



Interview of Charles Bachman

Interviewed by:
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Recorded October 26, 1988
Cambridge, MA

CHM Reference number: X5671.2010

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James Pelkey: Maybe you could start off by sharing how you got involved in this whole process, your intellectual roots relative to coming to this process.

Charles Bachman: Let me go back, Jim, if I can. By the time that I became involved in the standardization activity for data communications, I was working at Honeywell Information Systems in Boston, but actually part of the Phoenix organization advanced development group based out there, and I had been heading up a group within Honeywell for several years who were defining what Honeywell called its HDSA, or Honeywell Distributed System Architecture. This was a project that was designed to provide the kind of processor-to-processor and processor-to-terminal protocols necessary to connect an arbitrary number of machines and an arbitrary number of people together, and provide the basis for the way we thought people should be doing applications systems. Even at that time in the project, they understood it was in competition with [Systems Network Architecture] SNA, which was IBM's hierarchical approach to systems. For a long period of time I had been involved in projects that essentially were network oriented: database networks, or network databases (in contrast to hierarchical databases, which was the IBM thrust) where you had to recognize the need to be able to interconnect things in an arbitrary way, without having any one particular processor or terminal in charge. These were designed to be peer protocols, where everyone who was willing to come to the table and behave according to the rules was allowed to talk to anyone else who played by the same set of rules.

Pelkey: What year was this?

Bachman: This started probably about 1975.

Pelkey: Because SNA came out around '76.

Bachman: Well, about the same time, because the SNA discussions -- I had heard SNA presentations and knew what they were talking about, and had learned from reading about their materials, and I had been involved in earlier projects with Honeywell and GE before that, recognizing that we had created databases which allowed all kinds of interesting things to happen, but we did not have the means by which people could access those databases in a transaction-oriented mode that people were interested in and that businesses were interested in. So the Honeywell project began in roughly 1975 and proceeded and it developed quite a well defined set of specifications. In fact, the Honeywell specifications for HDSA were those which I used -- actually in the winter of 1978 -- to put together what was the ANSI proposal for ISO SC-16, so during -- let's see, it was actually the fall of '77 and the winter of 1978 --

Pelkey: It was winter of '76 I think. I think you put the proposal forth in March of '78.

Bachman: March of '78, so it was the winter of '77 -- I mean, the fall of '77 that these things were put together. It was the basis of, first of all, the ANSI committee put together an ANSI SPARC study group on Distributed Systems, which was the group that formed the foundation for the American delegation to the ISO committee, so at that time, there was a notion that distributed systems are different than open system interconnection.

Pelkey: Was this distributed systems group under ANSI a standing body?

Bachman: It was a group that was created in response to the establishment of SC-16, when SC-16 was first proposed at the Melbourne meeting of ISO TC97.

Pelkey: Do you remember when that was?

Bachman: I think it was November '76. It was a year and a half before we met for our Washington meeting. And at that meeting, if I understand the history of things, the British delegation proposed the establishment of an open system interconnection subcommittee, which was fought by the US delegation as being unnecessary and overruled by the rest of the people there, and therefore SC-16 was established. What happened to those things is that having established it, the next question is establishing a secretariat for such committees. Now the secretariat really represents some administrative offices

within the standards organizations, which would handle the administrative side of documentation, call for papers, and typically provide the chairman for the committee. So after the SC-16 was brought into existence, there was a struggle for control over that committee. The British wanted to be the secretariat and the US, having lost the notion of killing it, decided it wanted to be the secretariat because it knew so much better about these things. So it ended up that the United States was given the secretariat's responsibility of that group.

Pelkey: There was an SC-6?

Bachman: SC-6, yes, which is also part TC97, which was the data communication group which was already in existence, and the group that, in many ways, should have done what SC-16 was asked to do, and in some sense, the establishment of SC-16 was a recognition, I think, of the failure of SC-6 to do anything. SC-6 was basically a group of telecommunications people, out of the background of communications; PTT type communications folks who had never been involved in, let's say, computer-to-computer communications. What the British group wanted was to be able to set up the full set of protocols to do computer-to-computer communications, or computer-to-terminal in such a way that arbitrary things could be connected together.

