An Interview with

ALBERT S. HOAGLAND, Ph.D.

Interview #

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On

15 August 2013

Portland, Oregon

Computer Society Leaders Oral History Series
IEEE

Yost: My name is Jeffrey Yost from the Charles Babbage Institute at the University of Minnesota and this interview is for the IEEE Computer Society Leaders Oral History Initiative. It's August 15, 2013 and I'm in Portland, Oregon. This afternoon I'm sitting here with Albert Hoagland. Al, can you begin by just providing a little bit of biographical information—where you were born, where you grew up?

Hoagland: Yes. I was born and grew up in Berkeley, California. I was a student at UC Berkeley, and got my master's degree in 1948 and decided (pause)

Yost: That was for undergrad, as well as graduate school?

Hoagland: Excuse me?

Yost: Was that for undergrad as well as graduate school at Berkeley?

Hoagland: I got all my degrees there.

Yost: Okay.

Hoagland: And I was fortunate to be involved in; when I started going beyond 1948, a Professor [Paul] Morton was interested in getting money from the ONR [Office of Naval Research] to develop what you could call a university computer.

Yost: That's called CALDIC [California Digital Computer].

Hoagland: CALDIC. And at that time, this was getting to be quite a growing, important area. Most of the students would learn a bit, get a master's degree, and then go to work. But I, for various reasons, wanted to get a Ph.D. Well, this was a program where I met people that I had contact with much later; particularly Lou Stevens and John Haanstra.

Yost: Can you tell me why you wanted to get a Ph.D., rather than stop with a M.S.? You said 'various reasons?'

Hoagland: Well, yes, I like to say I suddenly decided. Actually, I based it on my father. He was a very well known scientist [in plant nutrition] at UC Berkeley, with major roles in the higher levels and I think there was no question, he expected me to go as far as I could in the academic world. What was particularly fortuitous was this was after World War II was over, and many more students were coming back. In fact, key faculty were coming back. So the timing was right and the opportunity to get in a new field was obviously a highly motivating factor. Now, when we started this project [CALDIC], it was based on a magnetic drum for memory. The drum was the only way as far as we could see—looking at various options— that we could get a suitable memory for the computer we had in mind. So this is when my life took a slight turn. It turned out that many of the other students, most of them, got in the program, got a master's degree, and were interested in going to work. Well the drum was a much longer term enterprise because you weren't using known technology, you were doing something that there was very little precedent for. Now once I undertook that, I was really committing to a much longer period than the other people who tended to come here and go. So I got involved in understanding a theory, which was related to what I call digital magnetic recording. That was the main gist of my thesis and the best people in the world at basic understanding were at Philips in Holland. The trouble was, into this program — like a couple, three years, two years, whatever — I began to see my career was going to have a dead end as far as this particular topic because magnetic cores were getting to the point with the next generation, which may not be much better than a drum but certainly were much more appealing. On the other hand, you don't start a program like that without a commitment, right? And I was learning a lot of things, so I continued.

Yost: Can you speak a little bit about Professor Morton, was he your primary advisor?

Hoagland: Well, Morton, he was a great guy and he sat in and tracked what was going on. But in the university environment, typically, you give students a free rein and then you

may need to redirect them if they start going down the wrong path. He did not intend to try and understand this like he could teach me what I was trying to do. My problem was these cores indicated [that] I was working on something that would be obsolete. I had no choice. I mean, I had to finish my Ph.D. and so I kept going and one day, I had two meetings, which briefly; John Haanstra, who had gone to IBM, he gave me a call one time and said I [pause]

Yost: He was a graduate student with you at Berkeley?

Hoagland: He was a grad student with me [pause]

Yost: But then he'd gone on to IBM?

Hoagland: Yes, he had just gone for a master's. He was an exceptionally bright person.

Yost: Doug Englebart was there too, as a grad student.

Hoagland: Well, John [Haanstra] was; the way I saw it, John's career; he wasn't with IBM for what he knew, *per se*. He was with IBM in part because they identified him as an outstanding leader that would get an executive rank. He was bright, he caught on, he was easy to work with, friendly. When he thought about things he was really bright, but the reason he didn't end up like most people who go to work for a company, he was given assignments to broaden his experience on how IBM worked and what were the issues in making computers for large corporations, and particularly, he had a lot of involvement with some Air Force stuff. But there are many points in history where he really showed why I think they hired him; this talent of dealing with both people and technology; sorting out the significant from the insignificant. And he never really alienated people. Lou Stevens was a real engineer. I only mention John because when IBM announced that they were going to have this new laboratory, John, knowing I'd finish up in a couple of years, or a year, even; said he wanted me to join him and Rey

[Reynold] Johnson, who took over that lab, for dinner in San Francisco. I thought, what I hoped to learn then, was this a real scientific laboratory or not.

Yost: When you were in graduate school, were you thinking about a career in industry or a career in academia, or what were your thoughts career-wise at the time?

Hoagland: I at very least hoped to get on the faculty at Berkeley. That would have obviously made my father extremely happy. On the other hand, if I did teaching from then on, it wasn't quite the same as solving a difficult problem for something new. So I really was hoping I could find a job and this talk with Lou was timely in the sense that IBM was doing something there, you know, that could be an opportunity right nearby [San Jose]. And Rey only told me two things; he didn't even talk about what I was doing, he talked about his interest in solving some problems people had with punch cards and finding particular cards in their stack. And what he told me; I remember what he said because Rey was dedicated to do something. He only was out there, actually, for IBM to look at new ideas and maybe in five years actually he'd come up with something. It could be fairly small; he only had, say, fifty, sixty people. But he said he wanted to get a product for IBM, which told me it certainly wasn't a research lab. And then he said, "And then there are two things that I will do. I will not do anything that will involve either Poughkeepsie or Endicott"; because he realized that if a small lab does something, they'll [the large facilities focused on products—Poughkeepsie and/or Endicott] eat 'em up, right? And he wanted to have something that was for San Jose itself. Now what he was telling me — though I never thought much about it — was he certainly wasn't going to work on either drums, which was a stronghold at Endicott, or tape, which was the stronghold at Poughkeepsie. It didn't sound like where I would go because it sounded more like a development group, right? But Stevens visited me.

Yost: When you met with Stevens and Rey Johnson, that was in 1953?

