Interview of Dave (David) Farber

Interviewed by:
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James Pelkey: In terms of intellectual history, the Irvine Ring and the work you did at the University of Irvine was critical. I'm interested the source of those ideas. Whether or not the Newhall /Pearce ring had preceded, in terms of conceptual knowledge, your work, and then from there, how it was passed over to MIT. I know the National Science Foundation funded some of your work. But who came in contact with your project, and whether or not anything cane from that?

David Farber: Why don't I go back to an earlier history; as you know, my background came out of Bell Laboratories. I spend ten years there in communication systems, the first electronic switching system, the system design of it, and then went over to the research division to do some work in programming languages, SNOBOL.

Pelkey: What years were these?

Farber: This was starting in '56, when I arrived at Bell Labs. I interviewed with people who were designing the first of the electronic switching machines, and it was an intriguing opportunity that I couldn't resist. So, I've been in communication for many, many, years, and so, at Bell Labs I also ran the computer center at Holmdel, so it was one of these serendipity blends of communication on one hand and computing on the other hand and programming languages on a third hand. There in my career I had also a full opportunity to be involved in the commercial side, cause I was, pseudo-commercial, I was the SHARE secretary, SHARE's the IBM scientific users group. So, at a rather tender age, I was exposed to the politics of the world. When I left Bell Labs, I went to RAND, and spent a couple years there; part, not working with, but heavily involved with, and affected by Paul Baran.

Pelkey: And what years were those?

Farber: This would be '56 to about '68.

Pelkey: Ok.

Farber: Then I spent about a year and a half interlude at Scientific Data Systems, Max Palevsky, who I see occasionally, and then had been teaching in the evenings at University of California at Irvine and they said: "Why don't you come down and think of getting a position here?" Well, it was clear that Xerox was wrecking SDS and themselves, so after a number of straining decisions, mainly because of stock options, which turned out to have been worth minus $10, I decided to go to Irvine.

Pelkey: And what year was that --

Farber: This would be '69, late '69. I arrived and, because of my industrial experience and the fact that, pragmatically I never got around to getting a doctorate, I had an Acting Associate Professor appointment, so I had two years to do something, which always tends to be amusing. About that time the minicomputer was coming onto the marketplace with a vengeance and, one of the things that interested me early on was could I use a whole bunch of these minicomputers together, to form a more effective computation environment, a multi-processor environment, and

for a number of reasons that are probably lost in my mind, I didn't think of the sort of natural - not natural anymore - but idea of putting them on a local processing, a plain multi-process scheme; mainly because they weren't built to do that very easily. At the time, there were a lot of different manufacturers and it wasn't clear who was going to win. In the, I guess it would be the early '70s, I went to a conference down in Georgia at, what's the name of that resort there, something Mountain, oh whatever, there was this communication conference, and there were a number of interesting papers.

Pelkey: Was that the IEEE?

Farber: IEEE. I wanting to say Magic Mountain, but that's not -- its a well known resort up there. And, there was some work reported by Newhall and Farmer on their ring. What that triggered me on, more than anything else was the notion that there was technology for local networking. It turns out at Bell Labs; one of the things that I was involved in was actually the world's first T-1 installation-to-installation computer ring, computer link. We had one between Murray Hill and Holmdale when it first opened, that was tying together our computers at both installations, and tying together remote graphics -- remote Xerographic printers. Now why Bell Labs never did anything with it that is beyond me. We can talk later about the culture.

Pelkey: Yeah. I'm going to come back to that.

Farber: But what the Newhall Farmer report did was to indicate to me that there was a technology there, so I went back to Irvine and started thinking of a set of objectives, and remember I have two years to come up with a project, to get it funded, and to get enough published on it, enough work done, so in two years I could go up for a permanent position. Good trick! The things that drive technology are always fun.

Pelkey: Yes.

