to be. That took two weeks of my time every quarter just to communicate, but it was critical to the operation. Then, of course, Control Data was always short of cash. They were profitable but they were growing too fast, so they were always in a cash flow bind. When the corporation got into a cash flow bind, we were right there with them, but we were also running out of space and they were telling us to cut back. So we had that internal conflict. I tried to shield the guys that worked for me from that. That was my job to handle that stuff and make sure that we could get the resources to keep this thing going, because it was a winner. All-in-all, it was just the most fun time of my life.

Gardner: So you are talking about two challenges: hiring and retaining people, plus managing the corporation. What were the other challenges of growing a rocket like that?

Berreth: Well, obviously, there was no substitute for good people and good engineering. I can't say enough good things about the guys in engineering, because it didn't matter if there was a problem; they went after it. Probably half the time the problems in manufacturing were caused by manufacturing. It wasn't an engineering problem but they needed engineering to come down and straighten them out. Engineering never hesitated to get down on the test floor and find out what was wrong, when manufacturing couldn't find it. If it was a margin issue, they would solve it. If it was something manufacturing was doing wrong, they would tell manufacturing what it was, so they could fix it and keep things going. There was never any backbiting or comments like "hey, why don't you guys get your act together?" None of that kind of B.S. Everybody was on the team and that's why it was so much fun.

Gardner: Did you tell Tom in 1978 that there were no engineering problems?

Berreth: I probably never told him that but I appreciated what he was doing.

Murnan: "Don't write so many ECOs", he would say. I think there was a culture at Normandale and then at Seagate, that still prevails to this day, of having a lot of patience. We had technical issues as serious as anybody else, where sometimes we would think we were not going to be able to meet the date, when we had to deliver the product. But we would find out that the competition had similar problems and by the time they got theirs fixed, we got ours fixed, as well. So everyone kept their nose to the grindstone and just worked on the issues; they didn't panic. They would just work it hard and believe they would eventually get there. I've always marveled at the attitude of the people in that organization. They just didn't give up and management didn't give up either. We've always had management that said, "Hey, we've got to get this fixed," rather than, "Hey, you screwed up. We're going to kill the program and go on to something else." Very seldom did that ever happen.

Berreth: It was never a kick ass and take numbers kind of atmosphere. There was an attitude that we're all in the same boat, and if the boat sinks we all drowned. It wasn't that I got the life jacket and you guys are going to drown, none of that. It was we're all here and we've got to make this thing work for us, not for anybody else.

Murnan: So that's a significant environment to be able to work in. If you've got the ability to hang with it and you get the support from upper management, as well as from your peers, then you're going to be successful. I think some companies probably lack that in one fashion or another. You've just got to have patience in this business.

Berreth: Yes, teamwork and camaraderie were always part of keeping that together and it was always good. I really didn't have to spend time refereeing. Of the whole time I was Vice President of the Division I can't remember any refereeing. I was just able to do my job and give them the resources and then they always got it done.

Gardner: Dick, would you care to share some of those memorable challenges where the team pulled together? Can you give me a specific example?

Berreth: I can't really recall a specific example, because it has been too long, but once we found the problem I never saw it take engineering more than 72 hours before we had a fix in hand. Now, it might take longer to get the parts and all of that before you could ship it to the field, but once we knew what the problem was, engineering got it done. The big problem was always trying to get it nailed down to the root problem, the same as in the medical profession. They can tell you 100 things that are not wrong with you but they have trouble identifying the one thing that is wrong with you, so they can fix it. The disk business was no different.

Gardner: Anything else you want to share with me about the SMD, MMD, CMD era?

Berreth: Well, I would just say it was the highlight of my career. And it was just a wonderful time. As a division vice president, I got a lot of accolades but I wasn't the guy that did the work and I never forgot that. I've got some memorabilia and things that I've collected and have on the wall at home. I go down and look at it and remember the good times and the things that happened. My frustrations were always in getting space and getting resources, including capital and money. I do remember one case where the company was short of money and said we couldn't have any new space. But we were out of space at Redwood Falls and just couldn't get our power supplies built, plus it was unsafe. When you are building ferro-resonant transformers that weigh 25 pounds a piece, if somebody drops one on their foot they will be out of there for a week or may even be permanently injured. So I said "I do not have permission for this, but go get the building that you want. Just rent it and pay for it out of petty cash. I'll sign it. Just get it done. We have to make the schedule and I will cover it someway." Eventually I had to tell my boss about it, and he said, "Don't tell me any more, that's enough. Just keep doing it." So there was that kind of frustration, because of the cash shortage that the corporation was going through, while the disk business was just going gang busters. As a private corporation we would have no problem because the profit margins were there and the customer base was there, so there would be no problem getting financing for it. Our receivables were all gold plated but we weren't the only player at the CDC table. So that was a personal frustration of mine - getting the resources so that the people could get their job done.