Hoagland: Yes, when Lou Stevens came, he said I'd like to show you our lab and I think there's something there that may interest you. I went down, and I didn't even have a

security clearance. But it probably didn't matter. I walked in and I saw what looked archaic, compared with what the university had. And it looked like some things that sort of looked Rube Goldberg like were being worked on. But I did catch my eye on a stack of magnetic disks and since Lou thought I'd be interested and knew what my research was at Berkeley, I got the impression there may be a future in what I was doing in research; and since the only unique thing I was working on was digital magnetic recording, I said they must be working on something there that's non-contact. So I had waited to make my visit, and Lou said, would you be willing to join us as a consultant. When you're a student, some extra money never hurt and so I agreed. I wasn't really near finishing my Ph.D. but then I found I was getting a way to take advantage of what I was doing and it also allowed me to better understand, by the flexibility of a new program like that, how the changes in design affects that.

Yost: What time commitment were you giving the lab versus your studies at that time?

Hoagland: I'd say, initially, my studies were more important. Yes, I mean I could hardly be sure what it was even worth to IBM, you know. However, I looked at SRI [Stanford Research Institute] and other places as I got closer to graduation, and they were doing things like magnetic logic devices, and some were working on [magnetic] ink on checks, and so forth, which really was not what I was involved in.

Yost: Bank of America and magnetic, to aid with the check processing problem?

Hoagland: Yes. I began to see that what I was doing was really vital to what was going on there. So any time I had time, I would help work. The difference was they wanted to position the head around; they couldn't just lock the spacing and forget it, like a drum. So they were totally dependent on non-contact magnetic recording, which was my focus. Here, it would really give me a challenge for the understanding I had of non-contact recording. I was just consulting. You may not know John Whinnery but he was a pretty important guy at Berkeley and was running the department. And so as I was wrapping up my Ph.D., he offered me a position as assistant professor. I really loved that guy. He was

pretty open. I told him how involved I was in this IBM research. And he said oh, you could still continue that on a pseudo industrial leave. Other faculty go do that. So I said fine; so I said I'd have one year. But as the year went by, the excitement of a new product became very obvious.

Yost: It was 1954 when you completed your doctorate, correct?

Hoagland: I completed my doctorate in 1954 and actually was on the faculty at Berkeley as assistant professor. Essentially, 1954-55.

Yost: That continued into 1956?

Hoagland: He extended it a year. Then in 1955, I realized it didn't make sense. 1955, the program still hadn't been announced, Lou Stevens was really dedicated to make it a product, so then I looked at it this way, I could always go back to the university but I didn't; I did some teaching nearby, I wasn't just using that to go consulting, I divided my time. So I talked to John [Whinnery] and he said, well, you want one more year.

Hoagland: [Laughs.] No, John, if I'm not worth rehiring if I come back, forget it. So I went to IBM actually full time, July 1, 1956, which is about three or four months before the announcement of the RAMAC [Random Access Method of Accounting and Control]. So when I went back, Lou Stevens was running the program through the product development phase to manufacturing.

Yost: Was there resistance, thinking product development should occur at Endicott or Poughkeepsie?

Hoagland: Product development is a goal of any engineer at IBM, or most companies. What it really says, the company has reached the stage where they're seriously thinking of this as a product of theirs, so they don't want any playing around. They want people to

set tight schedules; develop proof feasibility models; and the proving levels; so it's a totally different world. Lou Stevens was really made for that world, in some ways. And with Rey, if you wanted to work on something difficult or different, particularly, he would, if it sounded interesting, he'd say okay, go ahead. When you'd go into product development, you've got a schedule. An accountant will be measuring you right along the way. Lou drove the people who were there; a lot of new people came in, obviously; but you stayed with that program. You were going to be on their schedule; even asked to work nights and everything to meet the schedule, which was suited for a guy like Lou. But Rey Johnson was an inventor; he wasn't even an engineer. He got his degree in educational administration but he came up with good ideas and he never even pretended to think he would carry it any further. And what they did was give him some of the people he had and give him new targets to come up with bright ideas for; well, I certainly didn't feel I wanted to go into product development and I knew with a commitment to the RAMAC, they're going to put in a real research lab, which Rey headed, in a way, initially. So I went to Rey, and the program he had, to me, was another product development kind of thing, which, you know, you get a Ph.D., you want a little more creative opportunities for yourself. So, I was in a program that got some excellent people as it went along, which was looking to make a huge step forward in track density. But the RAMAC went ahead, and I made a decision that obviously, if you're going to get into a real research lab, you're not going to do too much of what I did when I was a student. I thought it worked well because I could always come back and do a course or two at Berkeley; it was only 50 miles, at the most. So I got into what at IBM was a new environment, because they were setting up a major research lab, which was going to have a division in San Jose.

Yost: So RAMAC was really *the* project that had spawned the rapid growth of the San Jose laboratory, wasn't it?

Hoagland: I think it was a product that gave IBM an opportunity [to develop high capacity storage using disk]. The thing that IBM started working on was to make 10 times the performance and 10 times in density.

Yost: The advanced disk files following project RAMAC?

Hoagland: Yes, it was called the 1301. In the Computer History Museum, I've written introductory material to those, too, because I was there at the time; and I will write more standard material. But basically, IBM reduced the size of the disk and the number of the disks to make a package cheaper for a lot of people who had yet to convert to disk. They found smaller disks could be much cheaper so they moved to smaller disks and you just buy many disks. If one disk fails you can recover information because you had other disks. So the whole dynamic changed.

Yost: The 1301 disk drive was used on IBM Stretch, arguably the first of the true supercomputers?

Hoagland: Yes, it was intended to be the drive for Stretch with special features where you could read and write simultaneously with multiple heads because they were washing data in and out. And it was the part of the program for the American Airlines airline reservation system, which was the first commercial application it was applied to; it got, it got behind schedule.

Yost: The famed Sabre project.

Hoagland: Yes, that was what it was. The project got behind because it made the wrong choice for recording. So there was a corporate test, of course I was on, to try and turn the program around. If you read my little article, Stretch, which [Thomas] Watson [Jr.] obviously wanted to be first [with launching the most powerful computer], which was a mistake because the market with American Airlines was going to be much bigger. And because of the pressure of Stretch, a lot of technology sort of was hurried and bypassed suitable testing. Stretch was supposed to be tested at Poughkeepsie and shipped. What happened was everyone was sort of late in what they were doing. And what do you think they received? They received a big stack of disks without flying heads, but air bearing heads. So if they really implemented the whole thing they probably had four air

compressor units. And that never seriously made sense to use something that fell far short in performance, far shorter, and was just ridiculous. But doing that took some pressure off San Jose in particular because [if] they were the only lab that didn't come through, that'd be difficult. And that also accelerated giving them money for American Airlines because everyone was focused on just what they should have in the beginning. So after that, Stretch progressed but as far as my career, I was, in 1962, I was offered an opportunity to go to the Netherlands.