Farber: During that period, in sort of thinking it out, what I wanted to do was explore some corners. I wanted to see just how decentralized I could make an environment. I knew that I could certainly build something similar to the IBM token passing loops to communicate between processors, and I could certainly build a master/slave processor. I had done that, or helped to do that at SDS. Actually, at SDS we had realized that it was difficult to build one that didn't have a unique master, because of the architecture of the SDS systems. So, what I decided to do was, let's see how far we can force this. And so the sort of objectives of what became known as the Distributed Computer System, DCS, was to see if we could do total distribution. No vulnerable point of error, with both communications and processing and software that was completely decentralized. Now, when I looked at it, given the notions or the ideas of Newhall and Farmer's token ring, there were at least two things wrong with it - at least two things wrong. One was a funny one. It used basically a funny way to designate the beginning of a message. It did a bipolar violation, and I was thinking, whatever I build, maybe it'll be nice some day if I can move it over wider areas using the T-1 link between them, back to the Bell Lab days. And bipolar violations are a big pain. You can't do that. The other thing is, both Newhall and Waiter, and Pearce rings didn't exit from Bell Labs until much later, both clearly had the notion of having a central control box. Central control boxes had bad characteristics in the sense that what

I wanted to do was build a system that could start very small and grow very large, and that would have no obvious vulnerabilities. Central control boxes cost you, right up front, a lot of money, so I decided we couldn't do that.

Pelkey: Ok.

Farber: And we sat back and said: "Is it feasible to build a completely decentralized token ring with no idea of the master station?" So that was one objective. The second objective was: "Can we build a token ring communication system that supports the type of software paradigms that we wanted?" Now remember, we wanted to build a completely decentralized system. We wanted one that would inherently know about process migration, would inherently be fault tolerant, all the good things. We decided very early on that we couldn't do that -- we couldn't do it by just building a sort of conventional system. We came upon -- and the genealogy of this is very vague in my mind -- but I think its probably one of the big contributions of that activity, and we decided that if we would do process migration and decentralization, we had to refer to things in different ways than the current networks had referred to them. In the early days, and even now, you talk about specific machines that you communicate with. Well there was no way we were going to do things different if user software knew about specific machines, even indirectly, so we thought of the idea of having software that would couple together by sending detached messages back-and-forth to each other. Now that's, to my knowledge, the first presentation of a message-based idea and further, if there were going to be messages to pass back and forth, couldn't we do it in such a way that the addresses were independent of the machines that the programs ran on? So we evolved this idea that we were going to have a process-structured software system, with messages that were process addressed. So I want to send a message to somebody, to some program, once I knew its name I just sort of sent it to that program and the underlying communication system would take care of it for me. Now, it turned out the ring was beautiful for this, because the thing we -- and it affected the way the ring was built. Notice that, we had two things. First, we wanted the addressing to be process oriented. Second of all, we had no idea where it was, or for that matter, because of the fault tolerance thing, how many of them there were. I might be dealing with a distributed data system that had a number of databases being maintained and synchronized. So I may send a message to a process of which there were many instantiations of it.

Pelkey: Ok.

Farber: So, to have the communication architecture support that, we had to have the idea that a message went around the whole ring looking for all possible destinations for that message, and only stop when they came back to the guy who sent them. Ok? And I was motivated by this fault tolerance behavior. And once you did that, you also picked up all the facts that, once you went around, you could come back with some additional information, like how did it do on its way around. What we designed was an interface that was operating at, in those days, 2.3 megabits, that had, inside the hardware, a table of process names that could be loaded by programs when they got installed, and as the message rotated around the ring, this was a distributed token ring, as it rotated around the ring, on the fly through each of these nodes, literally on the fly, bit at a time, it saw if this address, destination address, was one of the addresses that was in this associative store. If it was, it made a copy of it. At the end, it saw the

marker bit saying: "Hey, I made a copy of this. Happy day," and then went to spring circular, let the message circulate around, till it came to the guy at the end who took it off, you know, standard protocol. Basically, that's the ring we reported on in '71. Now we didn't have it built when we reported on it. Obviously! But, we proposed to the NSF in '70, fun to take a project to building a system like this, and asked for, what at that time was the largest research thing they had ever seen. We actually got about $250,000 a year which, for those days in computer science, was --

Pelkey: Big.

Farber: -- huge. It's still big, but by those standards it would be equivalent to a couple million a year now for a small group of people doing something. It got awarded, which surprised everybody including me, and so now the problem was to make it happen. Well, the reason is, it is one of these, again, serendipity things where the technology was coming together at just the right time, and the proposal came out at just the right time to excite people, and there was a program director down there who was sympathetic to sort of way out things. He also needed -- he was looking for something he could hang his hat on.