Pelkey: And the people that were part of IFIP 6.1 were working with SC-6, correct?

Bachman: Yes. I didn't know that group well at all.

Pelkey: Because that was a group that was the Vint Cerf led group, the 6.1 people.

Bachman: Didn't know those people at all.

Pelkey: As I understand, they were working with SC-6 on HDLC and those sorts of issues, but in fact, had not been very successful in understanding how to get to SC-6 and to move forward.

Bachman: Well, they didn't even understand that HDLC, or SDLC, which is the IBM original, was not really a protocol. It was a combination -- it was really an interface. Those are pretty fundamental things, so they struggled and really had not done anything in several years.

Pelkey: Do you know who led the British delegation to go around and get SC-16 established?

Bachman: I do know the name, now where can I find it? There was a man that was -- maybe the name will come to me, but I do know the name. I've met him a couple of times, but in the process of putting all this together, he was the initial person from the TC97 group. He was not active in SC-16 itself.

Pelkey: So he was lobbying at the TC97 level for the establishment of the separate study group -- subcommittee -- to focus just on computer-to-computer communications.

Bachman: Well, open system interconnection and all that implied,

Pelkey: And was that a phrase that was used then, 'open system interconnection?'

Bachman: Yes, from the very beginning, that was the title that the British proposed for this committee.

Pelkey: Was that a common expression at that point in time?

Bachman: No, I think it was something they invented. Essentially, what they were saying, any system that opened to this standard set of protocols would be able to play the game, and that as such, it was not proprietary. It's a public system that anyone could connect to.

Pelkey: So, after the Melbourne meeting in November of '76, some time elapsed before the secretariat was actually selected?

Bachman: Well, it took a while until the secretariat was selected, and then basically it took a while, essentially, to tell the world that something needs to be done, because it takes some work before you have your first international committee. So there was a group established under ANSI, in fact a study group under ANSI SPARC, which is their Systems Planning and Resources Committee -- goes by the initials S P A R C -- and they set up this distributed systems task group, and I was asked to chair that group. So, as the chairman of that --

Pelkey: Now, ANSI was part of ISO at this point?

Bachman: It was the US organization, which supports ISO activities.

Pelkey: Ok, so it was natural for them to be the body that would be concerned with who would be the delegate, and to be the -- at the ANSI body level was where the argument for 'who's going to be the secretariat?' was held.

Bachman: Actually, ANSI was the group that asked to be the secretariat, and the British standards organization asked to be the secretariat also. ANSI is the one that won out and ANSI became the secretariat, and they are secretariat for several of the standards committees. They have headquarters in New York and they have professional staff; people who are professional secretariats who handle those types of things.

Pelkey: Now how did you get to be part of this SPARC committee?

Bachman: The basis for this is that the people on the SPARC committee knew who I was. I had been involved in an earlier SPARC study group on database management system, which had put together an earlier architecture to tell how all the pieces of a database management system worked. It essentially established a group of layers of interfaces. You didn't talk about protocols then because there wasn't a communication aspect, but the earlier work on database management system really provided the prototype for the architecture of the seven layer protocol, so in fact, I just happen to have one here in my desk. I brought it in to show someone the other day.

Pelkey: You were saying Jerry Foley --

Bachman: Jerry Foley was from Burroughs, and had been on SPARC. He was a member of the SPARC committee, and started out as kind of the den leader, essentially getting things started up. Then I was, between the first and second meeting, I was appointed the chairman of it.

Pelkey: And you were mentioning that, in addition to Tom Steel, Dick des Jardins, John Day, John Ashton Brenner from IBM, and there was another IBM gentleman who had been on SC-6.

Bachman: Let's see if I still have this little thing indexed by ANSI . . .