Yost: Before we go into that, can you tell me had you become active in professional organizations by that time, the AIEE and/or the IRE?

Hoagland: I'm glad you brought that up. I published a paper [1953] on the design work for the AIEE [American Institute of Electrical Engineers], presented it at a conference at San Francisco, and it received an award, either first or second, I can't remember. And the IRE [Institute of Radio Engineers], I probably wasn't a member of.

Yost: Do you recall when you became a member of the AIEE?

Hoagland: I'm sure it was while I was at the university. At that time, the AIEE covered a lot of the activities that were standard at Berkeley like power machinery, transformers and all that. Let me get back to that, and talk about going to Holland and then I can get to that issue of IRE and AIEE very quickly. I ended up going to Holland because they [Philips] had super experts in magnetic recording and probably Rey, or rather IBM, didn't want them to get the edge, you see. The giant program with Philips, it was clear both companies were playing games. I quickly discovered that oh, this is a funny assignment. I can get great lunches but Phillips isn't really telling me what they're thinking should be done, and the IBM guy running the program is not telling them about IBM. So I, in my last year — was only there two years — [pause]

Yost: So it was a very guarded kind of relationship between the representatives of the two firms?

Hoagland: Yes. I went to IBM headquarters; I got so upset — but then I was young — the way things weren't moving. I met a VP there and he said we're quite satisfied, it's okay, just keep going. So I realized no one really gave a damn. So I told people at IBM there; or at least someone; that then what I'd like to have is my own office with a secretary, and I'd like to work on a book that I'd started before I went there. And they gave it to me, including cigars all the time. And it worked really well. In fact, if you looked at my [book]; which is the first book on digital recording; it was actually published by Wiley in 1963 and that's because, I could never have done that if I'd stayed in San Jose. All they wanted me to do was not rock the boat. This was fine with me. And that also ended up having fortuitous circumstances because I'd been up and seen this Yorktown center they were beginning to staff, and so forth. And one of the key people was a person I had worked with in San Jose, Art Anderson. Art called me and he said there's a job here at Yorktown if you're interested. It was more or less engineering sciences kind of activity. I told him if you maintain the same guarantee I got that I'll eventually be in San Jose, that's fine. And so I ended up in Connecticut, Stamford, Connecticut, and it was a great environment because then I suddenly saw real research going on, which really, San Jose wasn't doing. The big problem was my belief that I could turn that laboratory into getting involved with magnetic recording. I ran into two obstacles: the mission had been assigned to San Jose, but the real reason is, including San Jose, no one on the research side thought there was a real future [in magnetic disk recording] because it looks more like you're looking at a mechanical gizmo. I was appointed Director of Research Planning [Yorktown]. And even in that position, I couldn't [influence the research division to see a future for magnetic recording]; it probably was just as well but it was a great experience for me and I was very lucky. I did go to the research side because it gave me a whole different perspective on IBM. But that gets to the real point. I left and arrived at New York —that's where I worked in 1964, and I claim sometime in 1962-63 is when the IRE and AIEE merged [to become the IEEE]. Is that correct?

Yost: 1963, yes.

Hoagland: Right. I met someone, and I could only guess who it may have been, but Ed McCluskey at least was someone I had met in California before I left in 1962, and he talked a little bit about [developing a new] computer society thing [as part of IEEE]. But it may not have been him. I said, you know, I don't see much hope for this if you don't get involved in software, because in my experience, particularly when you go to Yorktown, you get a big fill of that. So we went and met a VP or some top global guy [of IEEE], and we told them that, that this [including software] should be the commitment or we'd go move [leave IEEE], to the more computer side with ACM [Association for Computing Machinery]. The IEEE said they planned to include software. And we knew we should stay and fight this one out with the IEEE. So I got involved with the IEEE initially through that dialogue, but remember, here I was coming to a new area where I was known; I must have been known pretty well because I was made a Fellow a few years later in 1966. But once I got started I quickly realized I didn't find too many people [in IEEE] that even identified themselves as engineers, double Es. I mean, there are a lot of scientists — physicists, chemists, all sorts of scientists— and if they were in special areas like magnetics, they would've been with the magnetic society, not the IEEE, the computer society. And what really changed my life as far as the Computer Society was concerned, I got to know people like Richard Tanaka and Keith Uncapher [who were involved with AFIPS, the American Federation of Information Processing Society]. And AFIPS was something that I found; well, I could be a Computer Society representative on AFIPS. But AFIPS was quite different [broader group that included organizations with interest in both computing and applications] and so at some point in this time period, I was put on their board. Now, IEEE Computer Society I think had five reps.

Yost: Before 1971, it was still called the Computer Group. It was the combined group that arose from the IRE and AIEE committees or subcommittees for computers.

Hoagland: Okay, it wasn't the Computer Society?

Yost: Not in name. It officially became an IEEE society in 1971 but there was a precursor the Computer Group, and that was active since its origin with the IEEE in 1963, and there was an AIEE subcommittee and IRE committee for computers before that.

Hoagland: When was it made a society?

Yost: 1971. From 1963 to 1971 it was the Computer Group.

Hoagland: That's very interesting. I'm glad you told me that because all my [earlier] activities, I was going to tell you, were really with AFIPS, not with the Computer Society. Now you're telling me there was no Computer Society.

Yost: Well there was a computer group, they just changed names and there were some other changes—it grew rapidly once elevated to a society in 1971, and the Computer Group was growing in size in the 1960s.

Hoagland: And that probably would be more centered in New York [City]. We were in Yorktown.

Yost: Do you recall what year you became involved with AFIPS, roughly?