Gardner: Segue now into a slightly different topic. Right in the middle of this you're no longer working for CDC. You're now part of MPI.

Berreth: Well, that was really almost no change, since MPI was a joint venture with Honeywell and it was 70 percent owned by Control Data and 30 percent by Honeywell. Honeywell realized that they were not going to be able to stay in the ballgame and continue to develop and build their own disk drives on their own. There was too much capital and engineering resources required to do that, plus do mainframes, software, controllers, and everything else that they needed to make a system. So that is why they were talking to us. They had bought drives from us in the past, when a new technology came out and they didn't have it yet, but eventually, they'd get there. Then they would quit buying from us, but they would come back as a customer, with the next technology introduction. So every two years we had them for a customer for 12 months. They finally gave up and said that's enough of that and joined forces with CDC in the MPI joint venture. From my standpoint, all it really amounted to was three or four extra meetings and trips a year for the MPI board meetings and that kind of thing. Other than that, we were still

with Control Data and were still at Normandale. Our life hadn't changed. Our facilities, our business, my office, didn't change. The guy I reported to was still the same guy. He was now the president of MPI.

Gardner: Who was that?

Berreth: Jerry Gilbert. He became President of MPI when MPI was formed and I was made Vice President of Normandale Operations in September of 1975.

Gardner: Now, the impetus behind these sorts of arrangements, I thought, was Tom Kamp

Berreth: Yes. But what was driving Tom Kamp was CDC was short of money. So he found a 30 percent partner to give him the money to grow this business. Tom was a great proponent of growing the business. He would say "The market's there, let's get it." I never had trouble with Tom, in terms of going after the market. The CPI joint venture that happened earlier for tape drives and printers was with National Cash Register. That was a way to share the funding and keep the printer and the tape drive business going. MPI was a joint venture with Honeywell in just the disk business. Then later there was PCI between Memorex and MPI to develop thin film heads, because that was going to take tons of capital equipment.

Gardner: I didn't realize that MPI was strictly disk drives. I thought they had other products besides disk drives.

Berreth: I can't remember a thing we ever did other than disk drives. Once MPI was formed, we had some old Honeywell products that we continued to build out for them but our charter was just disk drives. If it wasn't brown and round it wasn't ours.

Murnan: When I was working in the MPI products and planning area, we'd have joint planning sessions with Honeywell. They had major operations in Massachusetts, Paris, Phoenix and Milan. Those planning meetings always seemed to go very smoothly. Rather than telling us what the products should be, they wanted us to present what our thoughts were and then they would see how they could adapt those products in their computer lines. We would also make some adjustments, if we could, but there was never a major redesign or anything that needed to be done, just to fulfill some of their requirements. So that worked rather smoothly. You would think that would have added some difficulty but it really didn't, to my way of thinking.

Berreth: I would add that part of that reason is Honeywell understood that we were talking to a lot more systems customers than they were. Our knowledge base of what was going on, as far as usage of disk drives and where we saw things going was very broad, because of the large OEM customer base that we had. They were smart enough to see they really ought to look at all that we knew about the disk market and where it was going, so that they weren't off out in left field all themselves.

Gardner: That's actually an interesting point because the business did change from the early '70s when you were really designing for CDC and selling the products to a few system OEMs, plus the IBM Plug Compatible market. Then all of a sudden you are in this huge minicomputer market and the mainframe business sort of goes away or atrophies Talk about that transition.

Berreth: Well, it still was there, but as a percentage of the business, because of our growth in the minicomputer market, it became less and less. CDC was not even among our top 20 customers.

Gardner: When did that happen?