Interruption in the Interview

Pelkey: . . . During that fall of '77, the SPARC committee started putting together the US position?

Bachman: Yes, that's right, and that was put together based on the Honeywell position. Essentially that was all done and documented, so we had a coherent plan to present to the committee and that's what we took into the meeting in Washington, DC, which was the first meeting of SC-16.

Pelkey: Which was in March of '78.

Bachman: It seems to me it was the end of February, but maybe it was the first of March. I don't remember the date precisely.

Pelkey: At that meeting, I'm led to believe that at some point you put forward the US position –

Bachman: That's correct.

Pelkey: And there was also an attempt to break this SC-16 into three committees.

Bachman: Well, we made working subgroups for it. So there was an architecture group, which Hubert Zimmerman headed up; there was a -- I'm just trying to remember what the names were -- there was a group that was headed up by a man from England, Alwyn Langsford. [Leafing through some papers]

Pelkey: Yeah, he was upper layers, and lower layers was George White.

Bachman: George White. George was with the National Communications System.

Pelkey: So you created these three working groups, and you also put forward the US position, which happened to be this layered approach –

Bachman: Layered approach.

Pelkey: -- which was six layers, as you were saying.

Bachman: Yes, and the layer that wasn't in the original six layers was the bottom layer, which is the physical layer. So you think about someone coming from the applications level down, somehow he gets down there somewhere, I'm not sure what happens down there – and Hubert Zimmerman was the one who proposed to have a physical layer -- how do we know to put pulses on wires and things like that.

Pelkey: Now, I'm told that after you put your document forward and you took your work groups up, and that one group, the Hubert Zimmerman group, I guess, or some group of individuals, who had been somewhat familiar with how other things worked or for whatever reasons -- maybe you can give me some insight into what you thought their motivations were -- stayed up quite late that night putting something in writing that was handed back the following morning.

Bachman: Oh, the purpose was to put together an overall proposal, an architectural proposal, and that -- essentially, I guess in one sense, the purpose was to make what I had proposed and the US delegation proposed something, into an international proposal; essentially something to make it their own. Hubert Zimmerman was really the lead person in doing that. Really, he was one of the very most important people on that committee, maybe the most important person, in terms of the contributions to it.

Pelkey: So that night was a late night for some individuals?

Bachman: Well, those nights tend to be late nights, always. Other late nights -- the next meeting we had was in Paris, and we spent one night until, I guess, 2:00 or 3:00 in the morning updating the text of this thing and getting it copied -- I think five or six, maybe seven of us all rode home in Hubert's Deux Chevaux, which is not a very big car. We were all piled in on top of each other, having printed 120 copies into the wee small hours, collated them and stapled them. The group just worked very hard. It was a very good group of people, and so we went through, basically, a meeting every six months, which is twice what SC-6 ever imagined they could do. They said: "Well, you can't get all the work done."

Pelkey: What was driving you to do it this fast?

Bachman: It was important, and I guess my intent was to get the thing done, put it and place so people could use it. There was a need. It wasn't a hobby to go off to these meetings. The purpose was to -- if you're going to do something, get it done, so I pushed the group hard. We made very demanding schedules, one that was not, in the course of what ISO works at all, and everyone was -- some of us were unhappy because we were sending copies unofficially from delegation to delegation, instead of sending them through the secretariat who could, on his own time, could reproduce them and send them back out.

There was a group of people who felt "it pays to get the job done." It was a very big task, and it took some doing to get it done. I think there were 14 different nations involved. Getting everyone to understand the notion of a layered architecture and the implication of how things work and how they go together.

Pelkey: This concept of putting a framework together, the seven layers, versus just going and saying: "Here's what the protocol is going to be, here's the way it's going to work," was a different approach to the problem.