Hoagland: I think I ran a conference for them in either 1968 or so. I'd gotten involved [with AFIPS] in a conference in New York City [1963], and Bruce Gilchrist was there and these were people who also had a broader vision of computers. And once I was on AFIPS, I really had a meaningful role for the Computer Society because AFIPS gave me the leverage to do things I could never have done otherwise. Nor would the Computer Society have really done. I picked Tanaka, who clearly wanted to create an IFIPS [International Federation of Information Processing Societies], and he actually went over to IFIPS. But there was one thing he said that I recognized immediately, they did want a conference. That's what you said, right? AFIPS conference or whatever they called it. Well, to me, when I got on the board of AFIPS, which as I say, I wasn't pressing for a

long time, but there were five slots and I was on it. I recognized this exhibit thing was growing in popularity, which meant AFIPS was getting money, they couldn't spend their money except through the board, which had the societies, and couldn't really do anything unless ACM and the IEEE normally would agree. Just to show you where this could lead; I ran a second conference in Atlantic City about that time, and I got to know the IEEE really more through AFIPS than anything and now you explained why that probably happened. Being at Yorktown had a great advantage because I was directing a group of Ph.D.s and you don't direct Ph.D.s towards products, you try and guide things that are important that they work on. And I was always called out to look at other [research labs]; like at Boulder, the tape problem got in trouble, you know, I'd take a look. Even in San Jose I ended up taking a look. So I made a lot of contacts outside the area, but the people that had been — a list my daughter left me — a number of people I worked a great deal with, like [Anthony] Ralston from ACM; because AFIPS could do a great deal if they agreed. I think there's one place I had to win them over to get them to support your Charles Babbage Institute, because they were very reluctant. But then if I could pick up three or four of these small societies, and they were really small, I would have enough votes for the board to approve. So one of — I'll just sort of give you the big pitch here — as that conference grew, AFIPS said the quarters had to grow and we needed a place that ACM and IEEE would agree on, for AFIPS. And that's why it ended up in Washington, and that's where the IEEE Computer Society, from my point of view, ended up with its office. And that was because we had activities that required a lot of support in terms of conferences, getting speakers, publishing material, and so forth. And Washington was really enjoyed by the people from smaller locales. That's where [Washington, D.C.], presumably, things are fun. And that's why it got so big, and of course, IEEE had nothing to do with it; these are AFIPS monies so I could set the budgets, I could set the salaries, and IEEE knew where it was and I don't think they ever bothered to give us their standard thing they put in big volumes for really technical publications. These people in AFIPS weren't really thinking Computer Society. They were thinking of the bigger picture of the whole thing. ACM was there, and we were there in equal numbers because we saw they'd be very competitive, because we wanted to get into software and they certainly were there. And a lot of people thought, Jeez, it's great to rub shoulders and

know what's going on in the computer world. Let me go back; that was the first thing I always regard as a major contribution to the Computer Society itself. And because of where I was located, I had the kind of controls that dealt with conference issues and everyone was interested in the conference having money so I was in a position where most of these people didn't know how to run a conference. I had at least, foreknowledge, and at least I knew the importance of some talent you need for conferences. Now just skipping ahead, and then we can go back, I consider the next really major contribution to the Computer Society was the creation — and this happened in Colorado — of its own magazine *Computer*, with John Kirkley as editor. And our vision was; and my vision as we worked this thing out; was going to be more like where an average user could read and get a feeling for what's going on. It would have photographs; there could be questions raised and maybe answers. It was really not where people would ever publish their real scientific work.

Yost: It was to keep everyone broadly informed, easily readable by all.

Hoagland: Yes, broadly informed. And John Kirkley, a great guy; this was a tremendous opportunity. He lived in Los Angeles and that's where we set the headquarters for this [the magazine]. And I wrote some articles for that because a lot of what I was doing was tracking the advances of disk drives and they don't want to know about the nitty gritty of technical details, but they'd like to know whether it's going to go much further [as a technology] or not. John was very helpful in soliciting me to put together articles and he did that in other fields. So I thought it was something I was proud of but, more importantly from your point of view, the funding came in the same way it does, through the AFIPS funding. We never asked the IEEE for money because we realized if we did and they say no, then we're stuck. You will find that it really progressed to where it also covers software, right?

Yost: Yes, it got into software. So you became president of the Computer Society in 1973?

Hoagland: Yes [president 1972-1973]. And I think at that time, actually — I remember it now — I think Ed McCluskey was the president before me. And at that time, we did face the issues of an understanding with IEEE but I was driven to make that important because AFIPS was making money on this conference, right? They could hold them in a number of places. I saw, before the others because I was just a little closer to it, we're going to get devoured by commercial interests because once you get people to send pieces of equipment and so forth, many of which have very little; that anyone at AFIPS would understand or even IEEE, you couldn't compete with them. So I think the demise of AFIPS came with the entrance of the Las Vegas event; I don't know what they call it now, do you?

Yost: The Comdex show in Vegas, that started in the late 1970s?

Hoagland: The final meeting of AFIPS presidents occurred at one of their meetings, which had over 100,000 people. Commercial people were more interested in what products can they order; what schedules the disk stuff may be available on. And I always went to those conferences just because I learned more about the industry than anywhere else. But I think that's why I anticipated, given this situation, that the AFIPS spigot was not long for this world and one of the last things I feel I accomplished was; and I think I did that through AFIPS; yes, I did; was to supply the Charles Babbage Foundation. I met Erwin Tomash.

Yost: We're very grateful for your pioneering role with Erwin and others in helping found the Charles Babbage Foundation [1977] and Charles Babbage Institute [1979].

Hoagland: Oh, yes; I know. His dedication was great. He was more a businessman than, you know, the people at AFIPS and I understood something serious could result because he had good connections at the University of Minnesota, and that was one of my toughest fights because I think we gave him $50k. I don't think he cared so much what we gave him, he wanted to identify AFIPS as supporting the Charles Babbage Foundation. That's what we gave him. And of course, that was a particular argument because ACM and the

IEEE, meaning those people with IEEE on the computer side, with AFIPS, sort of were in disagreement. I think I was the president then, and AFIPS being the other academics you could anticipate that well, maybe this should be at another school. I could think of a lot of things they could disagree about. I spent a lot of energy and finally converted two of the key people around so there were always major decisions being made. I guess we went to Minnesota because there's this picture in a magazine. But I can tell you that if I hadn't got it in then [supported by AFIPS], it may never have happened and I think AFIPS dissolved not too long after that, in the early 1980s [AFIPS dissolved 1990]. It certainly played no real role in conferences after that.

Yost: In the early years of the Charles Babbage Institute, the funding that came to the Institute from AFIPS was absolutely critical.

Hoagland: We had the money but we had to agree among ourselves. Usually that wasn't hard to do, but just because of the university issue [the location issue] where all these mainly ACM people, and even IEEE people, were with universities. But then I was in a position where I could turn it around because I would expect that I will have the IEEE people with me and if I get some of these other little people, I may be able to override. I didn't want to do it that way. Two of the key people in ACM, at least made it a probable unanimous.

Yost: So when you were president of the Computer Society in the early to mid-1970s, what were your biggest goals and what were your biggest challenges?

