Charles Bachman
1973 Turing Award Recipient

Interviewed by Gardner Hendrie
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Video Interview Transcript

GH: Gardner Hendrie, interviewer

CB: Charles Bachman, 1973 Turing Award Recipient

GH: …Alright. We have here today with us Charlie Bachman, who's graciously agreed to do an oral history for the Computer History Museum. Thank you very much Charlie. I think I'd like to start out with a very simple question: What is your earliest recollection of what you wanted to do when you grew up?

CB: Well I guess the best answer, I don't really think of any early recollection...

GH: Okay.

CB: …about that. I just kind of grew into it.

GH: Alright. Now I have read that you decided to become a mechanical engineer relatively early. How did that come about? What influenced you to make that decision? And when did you make it?

CB: Well I grew up in East Lansing, Michigan, which is the heart of General Motors and Ford and Chrysler, building automobiles. And so you thought engineers were people who designed cars and things that go with them, and that's mainly mechanical engineering. So I just somehow thought that was the general course you took in engineering; if you didn't know what kind of engineer you want to be, you do mechanical engineer. And so that's what I did.

GH: Alright. But what led you to think engineering was what you would like? Were there courses in high school, or other influences that led you to say, "I think I want to be an engineer"?

CB: Well... only thing I can think of in high school is that the man who had taught mechanical drawing was a good friend, and was also the shop teacher and track team coach. And I was on the track team although I didn't run very fast, but I had a lot of respect for Mister Adams and what he did for us. And so probably there was some influence in terms of engineering that came from him, and his talking to us.

GH: Okay. I would like to focus most of this interview on your particular accomplishments. But the thing I'm most interested in is not precisely what you did, because that's very well documented, but where did the ideas come from and how did you end up deciding to do what you did? So maybe I should start with your time at Dow; that was your first job, correct?

CB: Yes.

GH: Okay. What experiences in Dow led you to start thinking about databases and the IDS that you eventually came up with?

CB: Well when I started working for Dow Chemical, they assigned me to a job in the engineering department. A big room with 150 engineers and big tables you could sit on your stool, and stand beside your stool with your fanny hanging out on your stool, and drafting board. It was an engineering school, engineering room. And so when I arrived there, I ended up getting several assignments all which related to information systems, for which I had no expectation. In fact the first assignment given to me by my new boss, was he says I got two valves that are going in a new water line, carrying water out to the far side of the plant, and one water valve costs five thousand dollars more than the other. And five thousand dollars then would buy you the nicest big Cadillac you might imagine. And I said, "Well I don't understand this." They said, "Well these are both 12-inch diameter gate valves that open and close, and the difference between the one and the other is how streamlined it is." So will it take a bigger pump behind it pumping water, or if it's small streamlined a smaller pump, less electricity, and therefore more efficient. And there was no scheme at that time in engineering practice that I could find that told me how to compare pumping water through this thing for 40 years, versus putting five thousand dollars more into this valve and save that money.

GH: Mm-hmm.

CB: And so as in many ways in my life, I had to reinvent something, because a lot of things have already been invented. And so I reinvented what turned out to be discounted cash flow.

GH: Okay

CB: So 20 years of this extra electricity pumping water, or five thousand dollars now, put your money down and take your benefit. And so that for the first project was an information system, and next project after that was another information system.

GH: Do you have any idea why you got assigned that, as opposed to one of the other 150 engineers sitting in this room?

CB: Well I don't really know why I was given that assignment to work for Aaron Brooks, but he was in charge of steam and power engineering.

GH: Yes.

CB: Because the company generated a lot of power and steam, steam for heating processes and power for the electrolytic processes I had. And I guess he had no-- well he had no one working for him directly at the time that I arrived on the scene, so it must be they felt that he needed help.

CB: And I had this mixed kind of a background, both business and engineering, although I don't know if anyone gets credit for that or not.

GH: Okay.

CB: It just happened.

GH: Yeah. But it may have been that he had seen your resume and he know that you'd been to business school also.

CB: Right.

GH: Yes.

CB: Well so that was kind of the start of it. Also part of that question is if you're going to do discounted cash flow, what interest rate do you discount things at?

GH: Okay.

CB: And so I was sent off to Carl Gerstacker's office, he was the treasurer of the company, and said, "Well what return on investment do you want?" He says, "The board of directors decides that." And I said, "That's very nice, but the engineers are deciding it all the time. Can you help them?"

And so we agreed that in the future, each of their big projects would have a target interest rate assigned to it by which we could do this discounted cash flow work. And so when this project was finished and I got off it, Carl Gerstacker called and said, "I'd like you to come down and talk to me." And he offered me a job in the finance department doing a real bona fide information system, looking at cash flow in the treasury and how much was invested in plant number one, who made the intermediate products for plant number two, for plant number three. For instance you may not think of aspirin as it's at Dow Chemical, but they make an enormous amount of acetylsalicylic acid, which is aspirin.

GH: Yes.

CB: And they said, "Well how much investment do we have, let's say for a ton of aspirin per year as a capacity?" Or ten times the-- And so I said, "Well..." He said, "Can you work on that?" And I said, "Sure." So I picked up a few things and belongings, and went downstairs and went to work for the finance department.

And in those days if you solved problems, you solved problems using punch card equipment. So I started working with the people in the punch card department, I started collecting all the cash investment things that they had, in terms of both, you know, some investments 20 years ago, 40 years ago. And they want to know, "Well what return on the original investment, just without any discounting, how much on--" If you do a discount at the rate the engineering index has come down.

GH: Right.

