Oral History of IBM RAMAC Follow-on Panel

Interviewed by:
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Jim Porter: Well, today we're gathered for this session to discuss what was going on at IBM in the mid-1950s when they had finished developing almost that first disk drive and were going to ship it probably within a year or two, that first disk drive with 24-inch disks, 50 of them in a stack, that changed the whole computer industry with the development of that random access device. But then the question became where could they go beyond that product? What happened next? So, with the development of that first disk drive, there was a lot of thinking going on obviously within the people that were involved at IBM to try to determine what it was possible to do with the recording technology they had developed, what could be done next with it, and then, of course, what did the market need and what did those other fellows at IBM who were planning systems really want in the way of storage products to put in those systems? So, we're going to discuss that in some detail today with people who were there and who were involved. But first, let's just go around the table and ask each of these gentlemen to introduce themselves with their name and a very brief background of what they were doing at that time within IBM -- Ken.

Ken Haughton: Okay. I'm Haughton. I joined IBM right in that time frame and I was with the company 25 years after that, and I guess that really about matches what you're looking for.

Jack Harker: Harker. I joined in '52, was the designer on the first RAMAC, then moved on to other projects that were going on at that time.

Lou Stevens: My name is Stevens and I joined IBM in 1949 in Poughkeepsie, worked on the IBM 701, moved to San Jose to help Rey Johnson with the start of the new San Jose Laboratory in 1952, stayed in San Jose for the next few years. I was the original product development laboratory manager when part of the advanced development operation stayed with Rey Johnson, and stayed with IBM for 25, 30 years. And then from there on in did a few other things. I taught school.

Porter: Al.

Al Hoagland: Al Hoagland. I'll start with a PR release. I'm actually currently director of the Magnetic Disk Heritage Center at Santa Clara University, got involved in magnetic storage on the drum memory system at Berkeley. After the gentleman next to me brought me on as a consultant in the '50s and I ended up joining IBM in 1956 and my first location was Julian Street under Rey Johnson, what was a come down in a way but it got better.

Porter: Well, I--

Hoagland: <inaudible> building.

Porter: Thank you, Al. I might just point out my name is Porter trying to be the moderate moderator for this session and I would point out that I never worked for IBM but I did work for the company that received the first box that IBM shipped called a disk drive to a company in San Francisco and used to show it off to business guests whenever they came to see me because it was such a strange looking thing putting on such a good show with that head moving around seeking all the time. So, those of us who appreciate what was happening during that era I think can appreciate the contributions of this group especially. But I would like to ask though just to kick this off what were the choices that IBM apparently had as they tried to determine what they could do for the next act after the first act, that RAMAC 24-inch disk drive. What could come next? Any comments?

Stevens: Well, I can address that. First of all, let's set the stage for what IBM as a business was in those days. It was primarily a corporation that was-- it had come through a lot of interesting things. Mostly the-- most of the business was related to punch cards and batch processing using magnetic tape to kind of replace the punch cards. So, the idea of a random access memory was not interesting business in those days. Though when we had developed an early disk drive it became obvious that a new modus operandi business wise was possible if the technology was there. Several important executives recognized that also. One of them, which I need to point out was a fellow named F. J. Wesley, who was the executive assistant to the then vice president, Executive Vice President L. H. La Motte, and Wesley recognized the changing environment that was possible with-- business environment that was possible with disks and wrote an important letter to his boss imploring that more resources be devoted to the development of random access memory or disk type random access memory. And the first question was, well what? So, a group was formed under then a gentleman by the name of John Haanstra who was an important ingredient into the early parts of the San Jose operation and John and two other gentlemen, Matt Gibson and Tom Leary, put together a report proposing the development of three different, three different kinds of storage areas, one million character file using plates or disks, plates or sheets of magnetic material. The thing became ultimately known as the 2321 product out of this. The other environment was a disk in the 50 million character range and it was ultimately when it was-- development was finished became what was the 1301 or the advanced disk file and the third area, which was suggested by the report was a million character file using a drum, magnetic drums. And some work was done but no definitive product came out of that.

Porter: Okay. A lot of choices could be derived from magnetic recording technology that was developing at that time.

Stevens: The real issue was how much development resource could be afforded to put on each of these guys and which one was the first priority.

Porter: Okay. And each of these devices would be a form in effect of direct access or random access memory.

Stevens: Yes, and you remember that San Jose was a growing small organization at the time and there was not a lot of resources to put on more than one, so which one do we put the resources on? And that was the ADF or the large 50 million character disk file was the first guy.

Porter: Which became the IBM 1301, which was introduced then in the early '60s.

Stevens: Right.

Porter: And the first disk drive then with flying heads. It still used the big 24-inch disks. It still had a stack of 50 of them, but the increase in capacity and performance was improved. But before it was finally introduced, some of these other projects actually got underway too, didn't they?

Stevens: Yes. The 2321 was known in those days as the VLCM or Very Large Capacity Memory. It got underway also and prototypes were built but not serious product quite that early. I can't remember the exact dates.

Porter: Jack has a thought.

Harker: I think the other side of this equation is that you look at the technology that had the air fed head for the RAMAC required a compressor. A fellow Jake Hagopian came up with the idea of using a self acting bearing which in a sense this is new because you can go back to papers that Lord Raleigh demonstrated the same thing. You could fly a flat penny over a rotating surface but he proposed using this as a carrier for the magnetic head and that made possible the concept of having a head for each disk instead of having-- moving in two directions. And, so that was something that gave rise to a different sort of concept. Another thing that was different and I think Al can talk about is how we would be recording.