Hoagland: My location played a key role. I wasn't; in fact I don't even remember that I spent much time worrying about IEEE committees as a separate thing because I was involved in research work. But a lot of people in AFIPS were just there because of AFIPS and I think the thing that hit me was, well, this conference is their savior. They couldn't have existed without that kind of money coming in. And they, themselves, weren't well equipped. They had to build an interface for conferences, they had to get connected to someone to take care of getting equipment delivery and showing, and that could only

apply for so long because of the expansion of the field. But I felt if that were not done, I may have been; well, IEEE had asked; or took it to themselves to find what we were doing with the money, if they'd stopped that, that would've stopped our ability on the magazine, which was really important because that, I thought, was the only way the society reflected where their interests were. And what you give up, of course, is you may not be cited as a reference for a deep technical paper. But the IEEE members were very receptive; but they never once tried to make a change in anything and I was on their board during that period, as you know, [for a] couple of years.

Yost: So you clearly backed the idea of a flagship magazine, *Computer*.

Hoagland: Yes, I did.

Yost: It was a pivotal moment, I think, early in the Computer Society's history.

Hoagland: Yes, that's how I think of it. I was involved at a time, and with sources of money and could do things that would probably never occur again. But then I was on the IEEE board, I guess, in that period and that was when I went to their big meeting in Bermuda that year and there was no stress. No one ever questioned what I did and it never was a topic. In fact, we hired one guy from the IEEE to work with us in Washington. There were no problems I could see except, for us, because after a year or two he wasn't measuring up to our standard because one of the jobs I had to do was evaluate salaries of people there, and all that. But then we got an executive director who took care of that burden and then we just had to agree with him. If I just stick to writing technical papers I wouldn't have been very good, because I kept getting drawn into the helping product programs, which you couldn't write about. And that's what I liked to see, what was accomplished. So now, around 1981 and 1982 [Trustee 1979-1981], I was still with the Charles Babbage Foundation during that period. But as I looked at it, I was pretty content with whatever the IEEE was now, and I saw an even bigger challenge for me, which is to help another part of the IEEE, which was the Magnetic Society. Art Anderson's the one who hired me to Yorktown. I also worked for him on my way back to

San Jose; some in Boulder. I'm sure some of my time it was on AFIPS in Boulder. Now, I was in Boulder [1970-1976] because they had decided that; the guy who ran the research center felt [that] magnetic recording had reached maturity so we weren't going to continue any recording [program]. The San Jose research lab must have agreed with him because they were saying the next step we're working on [magnetic bubbles], and their director even published a book on magnetic bubbles, which I disagreed [with]. So, I made a deal, because Art Anderson was in Boulder. I'll go to Boulder and that'll make good sense for research because even if they give up disk recording, certainly tape recording's going to be around forever, so I'll see how far how far we can go on tape. So I had a commitment to go on to San Jose; I had a commitment to stay involved in magnetic recording; and with Art Anderson there, he drew me into one of their really big programs that dealt with a big system with both disk and tape. And so I was really pleased with it. My wife was even more pleased because she liked New York after a while, but she really liked Boulder. On the other hand, sometime in probably 1975 or so — because I know I moved to California again in 1976 — the Office Products Division needed more status so IBM came up and said the Office Products Division, OPD, and General Products Division, which included tape and disk under Art Anderson, would share a site. And that was very naïve thinking because what happened was, to attract new people, OPD argued they had to get sort of the best locations and San Jose people felt aw, hell, we're just second class citizens. So it was not a situation that made sense to continue with, so Art had to agree okay, I'll move the tape area to Tucson and at least sixty percent of the Boulder people left IBM. I mean, if you live in Boulder, which I discovered, people loved; even if I'd get to work at 7AM, people were working at 6AM. And if I worked as late as 4:30, I was the only one working. They really wanted to get up in the mountains and hunt or fish, or just be in the outdoors.

Yost: It's a beautiful place.

Hoagland: Yes, and I'd say, for the right circumstances, I probably would've given up and gone back to California but I sure as hell wasn't going to go to Tucson. But since I always had this agreement with Art that I was going to go to San Jose, I did get back in

San Jose and then I found, Jesus Christ, I was told magnetic bubble is going to replace disk recording and so I had to think of another job. And then I saw the big mess they were in because they were late in real technology they could use, and working on technology they'd never use. Well again, that's where Art Anderson's office ended up [San Jose] so I went to talk to Art, who then ran tape and disk. He said, you know what I think is wrong with this whole area is that semiconductor is flowering. The universities are producing students that are very active in that technology. Here we have a technology only we are involved in; we don't draw at all on the resources of universities. So he gave me the assignment of trying to start a center for magnetic recording research at a major university with criteria that it would at least have to be in California. And that got me out of all the issues of what I'm going to do; this is a nice, clean assignment directly from the general products leader, and I knew him well. So I went to; I picked out one person [James Lemke], who helped me who was very academic oriented and we went to Stanford. You know what they said? They said well, this is fine except we're heavily tied up in semiconductor technology and this may not last more than five years, once IBM got those problems straightened out. Then I went to Berkeley, where I graduated and had been on the faculty. They went further; they were willing to pull together resources in areas we outlined but weren't able to set up a center, which would make it very difficult to attract people. So then, the last stop; we went to Davis [University of California at Davis], but that really was just a show we did. By this time, I was a pilot and he was a pilot [James Lemke], so it was really great doing this stuff. He lived in San Diego and he knew the top person at UCSD; Atkinson or something — was the very top person — and he went in and he sort of softened him up and then I think we dealt with someone called Lee Rudy [Engineering school Dean]. Everything worked much better because UC San Diego was in a real growth mode. I mean, they had to expand engineering. So we went in and because of his [Lemke] connections and the story I made, saying IBM would toss in a ton of money, we got a proposal from them, which was very attractive. The proposal was that they had to have four people with real knowledge of magnetic recording because we really wanted to get off and running. And I was given the assignment of being the Acting Director, and I got a lot of people I knew in the industry. They were to be in magnetics; they were to be in materials; they were to be in mechanics, which is very