Pelkey: And he worked with NSF and not ARPA?

Farber: This was NSF. Yeah, this is part of a long feeling that I've had, and will continue to have, that working with the DOD, while interesting, doesn't help this nation very much and, as much as the -- the judgments -- the values differ. When I design for a military system, I design for a different world. When I design for a commercial system, I design with a whole different set of values, and that propagate faster and they'll have more of an impact on the nation, so I tend to like to stay in the swing side when I can help it. Yeah, we went to NSF and got money.

Pelkey: Who was the program manager up there?

Farber: John Wayman. He's still there. And it took courage for John. A cute little story, that I might as well give out now, is one of my favorites. When it came time to renew, apply for renewal after two years, actually right before my tenure decision, I wrote a renewal proposal. We were coming along well, and John, when he sent me back the decision, which was yes, we'll go with another two years, sent back this set of reviews, quoting at one in particular, anonymous reviews. The review said: "Well, this proposal really shouldn't get funded because its duplicating the work that's being done at the University of California at Irvine," which shows you what reviews have --

Pelkey: That's why they're anonymous.

Farber: Whew. That was so funny.

Pelkey: Now, when you were dealing with this, the issues of protocols, where did you go to learn about them? How did you come up with those ideas; such as the concept of having just process addresses as opposed to physical address?

Farber: Well, I sat down with a couple of the kids, one a young faculty member named Rusty Barbero, and a couple of graduate students, and we just basically threw ideas around. The problem was, how were we going to migrate process? Well, you go through a thought process. How are you going to migrate a process? That was important. It turned out not to be very important, but early on it was important, because we wanted fault tolerance. You had to be able to -- the machines were notoriously flaky, in those days. In fact, when we demonstrated, we never really had to ever fake a crash.

Pelkey: Because it would just happen?

Farber: You, you stay around for an hour, one of the machines will go off. They were that flaky. Well, you say: "Well, how am I going to migrate a process?" Well, I could have tables in each machine, software tables, and every time I go to send a message I could look at those tables, for you know they are going to get out of kilter. You're going to spend a lot of energy trying to keep those tables up to date, and that sort of began a custom that -- a way of thinking I still do. Why not move that which is very hard to process, very hard to do in real time, out to a specialized piece of hardware? And that, rather than have the software look up, put in the physical address, let the hardware look up, and now all you have to do is make sure the information is out there. Its sort of a natural step, given this design objective, which was a distributed system --

Pelkey: Yes.

Farber: -- that was message based. If you had come about it from a local network standpoint, you never would have done that, because you wouldn't have had the abstraction of wanting to send anything over to the other machine.

Pelkey: Right, and you were thinking much more about migrating the process --

Farber: Much more about migration to process, and that defined the battle that we went into, people refused to accept, with a few exceptions, the notion that no person ever talked-- no machine ever talked to anther machine's process. In it, they're communicating and, certainly, over the next generation of computer systems, that's going to be the dominant discourse. So your networks should understand that. I can talk later, if you're interested, about my ideas on that. That's futuristic.

Pelkey: Right. Ok. Now, you went to this conference in Georgia, and Newhall and Pearce, were they are at the conference?

Farber: Pearce hadn't appeared on the scene at all. Pearce's papers didn't come out for another two years.

Pelkey: So this is Farmer and Newhall?

Farber: Farmer and Newhall, not Pearce.

Pelkey: Were Farmer and Newhall, were they there at this conference?

Farber: I think Newhall was there.

Pelkey: Did you interact with him?

Farber: Not for the next year and a half, then I called him up. Cause we stopped deviating. What they had done is they had gone out to try to make a product out of it. Newhall had gone up to Toronto. Farmer sort of dematerialized, and --

Pelkey: Where did Newhall go?

Farber: He went to Toronto, University of Toronto, and then tried to form a company to market the ring, but it turned out it was, again, it was a product before its time. There was no motivation for local networks. Who needed the Newhall network? You didn't have workstations. You didn't have anything you could put on a local network. Our machines barely communicated with another. So, if you looked at it from building a local network business, way too early. He could never make that business fly.