Hoagland: Yeah, actually the ADF view is the next generation following the RAMAC. I mean it's an automatic thing. You have a follow on. And, since the RAMAC was soaking up a lot of resources to become a product and so forth the guy to kick off something new obviously would be Rey Johnson, who got the RAMAC going. And they wanted to make a difference, so they picked very tough objectives. Now, Jack mentioned flying heads, which was obvious if you think about it that you could really cut down access time if you had a head per surface. Some work on drums had been used for flying heads but those weren't flat surfaces. Jake Hagopian sort of proved that you could glide a slider over the disk, not understanding the fundamentals of how you suspend it and so forth, but then I think he perceived that, okay, now you have a head per disk so now you may have 98 heads. So then you worry what the head cost is, you know. So, he looked at what is the cheapest head he could come up with and the cheapest thing you could think of for a head was a perpendicular probe, and I will say, because I didn't say it before, perpendicular recording is now a big thing but has been looked at for many years. In fact, at

Berkeley we found using a probe on a permaloy under layer of a drum, that we got better results than a ring head but they were highly unpredictable.

Porter: Al, I think we probably should interject a thought in the middle of your discussion.

Hoagland: Sure.

Porter: On what is the difference between longitudinal and perpendicular recording for those who are not familiar with the terms. Correct me if I'm wrong but the classic recording that we've grown used to from that first disk drive and which actually have been using most of the time since, the longitudinal recording is a magnetic domain which lies parallel to the recording surface and the magnetic domain being like a long, thin finger lying parallel with the surface. Perpendicular or vertical recording is the idea of putting that domain up, headed directly to the surface. It uses much less space and could go to much higher density. Is this a good summary?

Hoagland: Well, if you'd have stopped two sentences earlier, I would say yes. Well, the essential difference is, yes, if you record longitudinally the field you're working with is essentially magnetized and the disk in plane and that's the traditional way recordings have always been done, although a lot of people looked at perpendicular. There you want to magnetize the disk where the magnetization will be normal. Now, the advantage that motivated Jake did not have to do with density or the medium per se. It had to do with if you take in the simplest concept, if you just took a nail and put a little coil on it you have a perpendicular head. So, he saw that as really the breakthrough that he associated with this slider, as being really cheap given the number you would need. Then, to sort of show what it could do you have to find a surface which required a medium with a soft magnetic under layer because the flux has got to go out of this probe and be induced to go through the medium and then return elsewhere back to the head. Well, there are ways to make perpendicular surfaces, but he talked to Bob Muffley who is with IBM and he perceived this was well known technology. If you oxidize steel, you can get a ferric oxide very hard, thin film of oxide on top of a soft magnetic steel. Well now here was the other part of the equation. Now, in point of fact the other thing they argued for was instead of spin coating disk by disk in a sequential fashion you could run a rack of 50 disks in an oxidizing furnace and when it was through you'd have 50 disks. So, the concepts were really the sort of thing that I think Rey Johnson saw as really the way he liked to see things done, reach out and try something very different. Now, the challenges and there are still challenges today, although perpendicular recording is the most exciting thing in data storage today, the head and the disk have to work together because your return path is in a disk. It changes entirely the nature of designing the head. And then, as Jack knows better than anyone at this table, recording is based on some control of the distance between the head and the disk. So, here we have flying heads and no one really understood how to design. We have the magnetics which no one had really ever designed before, but if it all came off, it was going to be terrific. And, so that's how it started. Now, it turned out that one thing it couldn't have proceeded without was the flying heads because that reduction in access time was absolutely vital. It could have been done differently magnetically but the arguments

Jeff made and Muffley's sort of indication influenced him to try that and given it didn't have a very committed schedule, it was still the ADF, that's the direction they took. And, as I said, there was no obvious reason to say it was a bad choice. They just didn't have enough information to say it would work with that environment with the kind of materials we had in those days and so forth.

Porter: So, that's basically the reason it was not used. There wasn't enough technology off the shelf to be able to reduce it to practical.

Hoagland: I'm going to say something, Jim. I've written a paper on this in the 2003 issue of "Transactions on Magnetics." If you look at history in a bigger picture, for five years IBM committed its advanced recording technology to perpendicular recording and it wasn't until a huge crisis in the beginning of 1960, the management changes and where Jack and I were sucked back in the program that went back to the more conventional RAMAC kind of technology. I say that and I think it's very flattering to IBM. If you can go off on the wrong tangent for five years and still be the leader and be way ahead, you've got something. So, yes, they worked on it very hard but I think the problem was they were more focused on product specs than they were on the underlying technology on which they were building the product.

Harker: What happened to the program, I think Al knows better than I, is that although it started as a speculative advance development there were a couple of systems requirements that very quickly latched on to it as an essential part. One of them was the Stretch system developed for the AEC and the other was the Saber system for American Airlines.

Hoagland: Right.

Harker: And pretty soon those became commitments, so that sort of raised the stakes.

Hoagland: Yes, my God, you had no choice, right?

Porter: And they both, of course, shipped without perpendicular recording so this thing had to be made in advance.

Harker: That was a decision made in about, oh God, '59.

Hoagland: Yes, it was about then.

Harker: We were in formal tests by that time.

Hoagland: The actual decision--

Harker: And it was a Vic Witt decision.

Hoagland: Well, it really wasn't. No one at IBM-- there's one guy who makes decisions, I'll mention his name later, but in IBM they also use the task force approach. I happened to be on a task force so it was in January of 1960 they knew they were on a path that wasn't going to work. The consequence of that was it went more to the-- well, it actually went back to more RAMAC-like longitudinal recording and that's when Vic Witt was in charge of data source projects but they brought in Al Shugart in February, 1960, to run the engineering program and that's when things really took a turn for the better. And, Jack persisted, and see, the thing you always worry about it's okay if we do the stretch with pressurized air heads, are we giving up the chance to really come out?