CB: So then I could use that amount to calculate how much went into... from the salt wells, which are part of the chlorine production system, and the steam and power plant that made the electricity to separate the salt into chlorine gas, which went into monochlorobenzene, which went into salicylic acid. It helps, so how much capital behind this?

GH: Yes.

CB: And it turns out that that was a-- doing the same as a parts explosion in a manufacturing plant, except it's going in the opposite direction. Think of it as going up, well in a parts explosion you think about starting at the top and going down.

GH: Yes, of course.

CB: But it's the same calculation.

GH: Okay.

CB: So I was experienced in doing manufacturing structures. And so it took me a year and half to two years, I can't quite remember how much, to collect all the plant statistics from Midland, Michigan, which is the biggest plant, to Freeport, Texas, and to the California plant out there, I can't even think of the town it was in now. But anyway, got all those investment figures to go in and use punch cards to solve simultaneous equations and serial equations.

GH: Okay.

CB: And...

GH: Yeah, so you learned how to do equations using punch cards?

CB: Yes.

GH: Yes, alright.

CB: And explaining it to the man who was doing the scientific computing, that had some kind of little paper tape computer, and he said, "They call that the method of the stupid statistician."

GH: Yes.

CB: And I said, "That's interesting, it's got a name, alright, fine." And so some years later I said, "Well I'd like to find out who did that." So I went on-- this is later when Google was alive, and so I Googled this expression, "The method of the stupid statistician." And I got only one response.

GH: Yes?

CB: That was giving the credit to Charlie Bachman.

GH: And you know that wasn't the right answer.

CB: Wasn't the right answer, but no one else had claimed it either.

GH: So just explain briefly, the method of the stupid statistician is...

CB: It's a method by which you start out and as a first approximation you say, "Well every plant uses its share of the plant behind it." So you get the little augmentations of its capital. And you just keep repeating the same cycle, and the numbers get bigger but they slow down and they finally come to the point where you can do one more calculation and it doesn't change, because you've fully gotten all of the capital out of the original power plant, or the salt well in this case.

GH: Yes. So it's the method where you just make an intelligent guess as to...

CB: Make an approximation.

GH: Yes. You see what the answer is, it isn't the correct one, you change that...

CB: Right.

GH: …and you keep working back until you've assigned the correct valuable to the variables in the expression, to get the answer that you know is the right answer.

CB: Well it doesn't change, therefore it must be...

GH: Yeah, yeah, when it doesn't change...

CB: You fully devalue...

GH: Yes, okay.

CB: …send the money through.

GH: Yeah, right.

CB: So that was a punch card system which I got involved in, and we had a punch card calculator that did six calculations a minute.

GH: Okay.

CB: A 602A IBM punch card calculator.

GH: Okay.

CB: But it worked, so we went back and forth between the tabulator and the collator and the calculator about 20 times, to get a number that was not sufficiently different than the one before.

GH: Okay.

CB: Then the accuracy, it has a meaning.

GH: Yes. And then you had your answer.

CB: Had my answer.

GH: Okay.

CB: And Carl Gerstacker had his result, and last I heard that method was still being used on an IBM... not a 709, it was a-- anyway, it's one of those smaller computers that Dow had... rented.

GH: That they now use.

CB: Well they now used them 20, 30 years ago.

GH: Yes, okay. Okay, 20 or 30, yes, alright. Alright, very good.

CB: It's a long answer to a short question.

GH: No, no, the answer often is much longer than the question is. Good. Now tell me a little bit more about your experiences moving ahead at Dow. I know at one point they actually were going to purchase an IBM 709, but had you done other computing related projects using their tabulator equipment before that?

CB: No, I had not.

GH: Okay.

CB: In fact, at this point when I finished this project on the capital allocation, I was given an assignment in the pricing department establishing prices for agricultural products. For which I had no algorithm in my mind to know how you price anything.

GH: Yes.

CB: So I did not feel comfortable in that job that I was doing anything useful, or I was contributing to what was going on.

GH: Okay.

CB: So I asked the man I was working for, I can't even think of his name at the moment... Baird [ph?], "Could I get a job in production? Because I have not worked in production." So he said, "Sure, why don't you go up and talk to Dr. Shudie [ph?], who is the head of the plastics production?" And Midland had a big plant making polystyrene, and making Saran and other plastic products. So I talked to Dr. Shudie and he says, "Yeah, we can put you to work out here." So I was given an assignment in the Saran production as a process engineer. Not that I knew much about processing but I showed up on the scene, and spent three or four months working on a project to improve the drawing process on the Saran granules after they're polymerized in a water solution. The monomer turned into polymer granules, and with the proper agitation you got the right sized granule, but then you had to dry it. So I involved a scheme of... whirlwind like a silo; you blow stuff in and a lot of air in with it, it dried it out and the dry granules fell out the bottom, and the other stuff flew around inside till they got dry and dropped out.

GH: Okay.

CB: And then an opening came in one of the Styron plants, the Styron 475, and I was offered the job of assistant plant superintendent. And this was a big-- what looks like a five or six-story building, with big chemical reactors and whatnot, and made a form of Styron plastic, which for most Styron is hard, brittle plastic. But this 475 version, they put butter-- not butter, put rubber into it, dissolved rubber into it, which made a tougher product. And so it had a big market for refrigerator doors. It could be colored, as all the plastic colors could be, but if you bump into it with something it would kind of back out of the way for you. It didn't break the glass or the dish or whatnot.

GH: Okay.