Pelkey: And this is in the early '70s that he --

Farber: Very early '70s, yeah.

Pelkey: Do you know where he is today?

Farber: I would presume Bell Labs might keep track of him. I think he retired from the Labs. If he retired, then they have forwarding -- usually, what I do with the Labs -- the other possibility is to look in the IEEE.

Pelkey: Ok. So do you know what his motivation was to build the ring?

Farber: I can guess. If I were building a PBX, even back in those days, there was a lot of motivation, a lot of thought of taking them and doing interconnection. No that was after that time. Actually --

Pelkey: I've heard someplace it was this kind of a CO-to-CO sort of a --

Farber: You could do CO-to-CO…

Pelkey: -- that they were looking at, or passing control information between COs, or --

Farber: He might have been in that group. That's a strange way to do it, because normally COs are too far apart for that. If I were building a, what do you call it now, the remote CDOs, where you take the switching logic, and a few other things, and put it out in little --

Pelkey: Distribute it out --

Farber: -- places and then you put a central big switch or big control unit to control all of the -- but, at least when I left the Labs, there was nothing going on there. On the other hand, remember the way Bell Labs operated.

Pelkey: Prone to do their thing.

Farber: They did their own thing within broad charters, like the work they did in Snowball, was done in the electronic switching department. Why? We got interested in symbolic algebra. There was no reason, no correlation with the project there particularly, but it was left field. That's the way the Labs worked in those days.

Pelkey: So you were -- let me finish with my question, and then we'll -- and Farmer just kind of disappeared from the scene. Now, Pearce did some work independent of the two of them?

Farber: Pearce did some independent work. His interests were somewhat more than the multi-ring thing.

Pelkey: And where was his work done, do you recall?

Farber: It got published about two years -- two or three years after, so about '74, if I remember right, and it had this funny idea of specialized boxes also. Actually, it came after a paper we wrote down at Irvine on multiple rings, and how to connect multiple rings, where we did the same thing that John did, without specialized boxes, and that's the basis of what IBM had pushed, actually. Now, I knew John from Bell Labs days, but --

Pelkey: Did he ever attempt to get you around the work you were doing?

Farber: No.

Pelkey: Now, when you contacted Newhall did you share with him what you were thinking at that point in time?

Farber: I kept him updated on what we were doing. He had no interest. He was off trying to sell his token ring out as a product and running into real troubles. Capital problems with Canada; business in Canada. There was marginally a -- there was probably no business in this country, there certainly wasn't in Canada. So, like, I kept him updated for about two or three years, and then --

Pelkey: He just never displayed interest so you just stopped --

Farber: No, and I just stopped. I think I went up once and visited him for a couple hours. He wasn't interested in the field anymore. I'm not sure what he was interested in, and the one went to produce was fundamentally an exact copy of the one he had built, or designed. A lot of the things back in those days were published before they were built. Dangerous game, but quite often, certainly necessary in the academic community, at that time and still is. We built ours,

actually, and we got the renewal. By that point we had a software system running, and we had rudiments of the token ring running. BIG goddamn boards.

Pelkey: And this is about '70

Farber: '73 would be. We were able to demonstrate a three-processor system. We had actually bought, through incredible serendipity; we wanted to buy PDP11s. Actually, it was serendipity because we would not have gone down the path that we did -- we wanted to buy 11s, but a local company, Lockheed, was making something, it was an 11 clone called the Lockheed Sue.

Pelkey: S U E?

Farber: They were in the memory business, and they wanted to put some iron under their memories.

Pelkey: This was core memory that they were building?

Farber: Yeah, right: same thing that had gotten Intel and others into the computer side of the house. They're manufacturing memory, why not build the processor that goes under it and make all the money, not just on memory --

Pelkey: But at this time MOS memory was starting to come around, wasn't it?