Harker: Yeah, we had switched so the Stretch file was going to run with multiple compressors.

Hoagland: And there was no reason to believe that a longitudinal recording wasn't quite capable of being advanced. It's just all the effort went in the other and you couldn't have made a 1301 with air pressurized heads anyway. It wouldn't have made economic sense. So that's when it changed in February of '60. The whole scene in there changed.

Porter: So, let me ask a simple question. With five years of activity going on, on perpendicular recording, the development of the technology, was work going on in parallel to that, to parallel that to prepare further advances in the longitudinal recording which had been used on the RAMAC?

Hoagland: Well, there was further work on the advance RAMACs. I mean RAMAC double density and then I think they went one more factor, if I remember correctly.

Porter: Lou what--

Stevens: That was the--

Porter: 1405.

Stevens: It came out eventually.

Porter: The 1405 was the intermediary product, yeah.

Hoagland: So, this required advances in both the coatings on the disk and in the head structure and that was a resource they could fall back on. That's the way it was. Now, it turned out that when I joined Rey Johnson's organization at first we started to do-- we tried to support Jake and we learned a lot about this area but the responsibility was moved from Rey and then I started the single disk file program which had as its big thing circling on the disk proper to go to the significant advance in track density, which later was the technique used on a 3330. So we were delighted to be able to look to get our disk and heads, at least except for the inset we put in our disks, get our disks and heads out of the ADF program. So, we invested all our energy in servoing.

Porter: OK. Well, you did mention one of the other programs that came up during that period, the single disk program. Could you give us just a little brief overview on what that was all about?

Hoagland: Yeah. Its goal was anti-tape if you will. Its goal was on a single interchangeable disk to store the capacity of a tape cartridge, which in those days was ten megabytes and it, in fact, had a head structure so you could read data like you do on tape with seven heads, one head being the one that servoed the other seven. And, of course, the servoing permitting interchangeability in our track density, so it made a big step forward in track density but the idea of replacing tape was-- I don't know if you-- do you remember John Nolan?

Harker: No.

Hoagland: John Nolan was asked by Manny Piora to make a study of this and he came out with a very positive report of the advancements that could be made but the main message was the tape was really going to be threatened in many more ways. But you cannot, as I learned the hard way, in San Jose if you're going to make a problem for people in tape they'd like to see what the problem you're making is. So, we did transfer the hardware to Poughkeepsie and then it got lost there because Vic Witt reminded them he had the mission in disk. So, they stayed in tape. It probably worked out well for the company.

Stevens: You know, I'd like to return to the-- it was okay to meet one commitment off for the ADF with pressurized air bearings and RAMAC technology but I can't for the life of me remember what we did to reactivate the basic work on disks and heads to get the floating head and the vertical recording involved in such shape that it could come into products and we didn't have to go through all the funny business of meeting commitments. What did we do in those technology areas to bring ourselves up by the boot straps?

Porter: Ken.

Haughton: Well, we had-- that was actually the first project I really worked on as I came into Al's group and we had about four of us. Well, we had actually two groups. One was a theoretical group led by Bill Gross. One was a programmer, I guess Bill had done-- I mean manned and led by Bill. What's Bill's last name? We'll come back to it.

Harker: Michaels.

Haughton: Bill Michaels, right. And then we had about a four man group working on experimental work with those heads. And, it was interesting for more reasons than one. We were down in Julian Street and that's the only place I ever worked where you had to cover stuff at night because of the pigeons. But we did experimental work and frankly fed Bill Gross' analytical work and, of course, following Michaels' calculations. He was using the 650 to calculate using Gross' theoretical work. The experimental work tended to be a little bit ahead of the others just because we didn't have so much preparation all the time. We had-- I'll tell you a little side one. One time we were making these heads and some of them would crash and some of them would not crash and that's sort of the problem Jake had, as you recall. And, he said, "Well why the devil is that?" Well, it must be because we aren't getting them flat enough.

Harker: That was my contribution. I told you to get them flat.

Haughton: So we worked like crazy to get them really flat, an optical measurement and so on. Once we got them really flat they all failed.

Harker: At least you knew something new.

Haughton: Well, we learned a lot. So, that's when we turned to putting a curve on the surface and the fact of the matter is, is that you'll see theoretical works. I remember then I took a course in lubrication some years before that and I remember them saying this partial derivative had to be negative or it wouldn't work. And, it didn't dawn on me what the hell that meant. And, anyway, so we put a curve on the heads so that they-- and then we spent quite a lot of time optimizing that curve, finding out exactly an operating point so we could manufacture them. And, the single disk file that-- I went from there to work on that single disk file that Al mentioned just a minute ago and it used those heads and then I went over and worked on the 1301 where we again implemented them. And they worked pretty darn reliably and they sure beat the reliability of the compressor that we were doing there.

Stevens: Oh, boy, anything would beat that.

Porter: So there was serious work going on to refine that technology during that period by all means.

Harker: Yes. But even, you know, that is somewhat separate from the mode of recording because--

Stevens: That's right.

Harker: Because they were still building probe heads.

Stevens: Yeah.

Harker: So, when the time came and the decision was made to switch to longitudinal recording, it really just affected the magnetics, because the magnetic head design and the magnetic element really in the slider.

Stevens: And the disk.

Harker: And the disk and the disk was the bigger problem.