Bachman: In fact, it probably wasn't a different approach. It was a new approach in the sense of trying to identify all of the layers on which a protocol had to work. There have always been protocols, 'how do I signal down a pair of copper wires?' and if you think -- the HDLC is another protocol, it divided some things, and essentially what we did is take a very thorough case and look at this and said: "What we have is a need to signal at different levels, where each level in the architecture has a function." The lowest level, the sort of 'how do I get some kind of pulses over some kind of media?' and each level, well this level adds something to the contribution, but there was always that notion that at each level there was a connection from the sending party to the receiving party, and a set of rules by which they carried out their task, and what you'd do is you'd move up a layer, you essentially -- the purpose is to improve the quality of the communication, providing recovery and restart mechanisms. One thing is how do we get from one end to the other end of a pair of twisted wires, how do we get from one communication switch to another communication switch, and how do I get from one end of a network to the other end of the network, how do I get from one computer to another computer, and eventually, how we get from one application to another application? Each of these things had its own scope and responsibility.

Pelkey: But, if I understand correctly, it was different to do that at that point in time, was it not? You were taking this more comprehensive, global view of things. Before that, using the example of HDLC, it was much more confined. They were going to do this little thing, where you were saying: "Here's the more global approach to it. Here's where we're -- " and people are going to define, specifically, within each of these layers --

Bachman: Well, I think part of the answer is that starting from the position of someone who was involved in writing applications programs, you say: "Ok, starting from where we are at the top of the thing, we've got to go down until we get down to the ground." So you start to bite it off, you can say: "here's another layer, here's another layer," you don't know where you're going. We knew where we were going. We started with where we were going and worked down to meet where the communication people were, so we didn't need to invent new ways of twisting wires together.

Pelkey: Which is really, at some level, how the user orientation -- coming into this process -- what you were saying before about SC- 6 was really the telecommunications people, the telephony people, looking at the world, and here SC-16 became one of the application people looking at it and saying: "Ok, we know we've got to talk to all that stuff that's down there. Let's figure out how we view them in a logical, coherent way."

Bachman: That's right, and as I said, we had done the same thing in this database architecture. We had established seven layers there, and if you looked at existing software systems, they were layered, even though one may not have been designed specifically that way, where each layer, in effect, carries out a certain transformation from a logical concept to a more physical concept, and you go layer to layer down until you get to something which is purely physical; 'how do I put pulses on a disk or how do I put pulses on a wire?'

Pelkey: When you brought this proposal of the US delegation forward, was it received positively?

Bachman: I think almost everyone -- I'd say we probably had unanimous support of the concept of a layered architecture right from the beginning.

Pelkey: Why do you think that was?

Bachman: I guess because it fit, almost fit everyone's reality. There were many issues to be talked about, and to make sure that when we got from a general consensus to something which was very precise, but it didn't conflict with anyone's basic notion of what the problem with the world was. In fact, it gave them a point that we could rally around. We could work in parts on the different things, and in fact one of the committees -- or working groups -- which was Hubert Zimmerman's architecture group, the whole notion of what do we say, in general, about each layer, in terms of connections and establishment of connections and how do we name things being passed off, so what we tried to do, we established a set of generic names. There was a connection, then there was a physical connection and the link connection and the network connection, and each level your connection was qualified by the level name, so we could talk about six or seven different levels, and not have six sets of objects to deal with. We had the same set of objects at each level, and therefore we had -- but basically the same things to encode.

Pelkey: Were the names of these layers, did they come on pretty early or was there much discussion of debate about the names of the layers?

Bachman: No, I guess the only one that -- the link layer became the datalink layer. A few things changed, but most of them pretty much were there from the very first.

Pelkey: The one layer that many people said that they had concern about was this thing called 'Presentation Layer,' that somehow that, and the application layer -- a lot of people were concerned with that particular layer.