critical also. And there was a fourth category; I think it was recording systems. And that was approved; and we [IBM] gave them a lot of money; and they set up and shared almost the whole; part of a whole building for this. And everyone was pleased except the chair, Atkinson. Or he wasn't a dean; chancellor, I guess, because the last step; everyone had assumed I'd become director. I knew all the time what a great job this would be, and I was getting older, you know; and San Diego is a nice place. I thought about it real hard and then I said, I'd really be like a fish out of water because they didn't really have the infrastructure of startups and people making headlines in media; all the things I was very active with. I realized that I can't be there and really be that happy about that choice. So I learned one thing about chancellors; I told him no, I'm not going to accept the position and he really got angry. [Laughs.] He sort of left the room and I realized he expected me to say yes, and I think he understood from the way I said it, he couldn't turn me around. And this is almost my last transition. So I got back to San Jose. Now, I hadn't been involved in all the changes that had occurred; I was about two years in San Diego; and I got a marvelous break. I was at an age where IBM could grant early retirement to me and it was pretty nice what they do. I talked with a faculty member in magnetics at Santa Clara University. My argument was, look, the people who really need the education and training and understanding are in this valley. You're not going to be able to fly all the way to San Diego and back to San Jose. San Diego was really directed to doing basic research, which most of these companies don't need at that level; and I thought Santa Clara is far better suited in location than either Stanford or Berkeley because it was right close to the airport. And I went to talk to the guy who was running it [Santa Clara University]— and this is, of course, in my memo, and so forth — I put together this big advertisement of the role, because they did have early bird programs in graduate courses and I did a work focus on I call it Institute for Information Storage Technology [IIST], but that really meant disk, mostly. And I went in and I had a one-page proposal of this Institute, and he said, well, we're willing to advertise and take it on but we don't have any money in our budget for you. That's a tough thing. And I told them well, if this isn't worth supporting by industry, it isn't worth having. So he was happy and they really talked about this Institute coming; and I tried to raise a little money. But I found I had raised a lot of money for San Diego because they've got a lot of big companies there, so I

had to get little companies. I had planned to go back to the big companies but I had to go with little companies at first. So I couldn't go back to IBM right away. So I tacked together two or three of these startups that were making money and I learned something. If you ever get into this business [raising money], the first question is who signed up [already] for this institute? And I said well, no one yet. Their answer is always well, come back and see us later. I realized then, because I had worked personally with Al Shugart [Seagate CEO] long ago, on the 1301 [that I could go to him]. I said well, Al Shugart is not that kind of person; he'll either say no or yes. So I realized since I knew him, at least I could get a solid answer. If it were no, the whole thing probably wouldn't happen. If it were yes, he was well enough known I'd get a lot of leverage from the names he gave me. So I told him what I wanted to talk to him about and I had some paper. He just said tell me, so I gave him the general pitch and he said he'll sign up now for five years. Once I left his office I knew it was made and the next person I went to we got signed up. Well, if Seagate signed for it, they immediately signed up because here they could see he could capture all of these resources and information, and they'd be out in the cold. And the thing that helped was that I didn't need to hire the talent to teach because I could call up a guy at IBM and for $500, would you like to give a lecture? And I could get oversubscribed very quickly and some people would, like some guy who's with a company, would give a talk for free, anyway. So we educated an awful lot of people. At one time, the graduate program, which they actually called Early Bird because most of the courses were in the early morning, I'd say the Institute, about a third or more of the students were our students because it was a big expansion at the time. Now, doing that, I was teaching a lot of people from universities that had magnetics backgrounds; they were specialized in magnetics at the university and I got to know them. So finally I told them all, why don't we; I didn't need them all, I just said it would be good if we got four people together, we could put on TMRC, which ended up being called The Magnetic Recording Conference. The Institute was going to go ahead with something like that and it turned out we got enough to get started; we ran all their courses for the early years at Santa Clara University, which helped us because it got all these people like Jack Judy, and Minnesota, where he'd go to the annual TMRC Conference. With that going, I was preparing to look further, but not do another thing like that.

Hoagland: I got money from IEEE for a project I thought would be great for a senior projects activity, getting students to try and restore an original RAMAC just the mechanics of the drive and the servo-align features. And I had talked to people at IBM that knew me and got the IBM Corporate Archivist back east to say he had one free disk drive that he could loan. All this was now being done now, not under IIST, but what I called Magnetic Disk Heritage Center because the website I set up, which is MDHC, was to really focus on the early days of the disk drive.

Yost: When did you start the Magnetic Disk Heritage Center?

Hoagland: It was probably around 2003. Let's say it was up and running; it was totally separate from IIST. I didn't feel IIST, given Santa Clara University and the way that technology was changing, it probably could've kept running a conference but fewer and fewer graduates could get a master's degree and expect to get real work. And the Heritage Center was to make the RAMAC remembered [IEEE made the site of the original RAMAC project, 99 Notre Dame in San Jose, a historical landmark and RAMAC itself a historical technological milestone],. And so I put a lot of information on the Heritage Center [web site] from talks and original papers and things I could get, but I didn't have money to really do it right. In fact, the Heritage Center didn't have; we hadn't even raised much money. We got a little from the university [Santa Clara University] when I said I'm going to relocate [the RAMAC restoration project] I looked at where it could go. When we got the RAMAC, in a sense we were guaranteeing that IBM would be protecting this property and insuring, etcetera, etcetera. The university may be able to do that; certainly I couldn't. And so I took this to the Computer History Museum, which was coming together in Mountain View, and I talked to them and had meetings. Do you know any of them?

Yost: I know Dag Spicer well, and several other high level people there past and present.

Hoagland: Yeah. He's my technical person.

Hoagland: Do you know the executive director?

Yost: I haven't met the new one, John Hollar

Yost: Was this during John Toole's time or after, he was the previous CEO of CHM?

Hoagland: John Toole?

Yost: Yes, that was the leader of the museum [2003-2008]. And then roughly a half decade ago John Hollar [2008-present] took over.

Hoagland: Oh, yes. It was [John Toole]. But now [the Computer History Museum needed] to take care of a big exhibit, to show why they have this building, and try and get some history.

Yost: Right.

Hoagland: Okay. He was great. And when I saw some stuff written in the SIG [Special Interest Group] I felt was wrong, I talked to John and we took care of it; we didn't let it be used. I hate to say it, but a lot of people who look at history find two or three things they feel, or they remember reading, or knew, and so they feel they're making a contribution. Not necessarily on the merits of what they have to say, but they can create out of something they read, which is not too healthy, in a way. But, yeah, the restoration project went there [CHM] and I had volunteers who I knew at IBM take over from the students - it required engineering at this point, to get it in operational form. And it's featured at the museum, and a lot of that I relate to the museum recognizing the Heritage Center. In fact, Dag, I [recently] gave all of the stuff I had at my website to the Computer

History Museum and he has, I think, a contract to keep maintaining that site until it runs out the end of this year [2013] and then there's no point in redoing it. And so I had an office there [CHM], so I think clearly from 2005 to 2009, I was at the Computer History Museum; probably before, because that's when I first started working on my memoir.