Stevens: Yeah.

Harker: Because at that time there were really no specifications on the disk as far as local flatness and I think it was Ken and Russ Brumer that came up with the classic term X double dot, where you would measure the vertical acceleration of the disk surface.

Haughton: As it rotated.

Harker: And that was the key to success.

Porter: Can you recall at what point in time the decision was made, okay, we're now going on longitudinal recording and that's the future?

Haughton: Well, I can say this much is that I transferred from the research lab to the product development lab to develop the access mechanism for the 1301 and that was in 1960 in the spring and we'd already made that decision so that jibes with what Al just said.

Hoagland: Yes, it was formalized in this task force and it was just a question of implementation. Now, one of the things Al Shugart did, which was-- I considered very positive, John Haanstra and Charley Bash

came out, you were probably at that meeting, to get a schedule out of Al Shugart how this program was going to go now. And, Al kept repeating for it seemed like half the evening. He'd say "I can't tell you because we don't know enough" which was the truth of course. And, I got great respect for John Haanstra because John Haanstra finally caught on to the fact that him going back and telling him he got the thing back on track wasn't going to happen and he was big enough to understand that this was the right approach, you know, really figure out what's going on. And, so everything was geared to this transition back but if I-- in a lot of experience I've had otherwise someone comes in to take over a program and they promise they'll get it back on track and they sort of just like to show they're gung-ho and optimistic. Well, Al Shugart didn't, you know, the only way they'd have gotten anyone to say that they would have had to get him and get someone else. So, I thought that suddenly everyone realizing it really get fundamental data and analyze what the real truth was.

Harker: There was another little side issue on that. The corporation also had sort of lost faith in the self acting bearing and told us we should develop a low air flow, air fed head and I must admit I wasn't totally honest with the corporation because I didn't see any way that we could ever do that and make a product. So, I managed to get a group in ASDD--

Stevens: To do it.

Harker: To do the low consumption air fed head and there was a very bright guy there Dave Olay and he finally proved theoretically you couldn't do it.

Haughton: It was very effective because it was sort of a fire under me because I didn't believe we ought to go to air. Like you said, I didn't think you could and it just meant we had to make more progress with the self-acting bearings to keep it going.

Stevens: Well, we talked a lot about the head and so forth. When did we finally decide to leave ourselves only on particulate coding and for even vertical recording? How did we do this? The steam homo process or steel disks were a big part of the picture at one time and all of a sudden we decided we could not make reliable reproducible disks in volume using steel.

Haughton: Yeah, one of the problems--

Harker: I don't remember how we decided it.

Haughton: One of the problems we haven't mentioned relative to the steel disks was their enormous mass and inertia.

Harker: Right.

Haughton: And it upped the motor requirements very significantly, so we even tried laminating them with thin skins of steel with a honeycomb in between the thin skins.

Harker: Did we actually go to a paint on the oxidizing?

Haughton: Not on those. Not on those.

Harker: I can't remember.

Stevens: I don't remember going to paint at any point in that.

Harker: We did when we switched to longitudinal recording.

Hoagland: I think Jake's first experiments he actually just painted steel but then he learned from Muffley to get a much harder film by oxidizing. I was--

Stevens: I can remember that first experiment that Jake made at 99 Notre Dame, but anyway go ahead.

Hoagland: No. I think in those days we didn't have a media head group and an actuator group and a--

Stevens: Right.

Hoagland: And a flying head group. We were doing it differently, so when you get down to it if they hadn't called in other people and made this change who was the strong proponent to stay with perpendicular? There was none. The guys on the program the only side I'll ever remember about these disks is when about ten to 20 heads crashed at one time and the smoke just came off of that thing. So, it wasn't as though people were arguing we shouldn't make the change. I think there was opposition to the idea of abandoning the flying head and I felt Vic Witt finessed that by, I can't remember the name now, but he gave someone the responsibility of shipping this unit down to Los Alamos.

Harker: Gola.

Hoagland: Gola, Ralph.

Porter: Ralph Gola.

Hoagland: Ralph and that was just taken away from everyone else and they did it.

Porter: The Stretch.

Hoagland: Yeah, which had a lot of compressors.

Porter: There you go.

Hoagland: But that took a lot of heat off Al Shugart because that had been- Vic Witt took that away.

Porter: Well, the Stretch, of course, was shipped to Los Alamos and to Livermore.

Harker: That's the only one of them I think that had pressurized air heads.

Porter: Yeah. But those were an interim product era and in the meantime, of course, you're talking about approximately in '60 a decision was made to stay with longitudinal recording and, of course, out of that with the flying head came the 1301. Let me ask going back to some of the comments Lou made originally there were some definitions of other products, projects that should come out of some of this activity and, of course, there was the smaller diameter disk, which became the first disk pack drive, the 1311 later, and there was a strip file, a magnetic strip file. How did these get started?

Harker: The ones that came out as a result of the study that we talked about, one was this VLCM which was a strip file with pickers. And, as I recall, it started out just a longitudinal bin. It got moved various directions with a stationary picker and when it went from that to the rotary configuration it became the 2321. I think the original project manager for that was Don Johnson, the program manager.

Haughton: And he was certainly one of the key guys.

Harker: And then there was a third thing which was to build a million character file and that, the approach, and a guy named Ralph Morris was running it and recognize all these projects you don't think about them in terms of lots of people. If somebody gave you a project they expected you to do it.

Porter: Now, the million character file, of course, was a drum.

Harker: It was a drum.

Porter: Yeah.

Harker: And what he came up with was a cylinder of magnetic tape with two end caps and spin it and I guess the centrifugal force was to push it out against the head bar.