Berreth: I don't remember when we crossed over, but I had to remind them once in a while that, "we don't just deal with you." They didn't like to hear that, obviously, because we were still part of Control Data, but the truth of the matter is that they were doing large scientific stuff and that was not a huge percentage of the total market.

Gardner: I would have liked to have been there when you told them that they were not one of your top 20 accounts. Was Honeywell one of your top 50?

Berreth: Yes.

Gardner: You were measured and paid on a percentage markup which had you been an independent company, would have been a lot different. Was that ever an issue in terms of measurement or management interaction in the financial arrangement?

Berreth: It never was, as far as I was concerned. I always just felt blessed to be the guy that was running the ship. Frankly I was probably one of the few engineers in the world who felt he was always overpaid. Where I come from that was tremendous money and none of my relatives made money like that. **I** just felt privileged to have the opportunity and background to get into that job and to take a run at it.

Gardner: Tom, any changes in scope, as a result of the MPI arrangement, on the development side?

Murnan: No. I don't think so. I was going to just touch on something that I always thought was difficult for IBM, because they were very used to selling to the end user at very high prices. They ventured into the OEM market themselves, a little bit, but they always had that issue of "where do I set that OEM price? Where, do I set that end user price? How do I manage that whole thing?" Dick touched a little bit on our paradigm, which was that we were very focused and dependent upon our OEM customers.

Berreth: Right.

Murnan: That's what drove the business, so when CDC came along we didn't see that as being a big revenue stream for us. As a matter of fact it probably transferred at cost.

Berreth: Oh yes, it always did.

Murnan: So that also was a little bit of a difficulty within Control Data thinking "Here is MPI designing all of these disk drives and they just can't seem to tailor something that fits our needs and we can sell as a high volume thing to our end users." I don't know what to tell you. That was just the way the business went.

Berreth: CDC did have unique requirements for high performance, so we designed the HCD (High Capacity Drive) for them. That was 20 heads parallel, right?

Murnan: Yes. They always had scientific applications that needed a high data rate. They didn't need seek time; they needed data rate. We had the ability to offer parallel channels to get that data rate up and knew how to do that from the large files.

Berreth: That allowed us to reconfigure one of our OEM products as a special product for Control Data systems, without a lot of additional expense.

Gardner: Wasn't Control Data a bit schizophrenic in that sense, since they didn't do OEM sales? Were the OEM salesmen also selling CDC products?

Berreth: No, the OEM sale people did not sell anything except OEM products, but that included disk drives, packs, printers, tape drives, terminals, and some memory.

Gardner: But they were CDC.

Berreth: Yes, but they were strictly a CDC Peripheral Products Company sales force.

Gardner: Within CDC?

Berreth: Right.

Gardner: They weren't part of MPI?

Berreth: No**,** MPI did not have any sales.

Gardner: Wasn't there some schizophrenia inside CDC then with these OEM salesmen who wanted one class of products and a different set of systems salesmen, perhaps even reporting to the same sales VP, who wanted another set of products? How was that rationalized?

Berreth: Fortunately, Tom Kamp had his own vice president of sales, Gordon Brown, who reported directly to him in the Peripheral Products Company, and not into the other CDC groups. CDC Systems sales was a whole different group and Tom handled that interface. There was no question that there was some jealousy, particularly when the SMD took off and Control Data systems was not doing real well. The OEM salesmen in the Peripheral Products Company were making lots of money and they weren't making quota on the system side. …

Gardner: That must have been an interesting management challenge but I guess you guys didn't see it.

Berreth: I didn't have to handle it. Gordon Brown had that one, together with Tom Kamp

Gardner: Okay. We're down to about 20 minutes left in this session. I'll probably end it five minutes early, so that we can let the next folks in. Dick, you have some memorabilia you want to show us.

Berreth: Well, I got this particular sculpture that was done by a guy called Shoop and he had his gallery in Stillwater, MN. They commissioned him to make this and it was a limited edition. I don't remember how many were actually made but it's a brass casting of a 300 megabyte storage module drive. There were a few of those given out at the 100,000th anniversary.

Berreth: These mugs were given to every employee when we had our 100,000th celebration. I got two, because I was a division VP, and they are really a good mug. I still use them all of the time for coffee at breakfast. It just says MPI and has an outline of the SMD head pad. It also says 10 to the 5th on the other side, for the 100,000th SMD, and is dated July 1981.