CB: So I went to work out there in that plant for several years, until I got called back again by Carl Gerstacker which led to the next step in my process where he called me and said he wanted me to come and talk to Dr. Putnam. Well Dr. Putnam was a-- well these are all Dr. this, Dr. that, but...

GH: Yeah, okay.

CB: And all out of Cleveland, like... Dr. Shudie-- excuse me, Dr. Dow in the first place came out of the academic world, came to Midland to make bromine from the bromine wells.

GH: Oh, okay.

CB: But anyway, they invited me down to Dr. Putnam's office, who was at that time the general manager of the company.

GH: Okay.

CB: And on the board of directors and... he was-- the president of the company at the time was Lee Doan, who was a son-in-law of the founder of the company.

GH: Oh, okay.

CB: So family was still running things.

GH: Still involved in running the company, okay.

CB: At least as a figurehead. And so anyway, I went down to Dr. Shudie's [sic] office, and they said, "We're talking down here about getting one of these big new IBM computers. And we want to set up a department to run it, and we think that you'd be the right person to head it up." So I thought that was kind of interesting, and so as we were leaving the meeting I turned to Carl Gerstacker and said, "That sounds very interesting, I would like to think about it." And he says, "No, you go to work Monday."

CB: So I was seconded.

GH: Yes, you were appointed to that job.

CB: That's right.

GH: Yes.

CB: And so okay...

GH: Yeah, right.

CB: So the next Monday I showed up on the scene and said, "Where do I sit? And who do I work with?" And they said, "That's your job to find out."

GH: Oh, my goodness.

CB: So that was in 1957, was my first time you said I was really in the computer business.

GH: Right.

CB: But the punch card business is the computer business...

GH: Yes.

CB: …at least as far...

GH: And it always has been, yeah.

CB: Information systems. They have to make decisions, they make calculations, you had to make them with a desk calculator or a slide rule... it's information systems.

GH: Right, okay. Alright, that's interesting. So when was this computer supposed to arrive? Had they ordered it yet?

CB: No, they had not ordered anything. That was part of my assignment, was decide what kind of computer.

GH: Okay.

CB: So early in the game I said, "Well I should go visit Sperry Rand, who make UNIVACs." In fact they weren't UNIVACs yet, they were Sperry Rands still at that point. And visit IBM and see what they're talking about, and get a little of their education program they had for executives. Although how I got to be an executive quite so rapidly, I'm not quite sure. So then I went first of all to New York City, and went to a one-week programming course there for the UNIVAC...

GH: Was it probably the 1103...

CB: 1104A.

GH: Was it one of the machines they had done in Philadelphia? Like the UNIVAC III?

CB: No it was another one, this was a Minneapolis machine.

GH: Minneapolis machine, okay. From the ERA group, yes.

CB: 1104A I think it was.

GH: Okay.

CB: So I took a one-week programming course, and then shortly thereafter I went to Poughkeepsie to the homestead, where they had courses for people they're trying to teach... that they should buy an IBM machine. It was selling IBM and not any particular machine.

GH: Right.

CB: So I went there for my week or five days of training, and went back and I was much more impressed with the computer that UNIVAC showed me. And so I was nicely moving in the direction of acquiring a UNIVAC 1104A, and acquiring a staff of programmers. And we came bouncing up against... June 1958, when I wasn't aware the US industry at that-- what was going on, but there was one of these downfalls. And Dow had had a number of years that they were hiring and hiring and hiring, and never had fired anybody. And all of a sudden they had a whole bunch of people that were getting paid that were raising their costs, and their revenue didn't match it and they said, "Well we have to go back to January '58, and everyone we hired after then has to go."

GH: Okay.

CB: Nice round number. And I said to Carl Gerstacker, "Everyone in my group, and I've hired 30 people, came in after January, 1958." And he says, "Well, we'll make a special rule for you. You have to let half of your people go."

GH: Okay. Well that's hard.

CB: And so I said, "Look, these people I thought were the best I could find, and experienced people and whatnot." But I did the best I could to make a decision. And so I thanked the unlucky 30 people-- half of 30 people, 15. And the next thing I knew, half of what's left were gone. Said, "Dow's not going to do anything soon, we're going to get out of here to somebody else who wants to start on their computer business."

GH: Right.

CB: So we staffed a big project for Chrysler down in Detroit, people...

GH: Okay.

CB: Because they were going to get a 709 that we had ordered, replace this UNIVAC 1103A, but the IBM pressure became such that we said, "We ought to get an IBM computer instead of a UNIVAC computer."

GH: Okay, so IBM talked at the executive level...

CB: Yes.

GH: …and convinced them not to follow your technical recommendations.

CB: Right.

GH: Yes. Okay.

CB: So anyway, I was down to a very small group and I said, “Well let’s just go to work, see what we can do with the people here, and then learn what their existing systems are.”

GH: Okay.

CB: So we got down to a group of four or five, six people, and with closer allegiance to the existing punch card people. So I started working looking at the marketing system to see how we organized things with punch cards to do the things that eventually I would do almost identically on magnetic tape.

GH: Okay, alright. And so what projects did you work on? What projects did management want to see done on their new computer, when they get it?

CB: Well we had very little guidance from management, they were expecting me to provide the management.

GH: Okay.

CB: But one of the projects that we got into, I think I made a contribution to, was that they were in the process of building a brand new steam and power plant on the West Side. And I had met John... Mauchly, who was involved in the University of Pennsylvania project.

GH: Right.

CB: And...

GH: Now he had left Eckert and Mauchly...

CB: Yeah...

GH: …when it was sold to Remington Rand.