Haughton: It had a little pressure on it.

Harker: Okay. And unfortunately we were never successful in making it work. Al, you, but I never.

Hoagland: No, I can't remember. I'd only like to correct one thing you said Jim. That Stretch file was--had a challenge that never showed up on the 1301. Every single head it read in parallel on one of the two. It would be streaming data in, on the other streaming it out. And to build the rewrite channels and synchronize the data to get that kind of performance that was a fierce challenge.

Stevens: Yes. You've got all this skewed between…

Hoagland: Yeah, all sorts of things to deal with.

Stevens: Yeah and we didn't have all the magic technology that exists today to make that trivial.

Harker: That's right system buffers.

Stevens: Yes.

Porter: To go back to your strip file, how long did it take before it evolved from those early discussions until what became the design of the 2321?

Harker: Oh, it was probably started in '55, '56. I don't think that thing shipped until the mid-'60s, did it?

Hoagland: That's right.

Stevens: Well, where did Dennis Willard come into that? He was in that.

Harker: Dennis, who is that?

Stevens: Dennis Willard.

Harker: He was involved, yes.

Stevens: At some time.

Harker: At some time.

Stevens: When was that?

Harker: I don't remember where Dennis came from. He transferred in.

Hoagland: As I understand it, Jack, Shugart left the 1301 program to head this 2321 program.

Stevens: That's right.

Harker: Yeah, he did. He was set to take it over.

Porter: Now let me suggest you finish your thought in a moment after he changes the tape.

<off the record>

Porter: Are you ready? Okay. Now.

Hoagland: Yeah, I feel I owe it to an individual to mention the project here at this point. In addition to the single disk file in research or what Rey Johnson had, we also had what was called the Random Access Tape Storage, which is spelled RATS, so the program was called Mighty Mouse. It was configured around the same thing that drove us within a single disk file. It had a single cartridge of tape strips which held ten megabytes, the same as a tape reel but it was one stand and you could put this in and then you could put this in and then you could read 10 megabytes from tape strips much faster than you could read through a tape. And we looked at that but it was like a one or a one and a half person effort but for some reason, for the same reason there was work at Poughkeepsie on tape strips. I guess Peoria had taken over. The chief scientist wanted to get research to do things more relevant to maybe help in the

development. So, this one actually went through ’58, I guess, and there is a report on it. But it suffered from the same problem as-- we were focusing-- was a great mechanical engineer and focusing on the mechanics of this thing, so a great idea was to use steel strips that were oxidized. So we were screwing around with vertical recording again there. But then that wasn’t what he was focusing on is how do you handle the tape strips. So, that one came and went but it was directed towards this…

Porter: I’d like to-- the magnetic strip file, to go through that subject and really finish it off. It started as Jack was saying probably back there in maybe ’56 in that range.

Harker: Yeah, ’58 or so I think.

Porter: I heard it was a little earlier but who knows when the earliest--

Stevens: When Don first started work. Those were one man projects, Ken.

Haughton: Yeah.

Haughton: I’d like to come back to the question that I asked myself was how did we-- when did we make the-- when did we come to the realization that we weren’t going to make vertical recording on steel disks? When did we decide that and what did we decide to do? I cannot for the life of me--

Al Hoagland: Well, Jack is familiar with ’59, because it went into some testing in what ,,, August, September?

Harker: It was a total disaster.

Stevens: And it was a total disaster.

Harker: And so the program needed to be reset and there was still too damn many unknowns. See, in those days, Lou, we didn’t have defect skipping.

Stevens: Right.

Harker: You expected to have a perfect surface.

Stevens: Right.

Harker: And you just couldn't get it with a steel disk and so you couldn't get acceptable error rates. That in addition to all the other problems we had like not being able to reliably fly on the disk and stuff like that.

Stevens: A small problem like that.

Harker: But that was I think the killer.

Hoagland: Yeah. I think that was because actually I think it was Joe Sherry showed me they made about 400 pilot production models of these heads, so they really tried to figure out how to make these heads that Jake did design. I would claim if you look at technical reports you'll find a year or two later after all this, maybe even three years, you'll find a lot of good work on perpendicular recording. Al Austin wrote a long paper on it and a couple of other people, so they did the research but it was more trying to understand it than it was suggesting the design.

Stevens: Just the pragmatics of getting usable product that we might know what to do but we didn't know enough to know how to get a good disk.

Hoagland: Well actually, Lou, for a couple of years IBM worked on thin film head before they had a product.

Stevens: Yeah.

Hoagland: Look at they even took longer to come up with a thin film disk which everyone knew they should have been ready to do a lot before.

Stevens: But at one time we finally came to the realization we're not going to be able to make it, so we did something else.

Harker: Yes. I think it wasn't the-- it was not a judgment on the ultimate technology. It was what do you think you can do--

Stevens: Now on schedule.

Haughton: And be able to commit to it.

Stevens: Right, yeah.

Porter: It sounds like a judgment call there, Jack. What can you do now? And you couldn't do it, so went on to something else.

Harker: One of the things that, you know, we did, we went through an era where everybody was trying to do things with hydraulics and that I think started probably with that initial VLCM because I think it had a hydraulic.

Haughton: Well, I know the single disk file had a hydraulic system on it.

Harker: Yeah.

Haughton: And it was a module.

Hoagland: That was Jack Hildebrand.

Haughton: That was Jack Hildebrand did that and it was a modulated pulse so that if you wanted to move one way or the other you had more positives and negatives and it made enough noise you could hear it at least two miles away.