Bachman: I guess it was a world that had no meaning to the communication folks, and in fact, in the database world -- in fact, probably if one looks at the ANSI historic work on database management, one of the critical things they start out with, they say: "Well, we have to handle the problem of," what they call data independence, so that someone could evolve the physical storage formats without affecting the programs that are accessing the database. So what you were looking for is some way to treat the problem of the independence between data as spoken by one person and spoken by someone else. In an extreme case, you say: "Well, somebody wants to send things in ASCII to someone who wants to receive in EBCDIC," and yet the information is the same, and so the purpose of the presentation layer was essentially to do whatever translation is necessary to get it from the sender's information format to the receiver's information format. It's the kind of thing that most people didn't worry about. They say: "That's a programmer's problem," and yet, having come out of an environment where that was a critical problem, if we're going to have interconnectivity, the ability to shift things from one format to the other and have something in charge of that.

Pelkey: Now, after your first meeting -- you're saying you had this hectic pace of meeting every six months and sending documents directly to each other, not through the secretariat --

Bachman: Well, the secretariat, but also sending other copies directly.

Pelkey: So it was a very frantic pace for this kind of an organization. Were there any particular meetings that stood out in your mind as being important meetings?

Bachman: I guess not. I think every meeting was important. They were all making progress. One of the things; always you have new people at these meetings, so you spend part of the meeting getting people on board to talk about it. I guess the meetings that have become the most important are those when the reference model first got approved.

Pelkey: Was that the Berlin meeting?

Bachman: I couldn't really tell you that. The meetings have become blurred over time.

Pelkey: I might ask you to try to remember. I've been told that the Berlin meeting was one where there was this issue of finally, there had to be an approval of the seven layers, and that the US delegation stood

up first, and basically did not say yes but did not say no, and then some British delegate stood up and essentially said -- it was the first meeting he had attended, stood up and said he had his people look this document over, and the seven layers, and they basically told him it wasn't worth the paper it was written on, and the other delegates, having spent the last couple of years of their life working at this frantic pace and having spent a large number of hours, all kind of looked at each other, with this person saying that what they had been working on had been a waste of time, and that vote was called almost immediately and passed. Is that a romanticized notion of it? Does that jar your memory to help me?

Bachman: The Englishman's name was -- where is his name in here -- anyway, the English guy was part of the professional staff at the -- Mike Purton, British Standards Institute -- and the English had a perverse way of being right and wrong, in the sense that they were the beginning force that said: "We need standards," and yet the fact that we wrote the document in American English, not English English, bothered them. The document wasn't as elegant, in some ways, as it might be, so Mike Purton gave his infamous speech, as you say, which was so annoying to people that they said: "Ah, bullshit." Of course, I think you have to understand that the US delegation was always reluctant, even though if I analyze the way we tried to move that thing forward, it was not just the US delegation. It was all the delegations of the world who essentially represented the PTTs of the world plus their -- typically -- that country's one computer company, and said: "What we need if we're going to succeed is something which we all can play on a level field. We want a set of standards we all can work to," where essentially, the real opposition was SNA . . .

Tape Side Ends

Bachman: . . . against standards there, here there they were against those standards.

Pelkey: In fact HDLC never could get through until their SDLC was finally agreed to as well, so the US delegation, because it had these IBM representatives --

Bachman: IBM and Burroughs weren't sure they wanted standards. Honeywell wasn't sure they wanted standards, except that I said: "You do want standards," because in the beginning, the Honeywell management, when the issue came up, I said: "We should participate." They said: "No, we're not sure we want something which is a worldwide standard," because they were more concerned about losing sales than getting sales out of it. In fact, the way I got Honeywell involved is I talked to Madison and said: "How would you like me to be chairman of this committee?" And he said: "I'd love it."

Pelkey: Good for you.

Bachman: Because I felt strongly that these open systems interconnection issues --

Pelkey: Was in Honeywell's best interest and the industry's best interest.

Bachman: You know, the user's best interest. So I put myself into that situation, and IBM said it was inappropriate to have me as chairman of this group because the chairman should be neutral, sit there, and administer the thing and should not be a protagonist for anything. I was an aggressive chairman. I had a mission, and for a while we had a Honeywell delegate in the UK delegation, and in the French delegation, the Italian delegation, so that we had the Honeywell people coming, just as there were IBM people in all these delegations. ECMA was very, very important, because ECMA was working on their own drafts of the same thing, and again ECMA tried to provide a power equivalent to IBM.