CB: Yeah, Eckert left also.

GH: Yes.

CB: Eckert went to Boston, or-- you probably met him there. I did.

GH: Yes, I remember that.

CB: But John Mauchly had a project working with the Navy.

GH: He had become a consultant.

CB: Become a consultant.

GH: Yes.

CB: And he was helping them design what became a CPM.

GH: Mm-hmm.

CB: That's a system for which you could evaluate how long it takes to get something done.

GH: Right.

CB: And so we had the right position, we said, "Well if we knew all the information about how long to do step A and step B and step C, and step X, Y, Z, double X, double Y, Z, then we can figure what's the critical path?" CPM, it's critical path method. And so I went out to start talking to the design engineers and say, "Well how long's it take to do this?" And they just kind of want to cover up their faces and... "We don't make estimates, the construction people do." So the design people didn't claim credit in that job, so the construction people said, "Well we know more than anybody else does, but you want to know how long it takes to do job A, job B; that's kind of a hard number to write down. Can't we kind of give you a range of numbers?" And I said, "Well if I wanted say, with 5 percent confidence, how fast could you do it? And with 95 percent confidence could you really get it done then? And then 50 percent confidence." So I fitted a Poisson distribution to these three points, and I could calculate a formula for it and then I kept... reading about things about how to use random numbers. So I'll randomly select a hundred estimates out of each job based on its Poisson distribution.

GH: Right.

CB: And so then we ran a Mauchly software solution to calculate the critical path, and you got some numbers that were very optimistic, you got a couple of ways you could do it. And if you went to 95 percent out here you could say, "Well there's a lot of places there..." But people felt much more comfortable using the statistical approach, because it's not a hard, fast number. They say, "Well I only had 75 percent probability here, I only had 25 percent..."

GH: Yes, yes, I understand. The construction people, yeah.

CB: And so...

GH: And you could do that, you could get them to give you numbers that way. You couldn't get them to give you just one number.

CB: And so I was pleased that that seemed to work.

GH: Okay.

CB: And the program that I used to calculate what the Ellis Poisson distribution through the curve, was the first program I ever wrote. And the only program I wrote before I started the IDS project.

GH: Okay.

CB: So I was not quite what you'd say was an experienced programmer.

GH: Yes.

CB: Or I had one successful experience; that makes you very good.

GH: Right, oh yes. Now did you run this? You wrote a program for it, but did you run it on a computer?

CB: Well they had a 650 by that time.

GH: Ah.

CB: Out in the plant. So I went out to their 650 and...

GH: So you wrote the program from the 650.

CB: …one program for a 650.

GH: Okay, good.

CB: That calculated numbers.

GH: Yes, alright. Now did the rest of program that did the CPM, did you buy that from Mauchly? Had he written that? Or who wrote the overall program to...?

CB: Well the actual calculation came from Mauchly. And I don't know whether we paid for it or not, I don't remember.

GH: Yeah. You probably did, I mean Mauchly would want to get money for that.

CB: Reasonably guy.

GH: Yeah, yeah, exactly. Alright, very good.

CB: Now at the same time this period, which is in one sense a slow period between '58 and '60 when I joined GE, with the order of the IBM 709 we were qualified to join the SHARE organization. Which was a group of 701; not very many of those people, 704; lots of those people, and some people with 709s on order. And so I had a chance to go off and get involved, and I became the first chairman of the data processing committee of SHARE. Because most of them were engineers doing engineering calculations.

GH: Doing scientific calculations...

CB: Scientific, yes.

GH: …on those IBM scientific machines.

CB: Right.

GH: Yes. Now the 709 had not been shipped yet, right?

CB: Had not been shipped yet.

GH: Yes, okay. No 709s had been shipped yet.

CB: And it was supposed to be an advanced machine that could do... either replacement both for the 704 and the 705, which was IBM's business computer.

GH: Right.

CB: And so one of the things that showed up at that meeting was a man, Harry Tellier from GE Hanford, which was the Hanford Atomic Products Operation up in the State of Washington. Where they were operating the big plutonium plant where all the plutonium was made for the atomic bomb.

GH: For the Atomic Energy Commission.

CB: Right.

GH: They had the contract to run that plant, yeah.

CB: And they had an old... old, he must have been 35 or 40 by then, Harry Tellier who was running their data processing. And he was a former punch card installation operator, and he asked one of his people, "Can't we do something? Because we just seem like we're doing the same program over and over again, for every report we do. Can't we do something that we just write the one program and have it modified in some way, or...?" So he had one of his people sit down and spend about three months to write what became the 702-- excuse me, 705 report generator.

GH: Okay.

CB: And it...

GH: Well actually 702, because that's what he had, right?

CB: Yeah the 702, yes.

GH: 702 report generator.

CB: 702 report generator.

GH: Right.

CB: And in fact when they were there we ran the Dow Chemical annual sales reports on their 702 that year. Using their report generator we could essentially go through and describe what report we wanted on a paper, it looked like what the printer looked like, one column on the paper for every character on the punch card printer. And so I could recreate the reports in one week, this was authorized, we gave the machine time enough to run the reports and get back to Michigan, at no cost to us.

GH: Well that's pretty good.

CB: It was good.

GH: That was very cooperative in those days, right?

CB: They were very cooperative.

GH: Yes. And so you learned about it and you learned how to use it, and you saw all the advantages of it.

CB: Advantage of it. And so part of the thing we got started before I left Dow... to start the 709 report generator project.

GH: Ah, yes.

CB: Which became 9PAC.

GH: Okay.