Harker: And then starting with the ADF how were we going to move this whole--

Stevens: Big mass.

Harker: -- mass of heads and we went to a hydraulic actuator and I regret to say it was a Jonah, but it worked.

Haughton: Yeah, it worked, that's right.

Harker: And we couldn't really find out any other scheme that anybody would tell us had a better chance to work because I-- of course I wanted to keep the thin film sliders, the thin film, the self-acting sliders. I would have been delighted to find some way to ashcan that actuator, but we went-- I remember I went out

to Sperry on Long Island, who were leaders in hydraulic servo technology, and they looked at what we had and looked at what they could do and they told me, no, you've got a far better approach. They wouldn't--

Hoagland: My impression, Jack, is that after the conversion we went back to longitudinal probably one of the lingering long term concerns was the hydraulics actually more than anything.

Harker: Oh, yes. But then as a result of that we developed really as sort of a laboratory some fairly simple hydraulic systems and that's what we used for the 1311.

Stevens: That was a glob adder instead of a…

Haughton: It was both in the 1301 was both.

Stevens: 1301 glob adder and piston adder combined.

Haughton: Yeah, but no servo.

Stevens: No.

Porter: No. Well, you mentioned the 1311, which was the first 14-inch disk drive, which was being worked on before the 1301 actually was introduced.

Harker: Yeah.

Porter: Tell us about how that really got started and you were borrowing technology back and forth on that?

Hoagland: Could I just ask Jack, because you talked about this drum, right this <inaudible>

Harker: Yeah.

Hoagland: I seem to have read or somewhere got the impression that was the first place IBM was looking to use a voice coil servo.

Harker: Voice coil servo, yes it is.

Hoagland: <inaudible>

Harker: Yes, Ralph was going to use a voice coil servo on--

Haughton: And he was moving the drum.

Harker: Moving the head bar.

Haughton: Oh, that's right, a head bar.

Harker: A bar of heads and he used the voice coil actuator, yes.

Hoagland: Yeah, I think that's--

Harker: That was the first.

Hoagland: -- sort of significant first use of it.

Harker: Again, it was an interesting era because we were all -- we were very innocent and it couldn't be done and everybody wanted to get a project and make it succeed.

Porter: Okay.

Harker: You came up with a lot of inventions.

Porter: Now that 14-inch disk drive it was--

Harker: Well, it came out of originally a study that Lou assigned three of us to, Don Stevenson, oh, I'm drawing a blank.

Porter: They'll be recalled later.

Harker: Okay, recalled, to go and build a half cost RAMAC and we went around the company and did a lot of things and so part of that fell to me to define a file for a half and this was after the ADF was in development, and so I proposed a file that would have, I think, initially ten disks and it had to be half of a RAMAC. I should make it half-- the disk half as big, so the disk would be 12 inches. Only when I did that calculation I forgot to think about that you need some space outside the outer track for the head, so it became a 13-inch disk. And, actually it went through most of the development as a 13-inch disk and it was only towards the end of the development and Jim Carothers was running the project that they were having trouble with the density on the ID and Vic told them make the disk a little bigger. So, they made it a 14-inch disk.

Porter: Which somehow became the industry standard for the next 20 years.

Harker: Yeah. The next step of evolution of a low cost file I came up with this idea for an actuator, hydraulically operated but really just a two speed drive with a detent. And, I also saw the study that Nolan did on skip sequential processing. I said, gee, if I make this removable that's a different project. And by that time Larry Wilson had transferred out. The idea of a low cost RAMAC went by the board but he was defining a system which would be a low end card system and he wanted the file for the low end card system. So, the original design of that was for a system which through different evolution, well it became the 1410 and then through other evolution became the Series 3, the low end IBM processor line. But that was the origin of the low cost file.

Porter: Which became a very important introduction when you consider what happened after it.

Harker: Well, except there was another visionary planner, a guy named Chuck Hester and he said, "Well, if we make these things we can make 20,000 of them. We'll sell 20,000 of them," and he-- nobody believed him because we were talking then in terms of selling a few thousand.

Haughton: Yeah.

Harker: Of any system as being a big deal. But Chuck had the vision and he sold it and the corporation became very enamored of that device along the way and so it-- even under the pressure of the ADF problems it received good support.

Porter: And by the way the disk pack also sold in much larger quantities than the drives. Just like Gillette's razors and blades.

Harker: That's true. Just like the 1311 really just about made its forecast of 20,000.

Porter: Drives.

Harker: Which is nothing by today's standards.

Porter: But I would not-- I don't know how many disk packs for that driver shipped but many, many more than that.

Harker: Yes.

Porter: Several times that.

Haughton: Yes about six or seven times that. Jack was that Hal St. Clair [ph?]?

Harker: Hal St. Clair was the third guy, yes. Thank you. So, that's the story there.

Porter: So, it evolved and became <overlapping>.

Harker: Yeah and I did it with very conservative specs compared to the ADF, so I convinced people I wouldn't have a technology problem.

Porter: And, of course, then the strip file did evolve into an actual product.

Harker: Yes. Well then Al mentioned earlier, at the same time or in that same general time in ASDD they were developing an optical strip file.

Porter: How can we get a picture of what that optical file was all about? Who could describe that for us?

Harker: Well, certainly--

Stevens: This is the photo store?

Harker: The photo store.

Stevens: I don't think there's anybody around anymore that--

Harker: Well, Keeler.

Stevens: Keeler.

Harker: Maybe.

Stevens: Maybe, maybe not. Critchlow.

Hoagland: A lot of those people left IBM didn't they?

Stevens: Yeah.