Pelkey: But ECMA, were they a representative to SC-16, or did they only come through the country delegates?

Bachman: They came through the country delegates. They also came -- there were some observers, like CCITT had an observer there.

Pelkey: So ECMA had an observer. Also CCITT had an observer? Ok.

Bachman: Yes. There were people that work in the ECMA part -- they were working between our meetings, in ECMA, to try to bring the thing forward, and they were working both on the ECMA team and the -- and there were also, same way, there were people that were on CCITT teams working parallel. So one of the things that was most marvelous is that CCITT adopted documents that are almost identical to the ISO documents, so there wouldn't be any split between them. "There is only one way to do it, it's this way." So the CCITT was very cooperative. We had people working on the lower end of the protocols who were on SC-6 and were on CCITT.

Pelkey: So some of the SC-6 members were both SC-6 and SC-16 --

Bachman: And CCITT, worked all three committees.

Pelkey: If we could come back to this Berlin meeting, because I want to characterize that meeting in this book. Did the US delegation stand up and actually say something? I guess there was a process of calling for a vote, or a recognition that you were going to have to vote, in this meeting, whether or not you approve it and pass it on to the next stage of that standards making process. So everybody came. Were there a lot of people at this meeting?

Bachman: Well, these meetings are all typically attended by between 100 and 120 people, with the delegations from -- typically, we had US, France, Great Britain, Germany, Italy, Holland, Australia -- not Australia, excuse me -- Japan, Canada was always there, always had Sweden, Denmark was in and out, Norway was in and out, Switzerland was in and out. I think that was the first meeting the Chinese had shown up at, more as observers than anything else, but --

Pelkey: That must have been an intense meeting, knowing that this vote was going to be taken?

Bachman: You know, every meeting was intense. It sounds to me like you've been talking to John Day about it, because certainly John is about the best historian we have, and is the one who verifies -- probably better than I can -- because every meeting was important, and every vote was important. We had some of the humorous things along with this -- one of the rules of the ISO committee is that there are two official languages, French and English, and therefore, whenever -- the official part of the meeting -- there were working parts and the plenary parts -- the French would always give their speeches in French and then translators would translate it, but Hubert Zimmerman, who was the spokesman for the French group, would always write his speeches in English and give them to the translator, then he would read the English one out loud in French. He'd translate to French as he read it, but he wanted to make darn sure the words were right in English. So we had some of those humorous things. Another kind of humorous thing, along the same line, is that when we wrote the standard -- in the English language, there typically is a Latin based word and an Anglo-Saxon based word for everything. Well, we wrote everything using Anglo-Saxon based words because the translation was almost automatic. The whole notion of having to be able to translate this to French and do it straight- forward, we just picked those to make it easy.

Pelkey: Not to belabor the point, but that meeting, after Purton's infamous sour speech, was there a call for a vote relatively shortly after that?

Bachman: I couldn't answer that question.

Pelkey: But it was approved?

Bachman: It was approved as a draft specification, which was the next step.

Pelkey: And at the draft specification, what was the role of SC-16 at that point, once it went to draft level?

Bachman: Essentially, this is what went out for national vote and comment, with the intent being that people would then send back written comment about what their objections were, or what they felt was

missing, and that we would then incorporate those comments in the document before it was published in its formal form. So it was official notice to the world that we've got something we're proud of.

Pelkey: And were there very many comments that came back from this draft?

Bachman: Quite a few, but they were mostly trying to clarify things. I think all of the comments were, in essence, constructive comments. "You'll have a better document if you do this, and this, and this to it." In that mode, I think it was very positive, and did, at the next meeting, get approved.

Pelkey: And when did it become approved?

Bachman: I couldn't tell you that date anymore. It's lost.