CB: Which was finished about the time that I had left Dow Chemical.

GH: Okay. And did you do this as part of SHARE? So...

CB: That was done as a SHARE project.

GH: Yes, so various companies supplied people.

CB: Dow supplied a person, Union Carbide supplied and Phillips Petroleum... Pillsbury was another one. So there was eight or nine companies who put a project together, and actually we used a warehouse for an office in Long Island City for those people that were working fulltime away from home, and put together 9PAC. So I had experience in terms of building-- I wasn't working fulltime on that project, because Russ McGee took over the project leadership when we cancelled our 709 order. Because I was not authorized to be a SHARE member anymore.

GH: Right, okay.

CB: I wasn't a good guy anymore.

GH: Yes. You weren't invited to SHARE meetings anymore, yes.

CB: But anyway, so I had that experience additionally in terms of writing new-- I didn't write it but I designed programs, and knew what I wanted the report generator to do. Because we had an earlier report generator before it.

GH: Yeah, the 702.

CB: 702.

GH: The one from Hanford, yes. Yeah, so you'd seen what a good report generator looked like, so...

CB: Yes.

GH: …that helps a lot. Okay.

CB: So... at that time, late in the summer and the fall of 1959, I decided it's time that-- I wasn't going anywhere on this project at Dow Chemical, so it was time for me to find out something. So I...

GH: Now had Dow cancelled their order yet for the 709?

CB: They had cancelled it, yes, that's why I left SHARE.

GH: Yeah, okay.

CB: So I said, "Well I'll go talk to GE in Phoenix," where their computer department was-- also this was triggered by a Thompson Ramo Wooldridge connection I had through SHARE to interview there for a job, and then go to Hanford talk to them about a job. So I made a West Coast trip.

GH: And you had decided that you would talk to G-- how did you know about GE's computer department? Because they wouldn't be in SHARE, how did you...?

CB: Well GE was in SHARE... well GE was at that time a computer manufacturer, because they were doing the Bank of America Project.

GH: Right, yes.

CB: And they had a pretty good size-- but they also were the largest IBM commercial customer.

GH: So they were both.

CB: Yeah, both sides.

GH: They were on both sides, okay. Now I understand.

CB: So that Harry Tellier, the manager of data processing out in Hanford, knew about the project in New York run by a man named Ford Dicky. And he told Ford, "You ought to hire Charlie Bachman to do your project, because it's just what you need."

GH: Okay.

CB: And so Ford eventually got around to inviting me out to New York to visit him, because the New York-- corporate headquarters at that time for GE was in New York City. And so ended up... he hired me for the job.

GH: Now why did you take his job rather than...

CB: The others didn't offer me a job.

GH: Huh?

CB: They didn't offer me a job.

GH: They didn't?

CB: They didn't.

GH: Thompson Ramo Wooldridge didn't?

CB: Well Thompson Ramo Wooldridge said, "We can't hire you because you want too much money."

GH: Oh. Because Dow was paying you too much.

CB: Well no, it was too big a jump.

GH: Oh, you asked for a big increase. Okay.

CB: They said, “It’s too big a jump, we can offer you a job at a lower raise.”

GH: Now were they going to put you in their process control area, or just in data processing?

CB: No, this was there...

GH: Because I know they had a...

CB: No, they were building a computer.

GH: Yeah, they were building the RW-300...

CB: Yes.

GH: …for industrial control at this time.

CB: Well they also were working on the plans for a commercial computer.

GH: Ah, okay.

CB: And you would know the man who was heading that up, I can’t think of it right now.

GH: Okay, yes.

CB: But anyway, Ford Dicky offered me a job -- and we ought to at some point come round and talk about the project itself. Is this a good point to drop that in, in kind of the sequence of things?

GH: Yes. I’m going to ask you some questions about that...

CB: Okay.

GH: …I just want to finish up on the other...

CB: Okay, you go ahead.

GH: …places you looked. You went to the GE computer department too, is that correct?

CB: Yes, that’s correct.

GH: And what did they do? Were they interested in you or...?

CB: Not interested enough to do any follow-ups.

GH: Not interested enough to make follow-ups, or even make you an offer. What happened at Hanford?

CB: I wanted too much money.

GH: Again. There's this too much money theme coming. Did you interview with anybody else?

CB: No.

GH: No? Okay.

CB: So I interviewed with GE in New York...

GH: Yeah, so then you go to GE in New York, and what happened there?

CB: Well that's where, when I went there people were talking about ISP II, number two, Integrated Systems Project number two, there must have been a number one.

GH: Yes.

CB: And the number one project... I'll think of the man's name who headed it up, you know him for sure, went to IBM. But anyway, they did TABSOL, a table solutions -- which didn't really go anywhere, and so they worked for two or three years and didn't really know -- nothing clicked.

GH: Okay.

CB: But behind all this was the man who was the vice president of manufacturing for General Electric, and thought we needed-- "We," I talk as GE.

GH: Yes okay, that GE needed the...

CB: GE needed a generic manufacturing control system, because they had a hundred manufacturing divisions. And then right now he thought they had a hundred different projects going, each one building in their own manufacturing control system. And great expense and low probability of success. And they had had both experiences; too much money and not enough results.

GH: Right, okay.

CB: And so we think we ought to start over on this project. So the project was to create a generic manufacturing control system.

GH: And had it already been named ISP II?

CB: ISP II.

GH: At that point?

CB: That point.

GH: Okay.

CB: And Stan Williams was in charge of it. He'd come out of the power transformer division, and he'd come down to New York and was trying to put the project together. And so I came and climbed on board.