Harker: Well, Norm Vogel.

Stevens: Norm would be a--

Harker: Norm if he were here. He's back east.

Haughton: I thought he's in Santa Rosa.

Harker: Really?

Haughton: Yeah.

Harker: Oh, okay.

Porter: Tell me how it evolved actually though from an idea toward being a product out of this group of people, what happened?

Harker: There was a product. It was delivered to the intelligence agency. It was to store documents for retrieval, automated retrieval and also the project not only broke ground in terms of optical storage there

was a system study along with it that came up with one of the first data management strategies, software strategies for searching, and the fellow I remember that participated in that is Dick Fermer.

Hoagland: Yeah for the application you couldn't really have done it any other way and actually, Jim, you have to get into technologies where you're not quite sure what's going to come out of it. The longest running technology in my recollection is speech recognition, which is probably going on 28 years now and everyone believes some day it will happen and it will.

Porter: Well, I fully expect to be able to pull a computer out of my shirt pocket and just talk to it in the future years. I can't do it now.

Hoagland: People have felt the way you do 20 years ago.

Porter: But that's a good definition, Al, of how long some of these technologies can be conceived of and evolve before they become real tangible products and, again, going back to the beginning of magnetic recording on disks and what it evolved into, we've talked about several of those and I guess the only tangible ones that actually evolved into real tangible products would be the first flying head drive, the 1301 and then the 14-inch drive, the 1311, and the strip file, the data cell. All of those did become actual commercial products. Any others out of those that almost became that never did?

Harker: Not out of those but I think it's worth at least getting in that the operation that Rey ran continued to be a very productive organization and actually contributed a lot of other things. It was involved in education systems. It was involved in things like the optical card reader, the coding, bar coding, magnetic stripe cards. There were a lot of innovations that came out of that laboratory.

Porter: But in terms of magnetic recording have we covered the whole list?

Hoagland: Well, there's a time constant here, you know. We did a single disk file in '57, '59, so now when was the first application of this closed loop servo to the disk, not until the 3330. Well, how many years difference is that, right? It's about 12 years. Who knows 15 years from now that people won't sit around this table and say now why didn't San Jose latch on to perpendicular recording back in the '50s because all the disk drives now have perpendicular recording? And we'll just say that's how long it took to mature.

Porter: Interesting line of thought isn't it? The first holographic storage companies set up to make a product were started in the early '60s and we still don't have a product shipping yet 40 years later in terms of the kinds of storage products we're thinking of here. So, yes, you're right Al. It obviously takes a long time for a lot of these technologies from the time of first thought to evolve into tangible producible

products. But what-- just to ask one overall kind of a question on going back to the mid-'50s and the beginning of the '60s on the magnetic recording. Clearly, there had to be some people from the company headquarters who were concerned where all this was going to go and clearly there were people from the systems side that had some very interesting ideas on what they needed. Now, you've mentioned in several points here that there was a lot of demand for direct access or random access to the data which they couldn't get through tape drives. Was that the principal driving influence from the systems side toward what was being done here, the demand for random access, in addition, of course, to reducing cost, which is always there? We all realize that.

Stevens: The systems-- what was the Saber System became?

Harker: American Airlines.

Harker: Yeah, but no. What was the type number that came out of that, that was the processor that we did the ADF for, 1301 initial application.

Stevens: Oh God, my brain has gone squirrelly. It was for…

Harker: In those days they weren't going to eliminate tape drives. It was really a high speed auxiliary store more.

Porter: I didn't mean to eliminate them. I mean in addition to them before going to-

Harker: So, what they were looking for was really an aid to internal processing.

Haughton: They really got that. They started looking for it because they had a taste of it.

Harker: Yeah.

Haughton: It wasn't because-- they didn't come and say we've got to have it. They got a taste of it with the RAMAC and then they began to think and came up with those things.

Porter: Of course they had drums, which had direct access but which were relatively expensive for a megabyte capacity.

Stevens: Yes, it was a very limited capacity.

Harker: Yeah, and they wanted it because in those days the only internal storage was magnetic cores. Those were expensive and so they really looked at a device like the 1301 more as an auxiliary storage for the processor, the tape still being the main input/output devices and it wasn't until you've had systems like Saber mature and become commercial applications or general applications that you really saw and that didn't come about until you had the 2314, a file facility.

Porter: We should just comment that, of course, the 2314 evolved from that first 14-inch disk pack drive that you fellows did.

Harker: Yeah.

Porter: Next came the 2311 which was a doubling of capacity, but then by the middle of the '60s, only a few years later, had come the 2314 which brought it up to a magnificent 29 megabytes in one disk pack which became the monster tape drive of the 1960s in that it was used for the IBM system 360 which became the dominant worldwide computer mainframe system and carried untold tens of thousands of 2314 and 2314 equivalent drives along with it. So, yes, out of what we've talked about the 1311 became, yes, then evolved very shortly the monster disk drive product, and the biggest of all, and which served to be the one that a dozen companies became copycats about which made the so-called plug compatibles and started that whole independent disk drive industry, all out of that 14-inch disk pack drive, a few years after you brought it out.

Harker: Uh huh.

Porter: Well, any other thoughts on what was going on then in the minds of the folks at IBM in the second half of the '50s as to what would happen next after that RAMAC?

Hoagland: That would be a whole other story. I want to-- I'll catch you offline on this. I don't-- no, I think this is a nice way to wrap it up now. When you mentioned Larry Wilson's name something came to my mind.

Harker: Okay.

Porter: Okay, well gentlemen thank you very much. It's always fascinating to get these looking backward glimpses as to why all these things were done and how they were done and the results of them.