Yost: A great place, and great geography for such a museum and the content you worked on.

Yost: One thing I found really interesting that your memoir mentioned was that obviously after RAMAC the industry takes off in the region; the disk drive industry. And you mentioned that it was proposed at a time before Silicon Valley became called Silicon Valley, Iron Oxide Valley for the coating on disk drives. Do you have any context for that?

Hoagland: Oh, yes. For years, I used to show a slide with; showed a disk with red on it; it covers the world like red paint. It's pretty simple to me, in one sense. First, I'll take disk drive. IBM dominated disk drives until you sort of got to the late 1980s. The big market was high end systems and what they wanted was huge amounts of storage, which they still do today. Unobserved by IBM was another market that was developing, and because he's so well known, I credit Steve Jobs. That was an interest in looking at computers in terms of personal computers. Even IBM's desktop computer was really designed for office usage, if you think about it.

Yost: The original PC?

Hoagland: Yes. I was once advised; I got an invitation before I left San Jose, to give a talk to Steve Jobs, which sort of surprised me. Then I learned that they had a small disk group working and their interest was in it being part of Apple Computer. Now, they didn't pay me for this talk but not much later, I got delivered to my door, an Apple III, which had a built-in disk drive.

Now, something else going on along, which I helped influence, was with Berkeley and the computer science people at Berkeley. David Patterson and Randy Katz, and the guy who got a Ph.D. [Garth Gibson] for his work. They looked at; they came to me [IIST] and they wanted to learn about disk drives; and I tutored a course; and so forth. They talked about a small drive but they weren't thinking of PCs. Their argument was that they could make small drives much cheaper than they could make a great, big 14-inch and we could give reliability by having redundant disks. Now, that had a tremendous impact even though some people argued that they were looking at superficial data. I really had to support them because they learned about disk drives from me. But it really turned out true because, say the company is buying 40 14-inch disks. They could buy 100 of these smaller [disks] and still save money. Plus, the built in redundancy they developed said if one disk goes out you don't lose your data, you can keep running but you will update this. That attracted many more opportunities for smaller disk drives and probably more so, in fact, than just smaller computers. There are people that argue about it but I think if you look at the big picture, that made a huge difference in the sale of disks and you notice disks dropped to five-and-a-quarter, which was sort of the first standard. Then it dropped to three-and-a-half, and two-and-a-half, and it could go to one-eighty. But every time they dropped the size of the disk they didn't reduce capacity. Usually they would give you more and that's what totally transformed the industry. Now, if that had happened earlier, it probably would've been the equivalent of Iron Oxide Valley, or whatever. The trouble was that a Nobel Prize winner, as you know, moved to Stanford and that was the co-inventor of the point contact transistor [William Shockley]. And that drew tremendous interest because people could at least visualize in their world, solid state circuits replacing big vacuum tubes. Now he happened to bring out eight people who saw this opportunity and joined together. It wasn't one company; well, it was one company but it wasn't organized around one guy. They started making chips.

Yost: You're talking about Fairchild?

Hoagland: Yes, Fairchild. I knew one of those people quite well but he ended up doing something over at Santa Cruz because he cared where he lived. They all made a ton of

money. Now, I'll tell you something you'll know [that] not many people understand. People understand that these chips are little things that get smaller and smaller, and that's because they're going to high power optics, electron beams, etc. And the smaller they get, the higher performance. Now, in a disk drive, I'll ask you, what do you think is the key parameter in a disk drive? Setting performance. Do you have any idea?

Yost: No I don't.

Hoagland: Well I'll tell you. A lot of magnetics people don't know it. Although one thing I learned in my early days of working in non-contact recording is the magnetic field scale. And that means, you give me a drawing of the head and I can put a ruler the same distance as a tenth of an inch and I can label them with that and it will still work the same. So it scales both spacing wise and track wise, and the driving force — although there are a lot of other factors, I'm not trying to — and what drives that is spacing, the non-contact spacing, which is what I started my career on, non-contact recording. We never visualized you could get as close as they've gotten and that is not something every citizen can appreciate, right? Whereas semiconductors; if you took a disk drive apart, you'd need really complex photolithography [to visualize]. And I think Silicon Valley has certainly provided more jobs. I have no problem with it now; I did years ago. And now, of course, all of these technologies like a lot of the tons of disk drives are made in China, like tons of Apple iPhones are and the tons of semiconductor technology there.

Yost: Much of the microelectronics manufacturing industry.

Hoagland: Well, since Shugart and Seagate are the ones that started the trend [manufacturing in China] for disks. What he did was, he said well, Hong Kong has a pretty high skill set — and they do — and a lot of industries there, which they rely on. So I thought I'd look at Singapore, is that what I said? Singapore, yes [not Hong Kong]. And I was over there once, and it was true; I mean, it was a very experienced labor force. But he [Shugart] found that due to some government subsidies, I'm sure, some great price differentials in labor and all that; that he could buy his magnetic heads cheaper there

[Singapore] than anywhere else. And China was probably still in their Communist throes, anyway. And so Singapore, like San Diego, has a Center for Magnetic Recording Research, they have something equivalent in Singapore that's every bit as good and if not better. That doesn't mean probably today they aren't sending a lot of stuff to be done in China.

Yost: One thing I think I haven't had a chance to ask you about during your time as president of the Computer Society….we talked about conferences and you talked about publications with the launch of *Computer* …. Can you talk a bit about education and making connections to higher education, and students, and universities? I understand that getting students involved in the Computer Society became increasingly important in the 1970s. Can you talk about that?

Hoagland: Getting students involved?

Yost: And also the membership chapters.

Hoagland: Okay, I see what you're getting at. I would say most of the students with some exceptions would end up as Computer Society members. A smaller set would be Magnetic Society. However, I believe that most of the core people at the San Diego Center would be Magnetic Society. And a large part of what made a difference was when we took over the Magnetic Recording Conference. We deliberately mapped it like we had for IIST, that is, one just to be for magnetics, this to be for magnetics and computer use of storage, product storage. So we used to get some good talks on processing and they probably still do. I'm sure that the biggest thing they had in the last several years is vertical versus perpendicular recording, which appealed to true research magneticians. Well that basically interests magneticians, but it also would interest a lot of people who do signal processing and designing drive circuitry. People who were more real engineers and not into the theory, sort of concluded, it probably didn't make any difference, but now you had a history of arguments that every Magnetic Society— they have at their annual meeting. But I don't know if that answers your question.