Then this was the plaque I received when we shipped the 50,000 unit. It says "Presented to Richard A. Berreth, in commemoration of the 50,000th storage module drive, December 1979."

Later on OEM marketing gave me this cash cow award plaque, because they had made a ton of money on the SMD and were appreciative of it. We had shipped over $400 million of that product from 1975 through 1981.

[**Editor's note:** Photos of sculpture, mug and plaques reproduced in Exhibit 1 hereto.]

Gardner: And those are real dollars.

Berreth: Yes. That wasn't at end user pricing or anything, those were real dollars we collected from the OEM customers, over $400 million. The plaque itself is very oxidized, because I happened to store it

where it was quite damp for a while and didn't realize it. I really ought to get it redone. It just has a picture of a cow and says "To Dick Berreth in recognition and thanks for outstanding leadership of the Normandale team that produced Control Data's first cash cow."

Berreth: Then I have a photograph of the 5,000th delivery that I found in my file. There's the 5,000th unit, ready to go in the box. That's basically it for the memorabilia.

Gardner: I noticed you had an MPI Newsletter, but you don't have to show it

Berreth: We put out a paper at the 50,000th shipment and that one was quite thick, with hundreds of pictures in there of the employees from every one of the plants and everything. For the 100,000th shipment, we put out another one, but we evidently were short of money that year, because that's just a two-pager.

Murnan: Not very many pictures, right.

Berreth: Almost no pictures.

Murnan: Only Dick's picture.

Berreth: No, I'm not even in there. Just a picture of the plant and a picture of a bunch of drives

Murnan: You have a copy of that at the museum right?

Gardner: Both are contained in Tom's document gift to the museum.

[**Editor's note**: Prior to this interview Tom Murnan provided the following documents to the CHM in donation "CDC/IMP SMD documents (3), X3831.2007 (X3834.2007), Gift of Tom Murnan":

1. November 1972 development plan extract listing the properties of what became the SMD 9760.
2. 1977 CDC newsletter including an article, "Year of SMD"
3. Dec 14, 1979 internal Magnetics Peripherals publication, "Normandale Builds 50,000th Storage Module Device." Twenty-eight pages apparently consist of face shots of the persons within the various SMD organizations at related CDC locations in late 1979.
4. Aug 10, 1981 internal Magnetics Peripherals publication, "Normandale Celebrates Shipment of 100,000th SMD."]

Berreth: Of course, we also had free coffee, cookies and donuts for all of the employees, across all of the shifts and all of the plants, because it was a big deal.

Gardner: We have 10 minutes left. Tom, why don't you look back at what was the high point and what was the low point?

Murnan: I think in my career the high point is that I got to lead a development team that could be creative and really have a big influence on the product itself, the definition of the product. Then I got to see the product be produced and be successful. Anytime you design something and it becomes a successful product you can always say to yourself, "there's a little bit of me" in every one of those products that went out. I think that's the high point for probably any engineer that, someway or another, they influenced a product and they can take pride in achieving that.

Berreth: You bet

Murnan: I think the low points probably were just the concern that this thing wouldn't take off and we touched on that. We certainly had some early development issues like you have in most programs. It took a while for the customers to get the product integrated but Dick put some of those sales people on a quick fire sale to get that impetus for the whole thing to take off. There was always some level of patience, or maybe some level of funding, that we needed to tough this whole thing out. So that was always a concern of mine. I always believed we had a good product, and we were in the right position, but whether it would catch on or not, always remained to be seen and to be demonstrated

Berreth: Yes.

Murnan: Thus, the ability to work on something creative, to be able to define it and take it to a successful conclusion was probably a highlight in my career. Not saying that I didn't have other highlights, but this particular product had a big impact on the market. You could say that maybe there was some other thing that had an effect on the OEM market. I'm sure, if it hadn't have been us, it would have been somebody else who eventually would have come through and developed something. Maybe it would have been Century Data, ISS or DEC in the long-term. But I think the SMD was one of the great successes. In my career we had the ability to take the technology many steps beyond and eventually became part of Seagate. I think the Seagate acquisition of Control Data operation was a very good merger because it mixed the technology capability that we had with their low cost manufacturing mentality. That carried us through the '90s and then into 2000's as well, a couple of decades. That was a very beneficial merger.