Stevens: I'd like to make one observation.

Porter: Yes, Lou.

Stevens: Interesting to think about but usually there's one guy who you can come back to. And Jake Hagopian, most of these ideas can be traced back, their evolution can be traced back to something that Jake did, a remarkable, very quiet, very reserved individual who thought deeply about stuff and then went and did some simple thing to prove his point. So, I just wanted to make the point that it's interesting how all these great things that have been done started, most of them started with one or two guys thinking about something and doing it on their own and the initiative they start really was the key. I don't know how to express that any better. But Jake was an example of individual initiative, really, really important to planting the seeds.

Hoagland: He was what you would consider a true inventor.

Stevens: Oh God, was he ever.

Hoagland: Rey Johnson was a tremendous inventor, but he was a lot more than that.

Stevens: Yes.

Hoagland: He always wanted to implement visions he had and so he-- it could have never happened without that kind of person in charge. But, on the other hand, you need these guys who fool around and come up with ideas and Jake, I must say, off the record I have never seen a person keep an engineering notebook the way Pat…<overlapping laughter>. He was amazing. He kept everything right down to the tail.

Harker: Always got to co-sign too.

Stevens: Oh, God.

Porter: There had to have been a lot of outstanding individuals involved with these activities clearly to make it all happen in that way.

Stevens: Oh, yeah, but interesting to reflect on Rey Johnson and his environment. He was, of course, a great encourager of people to do their own thing and I can remember -- a guy joined the lab and he says,

"What am I going to do?" This was Al Stone, I think and he said "What am I going to do?" Rey says to him, "You'll find out. Just look around. You'll find something useful to do." You know that's the kind of a thing. It's all on your own. You felt responsible for doing something. He did -- he may make four or five suggestions as to some interesting thing to work on but he would never directly say you go do X, Y, Z.

Porter: It should be mentioned, I think, for those who maybe are seeing this tape that aren't familiar with Rey Johnson, Rey had started work as a schoolteacher in the Midwest and, being impatient with grading tests, had worked out a way to put little circles and dots on a thing so that kids could just fill in a dot and he then figured out a way to add all that up and grade it, got a patent or two on all of this. IBM found the patents, hired Rey, took him back east to their laboratories, and then in 1952 when they decided to set up the West Coast laboratory, they sent Rey out to San Jose to set it up and Rey became very well known for the techniques you've mentioned.

Haughton: Well, leadership and being able to get the tremendous contributions out of individuals.

Stevens: I sat down the other day to vote with my wife and guess what I voted on? Punch card. I said, "Guess who did this? Rey Johnson was the first guy. He didn't like to grade tests so he invented a test scoring machine." Here we are with a No. 2 pencil putting little things on punch cards.

Hoagland: You don't have the screen?

Stevens: No, we got punch cards with little things that are-- that a No. 2 pencil fills in the blanks.

Porter: More people are familiar and have been involved with the outgrowth of the inventions of Rey Johnson that almost any other inventor probably except Edison.

Stevens: I think that's probably right.

Porter: And Rey, of course, was a charming individual. I was lucky enough to have known him later on in life. He died I believe in '98 and my understanding is when he retired from IBM he had 82 patents in his name. So, one of the key individuals that allowed and encouraged all of this to happen.

Stevens: OH, yeah, he was the--

Harker: He was a wonderful manager.

Stevens: Wonderful manager.

Hoagland: Lou, I would have thought he was a problem given your relation in some of these products because when I -- to go into the lab, two things struck me. First, there was a lot of flux in the people. It looked like and this was my experience too, someone working on RAMAC for you. You've got to meet someone that comes up with a bright idea and by gosh they drift away and Rey encourages them to do their thing.

Stevens: Rey and I were very good friends, by the way.

Hoagland: Must have had to have been.

Stevens: And, if he wanted to steal somebody from me, be my guest.

Harker: That was true. I know in my own case.

Haughton: As a matter of fact, Rey would tell those new hires, sure, if somebody else has a problem that you can help them with.

Harker: Do it.

Haughton: You better do it.

Stevens: That's your job. Our first job is to help somebody that comes to you asking.

Haughton: Yeah, it was a really different world, yeah.

Porter: Isn't it great that the disk drive start up had a guy like Rey Johnson making that happen.

Stevens: Oh, yeah.

Porter: Later on in life he was awarded the National Technology Medal of Honor in a White House ceremony by the President of the United States.

Stevens: I was there.

Porter: I can't think of anybody that enjoyed it more, do you, and you were there?

Stevens: Not at all. Yes, I was there.

Hoagland: So now that you've said all that, I can't help but say we've got that building made a city landmark. We've got the building preserved. We'd like to put in a disk drive history museum in there but the news coming up is the IEEE has now made RAMAC and RAMAC system a milestone so the IEEE's president is going to come out in the spring and present a big plaque. So, yeah, you keep saying that but, of course, the Heritage Center directing to make something that the people of San Jose will understand is theirs instead of talking about being the capital of Silicon Valley.

Porter: Well, just one last note. The only technology product ever developed in the City of San Jose I ever heard of was the disk drive.

Hoagland: Well, yeah, but you got to be sensitive. Apparently, it also had the first radio station according to them.

Porter: Well, the first regular radio station, by Charles Herrold, rather "Doc Herrold", actually starting in 1909 or 1912, depending on who you believe, did the first regular radio broadcasts, but that was a few years before disk drives. So, with that, gentlemen, I think we probably should wind up this conversation and thank all of you very much for your contributions 50 years ago and today.

END OF INTERVIEW