Yost: Are there any topics that I haven't asked about that you would like to discuss before we conclude?

Hoagland: First, you realize; I'll draw one conclusion that I don't know if it's even correct. You saw I was solely dedicated to the Computer Society. I got by that and became solely dedicated to the Magnetic Society. In both instances, I was looking at more the way it interacts [with companies and academia] than the quality of the publications, *per se*. This TMRC I formed now has all the universities as members, could've well have originated; if it originated with the Magnetic Society, would've been appropriate and goal oriented because mainly the focus is magnetics as a key. But I think the IEEE tends to look at the higher research quality, although sometimes I believe if you do something sloppy; if you're going to write a more general article you want to be sure you have real sources. So it could've been the Magnetic Society could've taken over TMRC. It would've never been as big though because what AFIPS did was to fund essentially a computer marketed sales activity. In other words, a conference. A conference where people are not coming [for the seminars]; they may come for a few important talks, but they; you don't get 120,000 waiting around for some guy to talk. And they check all the things HP will display, and they can get big orders; and I know the discount may show up there. And I don't see any way they could've done that as; but if anything; I'm sure it's true in silicon technology there must be a big way they keep up with what's going on, including great input from Intel and the manufacturers. But it's not quite the same because whoever decides on the circuit you use is a pretty high level person. There are a lot of issues of whether it'll work, whether it will meet your supply needs, etc. Lot of people going to the computer society [conference] are just curious. Sony doesn't much care whether they buy but they'll find a few who do. It's more oriented to display, and so; TMRC would never be there. I don't think you can get that unless people want to know what's the latest thing. I would think you could set up a conference wherever you are; and you could get the digital people to display in a competitive environment their different iPhones, and their different laptop versions. But,

you know, Apple's not going to particularly be interested in the consumer buying a Windows machine.

Hoagland: As you will know yourselves, and are probably are learning, disk drives won't be seen by anyone pretty soon. Do you know that?

Yost: Yes.

Hoagland: And you know where they're all going, of course? Do you?

Yost: Where are they going?

Hoagland: Well I'll tell you. You've heard of the cloud? You've heard of this tremendous amount of information stored somewhere so that everyone seems to get all information all the time. That's all stored in the cloud and the cloud is computer disk drives. I mean, disk drives that are a terabyte or probably more now, that are small and cheap. And let's say Oregon has an earthquake and the place where the disk drives gets demolished. They don't want; nobody wants the user to feel an earthquake in Oregon.

Yost: They set up redundant systems, redundant locations for storage.

Hoagland: There have always been alternate sites they could switch to and that's part of why it used to be data was stored on mag tape, and I'm sure some still is. But now they say, did you get what you want, when you want it. You can't wait for a guy to go look down an aisle and see if a tape reel is there. So I think it will keep growing and some time that technology may change but I think the big difference to the user is he loves the cloud, he's glad he doesn't have a heavy disk. He's got a light iPad, for example, the web and all the things he wants; and if he likes to store all his pictures, he can stick them in the cloud, which is better than storing them himself because if his home burns down he may lose what he stored but presumably, the cloud won't burn down. At least we hope. So I think that's the world we're moving into.

Yost: Well thank you so much. This has been fascinating.

Hoagland: Did I answer the questions?

Yost: Yes, Thanks so much. I appreciate your time.

Yost: Right. We're interested in getting perspectives on the Computer Society but also documenting the whole career of leaders.

Hoagland: I appreciate that because I am now facing it. Trouble is, some of the key people in the disk area are passing away. They were there when the RAMAC was there. Now someone wants to write a history of it and he doesn't have anyone to talk to; but he will find old notes and those old notes can say almost anything, right? And you can't put them in any context, just because this guy mentioned this so maybe that's where the idea came from. So I believe that, like on RAMAC, in retrospect in computer history; I know IBM itself tried to get some of that history. It should've started earlier, like the 50th anniversary, or something. I have hopefully, some credibility because I can certainly recite many things people don't know.

Yost: The Computer History Museum did a number of group oral history interviews, including with you.

Hoagland: I have restricted my activities to where I really have unique experience. I worked on projects a lot of people worked on; and that is the RAMAC and a 1301. And there are things about 1301 that I now and then mention, and I talked to Dag about writing more about those two topics. But their SIG group will actually work on 3330, 3340, 3370, the whole list of IBM products and what they're trying to do is get someone who was on that project. Of course, they'd be young enough that there are a lot of people you could draw on to try and get the facts as straight as possible. You only want to be

suspicious if someone opts to work on something where no one is around [who did the original work], because then you're stuck with is this guy interpreting the data right.

Yost: Sort of triangulation to oral history and use of oral history.

Hoagland: I'm sure some great historians have resources that have helped to do that. I wanted to ask you; there was one question that occurred to me. [Pause.] Do you have a history on; well, let me ask you a question first. Do you know what a creator is? Let's say you do. Seminal creator. Do you know what an inventor is?

Yost: Yes.

Hoagland: What is an inventor?

Yost: Someone who develops an idea for something.

Hoagland: I'm going to tell you this because I tend to feel there is a restriction imposed by law. An inventor is someone whose name is on a patent and the patent asserts his right to claim that this is his invention. Now, 90 percent of patents are not filed by people who have [invented]; it's nice to put a guy's name on a patent but once, if you're working for a company and you join IBM, you have relinquished all your patent rights to IBM. Now, I only bring this up because in the RAMAC, the general feeling up until now is Rey is the inventor [but he is not on the patent]. He's also the creator. But that left the question of what is Lou Stevens, then? He's the inventor [according to the patent] of the RAMAC. Now, if we call Rey the inventor, the lawyers will say he's not the inventor because he's not on the patent. Steve Jobs solves this problem very well because he puts his name on all the patents, I guess, because he has 306. I say this because Lou Stevens is in the Inventors Hall of Fame for inventing the RAMAC disk drive. So you won't get universal acceptance if you just say Rey Johnson. And you may get disagreements if you say Lou Stevens. But if you ever get to talk to Dag; I was going to ask him about this because there are people who judge on the patent basis. Our restoration projects should show both

Rey and Lou, right? And someone who is writing history and doesn't understand this, there's not a universal understanding of this and they get objections but they don't understand why.

Yost: Well I think historians do not necessarily see the name on the patent as the inventor of a technology. They seek to do deeper research.

Yost: Well thank you so much.

Hoagland: Well what time is it?

Yost: It's 3:45.

Hoagland: Okay. So it worked pretty well for you?

Yost: Yes—Thanks again.