Berreth: We were just at the point where we were going to have to go offshore. Costs here were getting too high and Seagate was already there. So from that standpoint it was ideal, our technology with the manufacturing capability that they had.

Gardner: Tom, you retired from Seagate when?

Murnan: This time in 2007. I've been gone two years.

Gardner: So there's another whole tape on your experiences at Seagate?

Murnan: Probably so, but I'd have to study up on it. There is something like 80 products that we developed within Normandale over the years and I'm sure I worked on well over half of those. Believe it

or not, I eventually evolved into being the Executive Director of Technology, for the integration of heads, disks, and of all things, recording circuits. Now, I'm a mechanical engineer, so how do I get involved in that? I don't know, but I started to understand it a little bit after a while. So yes, there was probably a second phase to my career.

Gardner: There's another whole story there.

Murnan: Another whole story.

Gardner: Dick, why don't you sum up your experience at CDC. By the way, we sort of ended this with the peak of SMD in the early '80s, but you stayed at CDC for how long?

Berreth: I was at Control Data through 1986. I took over Normandale as Division VP in September 1975 and ran it through March 1981. By then we were up over 7,000 people in the division, so we divided it into three divisions and I went over to corporate as Corporate Vice President of quality, materials and manufacturing. Those were the worst two years of my life. I'm an operations guy, not a staff guy, and I found that out in those two years. It's always nice when you learn something about yourself; but I stuck it out. Then I was like an old navy sea captain; the first time I got a chance to get a ship I jumped the Pentagon and headed for the ocean. The first chance I had was we needed to get thin film heads into production. We had been working on them for some time in the lab but we now had to get them into production, because IBM was announcing another new generation of thin film head drives and we had to be there. So I said, "I'll take that job. I'll go run the division and put thin film heads into production." So I went back to the division, including the old ferrite head operation, and put the new thin film heads into production during my last three years.

Gardner: That's another whole tape that we will get to into the future. Now, would you talk about the high points and the low points? Sort of sum up the SMD experience and that will pretty much conclude this tape.

Berreth: Okay. The high point for me was always working with the people in the division, because there was always such a "can do" attitude. It didn't matter what was happening - we could do it. You know it sort of made you a believer that engineers can do anything; it's only a question of time and money. I really do believe that. But then you have to temper it with economics. So you've got to be able to do it and also make a little money on it. But it was just so much fun being part of getting so much done. The low points were fighting for capital and space, even when we were profitable. The things that should have been easy were difficult, while the things that were difficult really ended up being easy. They were just hard work. Everybody was good at their jobs and that's what made it fun.

Gardner: I think that's a great way to end this session. I really appreciate you guys taking the time to come in and I thank Cisco for making this facility available to us. It's been my pleasure to cover that period of time with you guys.

Murnan: Thank you, Tom. We appreciate it.

Berreth: Thank you.