Pelkey: What did your role become?

Bachman: Well, the last meeting that -- the meeting I resigned as chairman at, was at the Tokyo meeting, and that was in '71, I think.

Pelkey: You mean '81?

Bachman: '81 or '82, I'm not quite sure. What I had been doing, the product we're building right now is something that I've been working on on a part time basis, I just wanted the time to start working on it on a full time basis, and I just felt I couldn't give both projects the attention they needed. I felt that that group was well launched and on its way, and I had made my major contribution to it.

Pelkey: Let me ask you a more general question. The ARPA community was not telephony people. They weren't CCITT types, they weren't PTT types, they weren't American AT&T, they were computer scientists and so on wanting to be able to send data from one computer to another using something other than circuit switching. Those people really didn't participate much in this.

Bachman: I think their legacy was the packet switching that came on through as part of the definition of what happened at the network level. Those people -- you know, Louis Pouzin was very active in the beginning, and he was kind of a spin-off of the ARPA thing. He put together the French Cyclades network, but for some reason, I don't know why, they evaporated, and I guess, in part, maybe they evaporated because they were computer types and not -- computer science types and not information processing types. So what happened -- they'd solve their problem, of being able to use electronic mail between researchers, but they typically -- computer science types are not data oriented. They're not worried about how you set up transaction systems or access remote databases or things of that type.

Pelkey: Do you have anything that stands out in your mind, other than for the fact that this is obviously a very significant accomplishment. It's hard to go anywhere these days without seeing the seven layer model. You must take some satisfaction from that.

Bachman: Oh, a lot of satisfaction from it. In fact, as I look, there are certain roots that are associated with the current product we're building, and you say people have trouble understanding what the presentation layer is and what the application layer is. In some sense, what our business is today is how to tell people how to build their application system, and how to choose the kind of tools to do that, so in fact, we probably are dealing with the seventh and eighth layers in our business here.

Pelkey: It seems to me that if you start to look at the application layer, the things that are happening now, relative to EDI and X-400 and network management, and at the application layer, we almost need someone to start the process of looking at how you layer this seventh and above layers, because you have this very nice, orderly architecture from seven down, and then when you get to the point of having to look at what's happening at the seventh layer, all of a sudden it starts to look like an amoeba again.

Bachman: I think that's what we're doing right now, in fact, one of the major things I did before I left the ISO work is that I made some recommendations about what TC97 should do to essentially get the database work integrated with communication work, because it was kind of stumbling around and being, actually, handled by SC-5, which is the programming language group, and which was really stalled. So I put together a report which was presented to TC97 recommending that they essentially take what SC-16 was doing as an architecture group and say: "Ok let's look at the architecture of how data storage and retrieval comes into the same thing." In fact, there's a parallel set of layers that deal with, essentially, coming out of this work, layers of data storage and retrieval, which has a physical layer and a -- very much similar layers -- and a presentation layer, and one of the things they did, they restructured, and in fact have passed to -- I forget the name of the new one, SC-23 or SC-21 which replaced SC-16 -- which has the joint responsibility now of looking at architecture, handling both the reference models for Open System Interconnection as well as for data storage and retrieval so they could essentially bring them together, so there was a meaningful way to look at -- put all computer standards in their place, where they fit -- so that we looked at data storage and retrieval as being down the same parallel set of thing. Then there's these other layers dealing with "how do I develop programs?" and today, we talk about, in our product, we deal with what we call 'the implementation level,' and then a specification level. Implementation level really is where -- is the seventh layer of the ISO protocols -- that's where the application really works. The eighth layer is where I define what I want to do independent of any particular database management system, or any data communication system, or any programming language. The way to specify what you want in a canonical, or generic, way, that will let you then forward engineer to whatever target you want to run it on.

Pelkey: Good for you. I have no other questions.

Bachman: I hope this will provide some fuel for your document.

Pelkey: It has, and I greatly appreciate it. Thank you very much.

END OF THE INTERVIEW