Farber: Yeah. Not commercially; just beginning to come on the scene, but too expensive. People tended to buy core memory, small cores, certainly into the mid '70s, before even MOS memory in that class of machine, anyway. Let's see the -- IBM was still marketing cores -- big memories, just about that time, if I remember right. Now, having bought that machine, we found that, rapidly, there was no software or anything for it. If we had gotten the 11s, we might have ended up with more kluge, because there was a fair amount of software for that. It wouldn't have fitted it very well, but it would have -- we could have force fitted it and stored it. This was the opportunity -- the requirement to completely design everything, so we designed a compiler for it. There was no software at all, so we built from the ground up. That took us a fair amount of time. But in the mid '70s, basically due to a couple of real good students, we had a three machine complex running. The token ring, the ring was running, big cable, at about 2.4 megabits.

Pelkey: Do you recall when you got a three-node network up?

Farber: I remember them calling me down and saying: "We finally got it running. The hardware, the token ring, was a real kluge, because --

Pelkey: What year was this when you got it running? '74, '75?

Farber: No, it should have been about late '73, early '74 they got something running. Real kluge, because the kids were computer science majors whom, courtesy of this project, became very good hardware designers. I mean, that's happened in a lot of projects that I ended up --

Pelkey: Who were some of the students?

Farber: Paul Markapepkis, Mike Lyle. How fast you forget them. Larry Rowe from Berkeley, he's at Berkeley now; guy who now runs, something Olsen, who now runs Meridian Software down in the Bay Area. These were young kids. They got it running, called me down and said: "Look. It's running!" We had seen the tokens going around the ring and then we had developed all the software in one machine, cause if you look at what the rules say, we had a mult- -- single -- machine operating system that, once you turned on the ring, it should have done what it does. What it did throughout its whole existence is assume it was on a multi-, a distributed environment, but there was nobody there except itself, so it just loaded everything among itself. When we turned on the ring, inside a day it was running on three machines. It went that fast. We had assumed it would take us a week or two to iron out the bugs, but there were none, for that part of it. There were a lot of bugs elsewhere, but it just distributed like a bat out of hell. Mostly it was getting it up on three machines physically and keeping it running. We had one of the kids develop a bug "tester" that worked fairly well, but it turned out we didn't need it. Again, the software was clean. We really forced the cleanliness throughout.

Pelkey: What languages were you using at that point in time?

Farber: It was a little Pascal like language. I can't even remember what it was, now.

Pelkey: Did you do daisy chains?

Farber: In what way?

Pelkey: From machine-to-machine?

Farber: Well, we had a specialized board sitting off the bus that was the token ring card. It was identical in what it does to any of the current token rings, except that it had this table in it in addition, but the current -- I'll talk about what happened to the table later on.

Pelkey: Ok.

Farber: And it ran, and at that point it got very popular, and it was a very strange situation. People start hearing about it, and we get these phone calls saying: "We'd like to come down and see it." We'd say: "You mean you want to talk?" "We want to come down." "You want to talk about it? "No, we want to see it." Take them down the lab and point out to the more intelligent of them that, for all you know, we're lying to you. You can't see the bits going around. We had this big wire, coiled twisted pair off in the corner, because you needed some -- we wanted to test it at the extremes of length, and inside one room you can't, so we just packed coils of wire to get some length. But, they came down. We had ISO . . .

Tape Side Ends

Pelkey: -- and now, other than from being a small part of the lease-line modem business is a non-factor in the data communications industry. Why and how did that happen?

Farber: Well, part of it is an on-going perception, and it may be a correct one in a funny way, and totally incorrect in others, on the part of the AT&T that data communications is not a central part of their business. You know, every, and part of it is experience. Starting when I was there, so that's thirty years ago, close on, every year people would come up and say: "In five years, data communications will be a dominant part of your business." And, every five years they would look back and say: "Well, it hasn't happened yet, but wait. Five years from now." And it hasn't materialized, and if you look at least the visible data communication business, i.e. the band carriers, they're not enough -- they don't have enough income to provide toothpicks. It's just not a significant business. Now you can argue that a lot of their facilities carry data communication traffic, but on the other hand, there's no -- no one has any good idea of how to make that materialize into business AT&T can benefit from. Now, internally, within the system, all over the system, it is a distributed computer system, heavy use of digital communication within the system. It's just, every time they try to go out and market it, the market does not appear. Modems, sure --

Pelkey: But they're not even a factor in modems anymore.