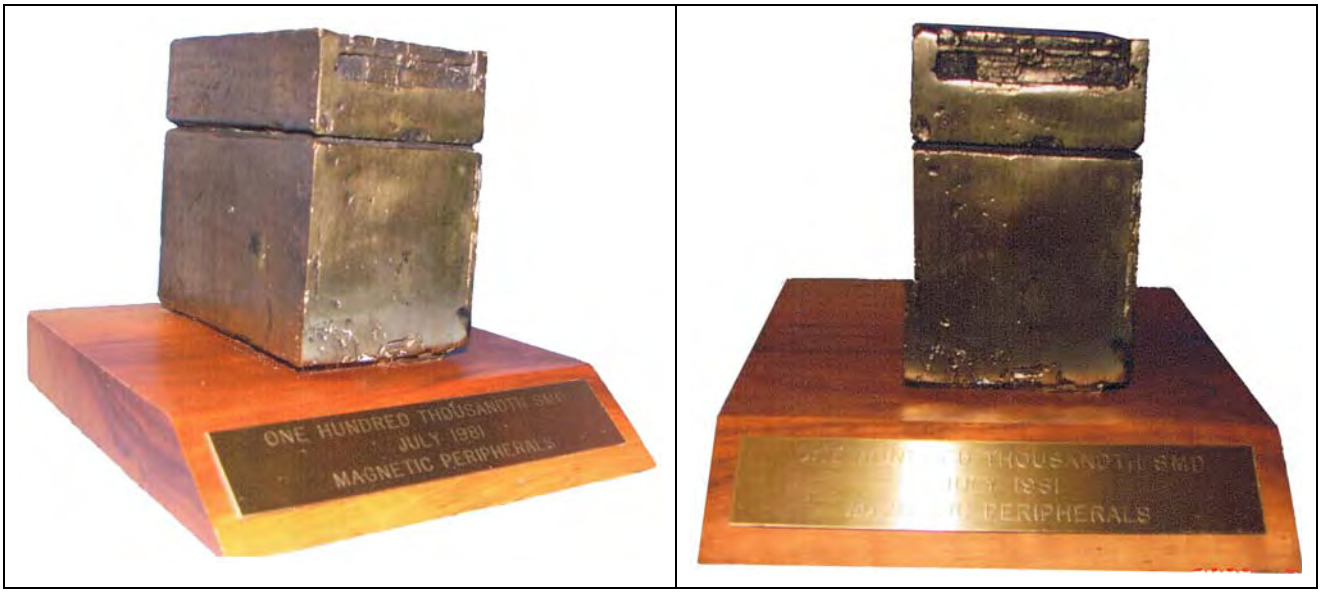
END OF INTERVIEW

Editing notes:

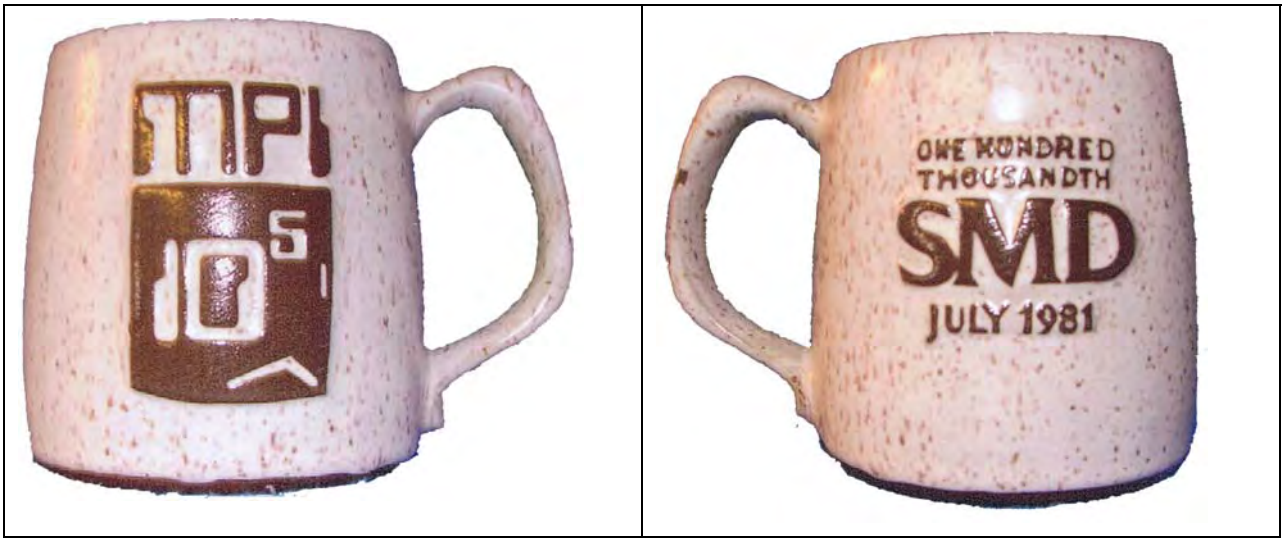
1. Initial edit by Tom Burniece; completed June 10, 2010
2. Burniece edit reviewed by Richard Berreth; August 30, 2010; email comments added by Tom Gardner
3. Burniece edit reviewed and edited by Tom Murnan; completed November 28, 2010
4. Final edit by Tom Gardner, December 2010.

Plaque memorializing the 50,000th SMD drive.

Sculpture memorializing 100,000th SMD drive:



Mug memorializing 100,000th SMD drive



Plaque memorializing the 100,000th SMD drive.