GH: Okay. Could I ask one question?

CB: Of course.

GH: Now so this was a corporate group that oversaw all of manufacturing for GE? I understand GE was very diversified, in the sense that the plant managers had a lot of autonomy to go...

CB: Yeah they did, yes.

GH: …do their own thing. So what was this? This was an overlay or a sort of organization?

CB: Well this was the group that looked at generic problems.

GH: Ah, okay.

CB: And did consulting. But they didn't do a lot of development on their own.

GH: Okay, alright.

CB: So this was a new thing that-- well bigger computers were new things.

GH: Yes, at that time.

CB: New tools, new opportunities. So this group, the only people there were people who had either been hired for the ISP I project, one of the men was still there from that project. When I joined the ISP II team, I was the last man in, so to speak.

GH: Okay.

CB: And I've told some people since then that I was hired to be the chief architect. I don't know that's true or not but I know I was the chief architect.

GH: You quickly figured out the…

CB: I was the one.

GH: That nobody else was going to do it, so that's what you were going to do.

CB: Right. Yes.

GH: Okay.

CB: So that we had, in fact, Stan Williams and myself and Bob, whose last name I can't think of at the moment, all from production control service, which is one of the staff groups located in New York City.

GH: Okay.

CB: We're all, or the three of us, were full-time on the project. The rest were all someone from the engineering staff part-time, when you can find some time work with these guys. Same thing. Someone from accounting, someone from marketing service. Someone from purchasing service. So we had a bunch of people who had come to meetings once in a while but they weren't workers in the normal sense. You couldn't schedule them or assign them anything.

GH: Yes.

CB: So Stan and I were really the principle workers.

GH: Mm-hm.

CB: And did most of the work. We kind of divided the work as we got along the way to-- I was kind of chief architect but also I was chief programmer.

GH: Okay.

CB: Working on my second program.

GH: Now, when you got there, had they come up with the concept of the MIACS? You know, did they have an outline in their heads about that or…

CB: Well, no. They had--

GH: How much had been done on that?

CB: They had five letters. Manufacturing, Information and Control System.

GH: Yes.

CB: That's what they had.

GH: And they had nothing behind it?

CB: Nothing behind it.

GH: All right. So there was no concept of that and operating as an application with a database or any of that?

CB: No.

GH: Okay. I just didn't know how far along they were. They just knew that they wanted to come up with a generic system.

CB: They basically had acquired a team.

GH: Mm-hm.

CB: Three full-time people and bunch of stringers who were consultants. That was their job.

GH: Yes. Yes.

CB: And they could help consult on their part of the manufacturing process.

GH: Right. Okay. So what did you do first when you got there? What did you and Stan…

CB: Well, first we--

GH: What did you have to figure out first?

CB: Well, first thing we had to figure out was, "Where's our laboratory?" I don't mean lavatory like toilet. I mean--

GH: Yeah.

CB: --laboratory where you do research work.

GH: Right.

CB: And so we needed a GE department who's willing to have us come and spend lot of time with them figuring out how they ran manufacturing control.

GH: Mm-hm.

CB: And so Stan made some trips around and had been making trips looking for someone who's willing to expose their business to corporate staff.

GH: Yes, which--

CB: And you have to understand, that's touchy.

GH: I understand you. That is dangerous and you don't do that if you can get away with it.

CB: That’s touchy. But we did get approval from the man who had had a high voltage switch gear department.

GH: Okay.

CB: He invited us to come down and use his business as a laboratory and set us up with a office facility across an old grocery, little old grocery store across the street where we could set up some desks and whiteboards and whatnot. They weren’t whiteboards. They were blackboards in those days.

GH: Yes.

CB: And we could, people could come over, to have meetings. And this was at 69th and Elmwood in Philadelphia.

GH: Okay.

CB: There’s a big old manufacturing building there which is seven or eight stories high and a block square. Whole block, seven stories high, that was both high voltage switchgear, medium voltage switchgear department, and also small, low voltage switchgear department.

GH: Okay.

CB: All of them living there in the… But it was high voltage switchgear that signed up with us. And so we started going out to come to-- when, the first visit we went, you know, I was just walking with Stan and the other people through the plant that high voltage was using and just pointing out various things. And I remember going into the machine shop, which was one whole floor of this building, where they made parts, which got put together to make, high voltage maybe up, to, I don’t know, a million volts or something. Very high voltage. Circuit breakers for transmission lines.

GH: Yes.

CB: And I noticed a bunch of tote bins. Well, I was told to call it tote bins. A steel box about that big by that big, about that deep. Full of parts. And with a bunch of punch cards wired on the end of it. I looked and these punch cards would describe really, they might say, “cut off, drilled this way, grind this, do so--“ you’re fabricating this piece of raw stock into something that-- and the raw stock got cut into the length someplace else and was delivered to where the next machine operation was.

GH: Right.

CB: And I noticed, had looked at these cards. They all had not only an order number on it, but it had a date on it and an operation to be done, and so it was a piece of a manufacturing plan on each punch card. There’s a whole lot of punch cards all wired together, and then each machinist would take one card, do his, and put the rest back wherever it was standing. It may be standing on the floor someplace or on top of a radiator. In fact, we talked about it being radiator storage because everything was being covered with tote bins in process. And I looked at this and I said, "Well--" some of these dates had already gone by and they hadn't done it yet, and I said, "Well, this is the plan that was made by the computer," and so once that order came in the computer planned to make it and punched the cards out and set it off to whoever was doing the first operation on it.