Farber: No, they're not a factor in modems and I think that's --

Pelkey: Not multiplexers, not local area networks, not T-1 multiplexers…..

Farber: I think that is a result of a bad history. The Western Electric couldn't engineer anything cheaply. It still can't. It does beautiful polished stuff that'll last years. The market has changed. It's not forty years anymore, and Western has been very slow to change, but on the other hand, if you look at where some of the innovative modem technology came out of, it derives from some Bell Labs stuff.

Pelkey: Right.

Farber: But they just were never able to manufacture and market commercially -- market to the retail world, and there is no mechanism now for even marketing to the business world viably.

Pelkey: Ok.

Farber: But, if you look inside at the research going on, if anything, there's about four or five research projects in innovative digital technology, all the way from home networking to high speed improvements -- dramatic improvements on the DataKit technology, and that's good technology. The stuff they have in very high-speed packet switching is leading stuff. Where AT&T can never figure out how to make a profit out of that --

Pelkey: Now Sandy

Farber: Frazier.

Pelkey: Frazier, built a network called Spider?

Farber: Sandy built a network called Spider (ring) net that was fairly late in the game.

Pelkey: In the '80s?

Farber: Well, late '70s early '80s. It was derivative of the Cambridge system, the Cambridge ring, and never got anyplace, but what he did with ideas that came out of that, not directly, but from the work, is the DataKit, which is, you know, widely used within the operating companies. The problem with AT&T is what business is it in? And how does it take all this money -- nice technology and make money for AT&T?

Pelkey: Yes.

Farber: And that's hard. I don't see it.

Pelkey: So, now in the early days, certainly the modem business was a business of applied mathematicians, applied mathematics I should say.

Farber: Right.

Pelkey: And of coding. And those were the skill sets that were required, and it was an analog world.

Farber: It was an analog world. Now, it's a different set of skill sets, but still bright people are bright people and the Lab still has a large number of bright people. If AT&T, in my view at least, if AT&T could understand and, I don't think very many people have the vaguest idea of how do you take and capitalize on the Laboratories, as a business where AT&T is not in the retailing business. They're in the CO business, and doing very well there. I mean, their network as a whole is profitable, but its a cash sink, and what they need is more things to produce the cash, not sink it, and what advice would I give them on how to capitalize on that technology? You could see it being somewhat of a think tank that sells licensing and everything, but that doesn't make any sense

Pelkey: Unless you have any other comments in terms of the AT&T Bell Labs, let's proceed.

Farber: No, I don't.

Pelkey: The one missed opportunity is important to understand in terms of, having gone from analog to digital and having gone from what's happened --

Farber: Well, it's a failure, in my view; it's a failure of AT&T, not of Bell Labs.

Pelkey: Right. I mean, Bell Labs, I remember ten years ago, that place was as filled with creative people playing with computers and --

Farber: And there was creative work, but there was no way to transfer it into the market. The same thing is happening with Belcorp. There is an opportunity. They have a good set of people, maybe not as brilliant as Bell Labs, but close to it. They have the market, even with Judge Green in the act, but they'll probably drop that too.

Pelkey: Coming back to people. You shared some of the things you dealt with Bob Metcalfe. Did you ever deal with Ralph Ungermann?

Farber: No.

Pelkey: Bill Carrico?

Farber: No. So in terms of local area networking, other than what happened at Proteon and some conversations around that and Bob Metcalfe -- On the people side, I got out of it in the sense that I went to other things just about the time when the market started taking off. I know the people because they came to talks I gave, but I did not get involved with --

Pelkey: We were talking on the walk over here about Arpanet and E- mail. E-mail wasn't part of the original specifications for Arpanet.

Farber: No, E-mail was serendipity.

Pelkey: And yet, it became the dominant raison d'etre for Arpanet at some point --

Farber: And all the other networks.

Pelkey: -- and all the other networks. Why wasn't it thought of, perceived, understood up front and, why did it become such a big success?