GH: And the cards just kept going along.

CB: Kept going along and being taken--

GH: With the bins, yes, as stuff moved.

CB: But the thing is that the dates on it are irrelevant.

GH: Right.

CB: Because if anything went wrong there was no way to fix the plan. And this is one of the first major learning points on my part because when I was in the army in the antiaircraft corps we had antiaircraft guns, 90 millimeter guns that we aimed at Japanese airplanes over along the coast of New Guinea during the war, and I knew that these guns were very accurate and the computer was a mechanical computer, a physical computer. It was like a card table on three sides. It was like in a box with an analog computer that could look at an airplane through some telescopes on it that could aim it. There's the airplane there. Somebody started turning this wheel, which made the thing rotate on a vertical axis, and on this side turning it made the elevation change. And so their job was to get this thing aimed at a Japanese airplane and then keep the crosshairs on the Japanese airplane, and this mechanical computer would say, "I can see you here. I can see you here. I can see you here. Therefore, in 15 or 18 or 21 seconds you ought to be on radar," and so our guns would be automatically changed and we'd fire them, but the airplane wasn't there. It went off someplace else. And so the thing I observed is that we had guns that were very good at shooting at a sock getting towed behind a target plane for practice, and we were very good at hitting them. But in my area of the war we weren't hitting anything with our antiaircraft guns. But then I said, "Oh, that bomb site is assuming they're going to fly straight, too," so they weren't hitting their targets. They were dropping their bombs. They were making a lot of noise and we were making a lot of noise, but we weren't doing a lot of damage, either of us. So I said, "Well, that's the same problem that these manufacturing control systems have." They fire a shell, a pack punch cards that go off into the factory, and regardless of whether somebody made a mistake machining something and they had to start over again or whatever it might be over there, they didn't have the machine available, it got off schedule, no way to redeem it. So they had a bunch of men called expediters who would pick up the deck of cards and say, "Now, I'll- I'll go here and talk my way through the shop and see if we can't catch up on it." And as they frequently found out the customer had called in and said, "Where's my order," before the shop figured out they weren't on schedule, so they were a little embarrassed about the situation and so they wanted a system that would get it manufactured on schedule or at least would tell them that they're not on schedule. And so I was thinking about, well, how is the antiaircraft people or people who shoot the airplanes down now know or use Sidewinder missiles, and Sidewinder missiles aren't very smart. They say, “I can see you and I’m coming after you.” “Ooh, you moved.” “You moved again.” And by then I’ve caught up with you. Boom! And so the Sidewinder missiles with a very small computer, minimum logic that I can see you and I can aim at you. I can steer myself and I can fly twice as fast as you can. And the Sidewinder missiles were very successful where the 90-millimeter guns you could shoot at a flight of airplanes you might hit somebody but you wouldn’t hit the target. So that was -- we had to do something with the system because this plan with the punch cards was made on a computer, an IBM -- not IBM but a GE 225 computer was used made punch out cards, so it wasn’t the computer’s fault. It’s just it wasn’t programmed to have any way to call the cards back in again and fix them up.

GH: There was no real-time updating. There was no way to do that.

CB: No real time. It’s just one second of real time but then in their case it might be three months or six months out and no way to catch up, so I said, “Well, we need a system that when a plan gets off schedule we can reschedule it even if we have to go back and tell the customer that, ‘I’m sorry. We’re gonna be late.’ At least the customer knew we knew it was gonna be late.” So that was the first design thought was this thing has got to be real time.

GH: And iterative.

CB: Yes, iterative, and so we could do that. So that was the first thing. Then they said, “Well, how do we-- how do you do this update?” Well, that was the time when the big discs were just coming out. The discs were new. IBM had what they called a--

GH: They had a RAMAC.

CB: A RAMAC, yes, one disc on a computer, which--

GH: And that was GE at this point planning because you probably had to use GE computers, didn’t you?

CB: Well, we were planning to get general-purpose computers, and they had a -- well, the 225 computer, which we worked on was a general-purpose computer. It was you might say a smaller IBM 704 or a smaller 1104A, which are very similar machines, von Neumann machines. This is just smaller in the sense it had a smaller memory. You could have it in 8K words or 16K words. Those were your choices. Of course, with the 704 you could have 32K words. In the same sense it was a little bit slower, and it was a junior computer.

GH: Well, it was a core memory machine. It did have core memory, right?

CB: It had core memory.

GH: Yes, it wasn't a drum machine like a process control computers that they would have at the same time.

CB: Or the 650 was a drum computer.

GH: Absolutely, yes, okay.

CB: And they were wiring those boards by hand out in the back of the plant.

GH: Yeah, okay. All right, so you know you've got to make this iterative, so do you remember sort of what were your next thoughts as you worked through in your mind how this had to be organized or architected?

CB: Well, the next thought went through my mind is that someplace in one of the computer journals-- and I've never been able to find the issue. I thought it was one I was writing about artificial intelligence, but it wasn't the IBM group and it wasn't the MIT group, but it talked about list processing, and I said, "Well, we could do list processing on a disc," and I had read someplace else about the Ferranti Atlas virtual memory.

GH: Oh, yes, the paging in the Ferranti Atlas.

CB: That they call a backing store. That's how it got to be an integrated data store, from the backing store, so this became the data store before we had databases. So the Ferranti Atlas was clear and away, because it was the new kid on the block because you could write programs bigger than your computer and you could bring pages of it in at a time. I said, "Well, we could just do that with a database."