Farber: Well, let me start from the past. It's the same reason that telephones are a big success. People want to communicate. We're in a culture where we're spread horribly thin, especially the academic world. I was one of the responsible parties for getting CSNET off the ground, which is one of the early discipline networks, and the motivation there was, if you look at computer science as a field, its spread almost markedly thin across the county. Everybody has a department. Almost all of them are subcritical, and it is getting increasingly more difficult to work together. Now, electronics, same as the telephone provided in its day a vehicle, and the telegraph before that, for people to communicate. E-mail is that vehicle now. Monday, I have a meeting that has people in there places. Me, here, but the other two, one's in Portland, ME and one's in the main place in Pasadena CA. The guy in Portland likes to live in Portland. The staff that he manages is in Pasadena. All our communication is by E-mail.

Pelkey: And how much loss of effectiveness do you think happens?

Farber: He thinks it’s more effective, actually.

Pelkey: What's your opinion?

Farber: I think its more effective. His part is his management style. Part is the way we build things, which is fundamentally a computer-assisted system. His management style is availability, but not tight management. The control style is by design documents. You don't have to actually sit there and read. I think he's probably more effective because he's not there all the time. Guys assume better responsibility. He goes back once a month. It works fine. Could it work without E-mail? No way. It just could not work. We couldn't handle the type of metabolism, and its same in the academic community. I was one of the early perpetrators of these things. I had graduate students all over the country. Why not? People like to communicate, and E-mail is communications.

Pelkey: Do you think that the communication medium will, given what's happened in communications in that it's going more and more internally, with local area networks in the business the environments --

Farber: What's happening, if you look, certainly in the technological fields, look at a relatively conservative company, Les (Vedez) will kill for this but I'll say it anyway, Intel, which I consider a very conservative company internally, they have a huge network and even Andy (Grove) and Vedez use electronic mail. In fact, it's the only way to get hold of them now. They use email internally, intensely, to operate their distributed company. All the technological companies --

Pelkey: Do they do it for more than communications? Do they do problem solving on it? Do they organize ad hoc groups, attack problems and?

Farber: Oh yes. Yeah. Now they're coming up to steam slower. There, it started from the bottom.

Pelkey: Right.

Farber: And eventually the management, usually because they were getting tired of traveling, decided that maybe the guys knew what was going on down there. At places like HP, it tended to happen more from the top down, but yes, there are different places along their understanding of the profile of any technology. They've all suffered. It's not without its problems, as you know. Power shifts. Now people who write well have more influence than people who talk. Again, there's no emotion, and I've gotten scars up and down my back from that. Not so much the industrial world, I learned by then, but with government you can get into this accelerating conflict and not realize it's happening until it's damned near screaming across the screen. At that point you learn you take up the phone because it has voice. I think it could have an incredible benefit to our educational system, if we, as a country, would take advantage of it.

Pelkey: Yeah.

Farber: I've watched my kids and others using that to correspond with their seniors and their peers, and it's an interesting culture. It's coming up as it did in ham, its coming up through the amateurs, but this time the university support is there --

Pelkey: Yes.

Farber: -- and the commercial support. But its still not, I don't think -- it's a funny thing, because it's still not accepted. If you went into Washington and said: "We're building a network for electronic mail." You wouldn't say that.

Pelkey: Yeah, right.

Farber: Because that somehow doesn't sound right, even though you know that's what it'll be used for. There's business there. Unfortunately, for the life of me, I don't see how to make money on it.

Pelkey: Right, right. I'm not sure I do either. People who --

Farber: By the way, it does bring up an interesting thing. It's one of those places where, in fact, the need for security and privacy become dominant.

Pelkey: Yes.

Farber: And that's where I think there is a business.

Pelkey: I agree with that completely. Students who worked for you that went on to become factors at other communication companies?

Farber: Yeah, quite a few. Well, with companies? A large part of my students have -- yeah, ok. Jon Postel, who is certainly my student. Dave Zinkowski of Belcorp.

Pelkey: Where was Jon your student?

Farber: I supervised his thesis when I was at Irvine and he was at UCLA, and I gained five pounds supervising his thesis because the only time we could meet was for breakfast, and we always met in this pancake place and my weight --

Pelkey: Long Beach, or someplace?

Farber: Actually Santa Monica. I lived in the Palisades. So we'd meet there in the morning, go over things; then I'd drive down to Irvine. Good pancakes.

Pelkey: I really like Jon.

Farber: Oh Jon's a character. Dave Zinkowski who is a rising young star at Belcorp. A couple of my people are at Belcorp and a couple at Bell Labs. A lot went into the academic world and they're doing good things there. The communication business is a funny one because they're scattered all around.

Pelkey: We were chatting, again on the way over, about this concept about the future, and the implications of having communications networks out there, and increasingly they're going to become more prevalent, and more and more people are getting connected to them, and that that's going to have implications on the future. I was sharing with you this concept of what I think might happen within business environments. There's going to be a shift of this kind of management science paradigm. You mentioned you've had some conversations with some people at Wharton in terms of the same sorts of things.

Farber: Wharton and Annenberg are both interested in using that as a lever for making out management structures more efficient --

Pelkey: Right.

Farber: -- by the way -- if we're as good or as bad in competing in technology, let's suppose we stay about as good, their feeling is that our technological competition is in better shape than our abilities to do anything with it, and that part of our problem in doing anything with it is our management structure has gotten completely out of control, and we're in just as bad a shape as most of our competitors, if not worse; and the easy -- not the easy, one way that we can become more competitive which will fit in out culture better than, say, the Japanese, is to squish the management levels, and make that more efficient.

Pelkey: Right.

Farber: Now that produces an interesting set of dislocations, but it's happening. E-mail has that nice tendency to squish the structure.

Pelkey: Yeah. I agree with you. Are there any professors in particular at Wharton that --

Farber: Yeah. There's Jerry Faulhaber. Give me a minute. There are about four of them. I realize I just went there about a month ago. I can send you their names.

Pelkey: Maybe one of the things we could do is, maybe in the future, after you get settled in, maybe I could come to Philadelphia and we could have a dinner or a lunch or something and we could all chat about this, because that's an interesting -- that's an area of great interest to me and it sounds like it is to you as well.

Farber: It is to me. I'll make sure I send you their names.

Pelkey: I believe you've answered most of the question that I had, in terms of the history of developments and, when you came to Delaware. Is there anything that was significant in terms of how you pressed forward some of these kind of communications things I'm working on?

Farber: Oh, yeah. Well there was a second generation DCS which was built here, which actually is still being used in Belcorp and is in some of their products. My interest in local networks, here and at Penn, will be heavily in -- what I tried to do is pick a design point --

Pelkey: Right.

Farber: Where everything we know how to do breaks. I want to pick the speed where I don't know how to build switching fabrics that operate at that speed, but its not a factor of two away. You can build fabrics that run at 300 megabits packet switched so I'll pick 500. Protocols: all our protocols collapse. You're just not going to run ISO over those speeds; all our abilities to bring things in and out of machines collapse. We don't know how to do it, although we're closer there. And the applications just are not there. I don't want to Telnet across at those speeds. So it boosts everything up to an area where things are wide open; and it's basically where we were back in the '70s, early '70s, with networking. A whole new set of games, and what I intend to do is try to explore a significant part of that. For instance, in the applications, there are some real sweet ones in the medical business that are real. They may even contribute to society, heaven for bid. Distributed collaboration in the general sense of the word. Not picture phone.

Pelkey: Right.

Farber: There's a case, by the way, where one of the early things we were going to do, courtesy of a guy at Wharton, at Annenberg, who kept beating me over the head saying: "Will you stop giving me technology. Let's go out and look at organizations and find out where the problem is, and then find technology that will solve that problem, and that way we maybe can succeed," cause the argument of the old picture phone problem was it solved a much, needed gap. It filled one, but you don't want to fill gaps that you need. And that's one of the things we're going to do over the next six months is go in and look at business and look at structures and say, not so much me because that's not my bag, but those guys, theoretically it is their bag, where are the problems?

Pelkey: Yes.

Farber: And now where is there technology that can be put in place to solve those problems. And if that works, then we may in fact generate the business rationale. Right now, I think its important is to explore those boundaries, I don't think our communication companies will do it.

Pelkey: I agree.

Farber: There's no perceived market. It will be done, but not here.

Pelkey: I'm afraid you're right. Thank you so very much for your time.

Farber: OK, good.

END OF THE INTERVIEW