GH: And you could do it automatically as opposed to the old way. I mean people had been doing that but they had to structure the program and bring in one piece of it, do that and then under program control say, all right, now we need the next piece.

CB: But that's not a virtual memory, though.

GH: And it's not automatic.

CB: Not automatic.

GH: Yes, where you don't worry about moving the program. The programmer doesn't worry about moving--

CB: No, no, no, that's not true because in IDS there are things you can do to cluster things opportunistically. So if you want to store a purchase order you want to store each line item record in the same page, so you bring the purchase order in you get the whole order in. And the database administrator's job there's some tools by which you can enhance the performance by clustering things in a way that will respond to the most likely uses of the data. But if you have some other uses very different it'll still run. It'll just run slower.

GH: Yes, okay. Very good, very good. So, anyway--

CB: But it still was automatic.

GH: --I think we got off on a tangent here. So you knew about discs and you knew about—

CB: Virtual memory. Oh, we also knew that virtual memory in the case of the RAMAC-- well, not virtual memory but the fact that IBM intended to use a block of data from the tape or from the RAMAC, which was one logical record. Turns out if you're randomly selecting things from blocks that have only one logical record and as you're going to load things randomly you're very quickly going to get to the point where you have duplicate things randomized to the same block number, so then you have to go to an overflow height and put it someplace else. But if you make a block big enough to handle 50 records then you could maybe operate your disc at 80 or 90 percent physical capacity without getting excessive overflow. So I did some studying of how the numbers worked and said, "Well, if we're gonna use blocks...." and UNIVAC used blocks on their tapes, too. IBM always used-- a logical record was one physical block, which meant that their 705s ran slowly; 702s ran faster because they had a 200-character buffer. So they could have a 200-character block if they wanted to. So you got a real lot of useful data in there.

GH: Okay. Yes, and you were going to say....

CB: I was going to say that we were talking about how close to the frontier of availability the discs were. Well, it turns out that when we were ready to try to run IDS to make sure it was running through some test execution we did not have a disc available, so we used two magnetic tapes to simulate a disc. We just created a tape that had 64 blocks on it, and so which block do you want? You want block 10? Okay. Copy one, two, three, four, five, six up to ten. Okay, there's the one you wanted. You want eleven? That's easy. That's right behind us here. Boop. Ooh, you want number five now? Oops. We've got to go all the rest of them over and then come back one, two, three, four, five. And we got perfect functional equivalency. It was very slow but we could--

GH: Very slow.

CB: --but we could test it.

GH: Okay, that's very good. So you figured out a way to actually run, though very slow but with all the logic of the program working the way it was supposed to.

CB: And it was doing its job.

GH: Okay. Now talk to me a little bit about the manufacturing control system. You sort of had to figure out how that was going to work. Did you figure that out before you figured out how to do the integrated data store, or did you work those out all together?

CB: Well, in the first year of the project from January to December 1961 I had written the onsite complete, great detailed description of what IDS was, how it worked, and I had rounded up a bunch of data processing managers in GE who we call Friends of IDS to look over my shoulder and critique it as I went so they could see what's going on and bring their experience to bear on it. So we had such things as the virtual memory, the clustering, the randomization. All those things are all laid out in place. And we had actually just created a way at the meta level to store that information so we could record it. And we had some very funny looking drawings that we made at that point, which were a very early version of the data structure diagrams that we used later on, but they were really ugly. They were helpful but they were ugly. But in the first year we had-- and we went back, took our team back to Philadelphia to high voltage switchgear and had the corporate staff, vice president, several of them come down to listen to this presentation. And of course you made flipcharts in those days. In fact, I thought they were quite artistic. I would loved to have saved them.

GH: Okay.

CB: I would have loved to have saved them.

GH: Oh, yes, but you didn't. Yes, you couldn't.

CB: I thought about it, but I didn't know how important they could've been. Although in the program that we did for the Computer History Museum on IDS some years ago I had a couple of these flipcharts I had photographed. So the one of the pigeons in the pigeonholes if you ever remember seeing that--

GH: No, I don't.

CB: Did you ever see that lecture I gave on the assembling ideas?

GH: I think I did, but it's so long ago I don't remember it clearly.

CB: But, anyway, we had all the management team there including the general manager of the high voltage switchgear department and he had invited his medium voltage switchgear department counterpart and also the low voltage switchgear counterpart, and I think he was thinking ahead because when it was all said and done he said, "Well, this is all very nice but I've got other things to do. I'm- I'm not gonna continue the project, so my- my de-- this is my department, and I've spent a year with you and thank you for letting me do it but I- I'm done." And fortunately the low voltage switchgear general manager put his hand up and said, "I'll take it over." And so the first department that it was actually up and running in was the low voltage switchgear department, and that general manager furnished his top systems people to help bring their knowledge into the project.

GH: Okay. And you didn't need to move because they were all in the same building.

CB: They were all in the same building and we were still in the office across the street, which worked out fine for us.

GH: Yes, very good. That's excellent. So did you have to get authorization at some point to really implement this from corporate, or was that one of the purposes of this sort of meeting after a year after you worked it out?

CB: Well, at the end of the first year it's the question do we go forward and how do we go forward, and we didn't go forward in high voltage switchgear. We moved to low voltage switchgear. Fortunately there was someone there who was prepared to take the risk because people tell stories. I remember talking about one of the general managers down there who didn't fix the roof of his building that was leaking because the repair work would come under current expenses and would affect his P&L, so they just mopped up around the leaky roof and didn't invest in fixing it because he was bucking for the next job up the hill, which meant basically how good are you at making a profit. So there are a lot of things that the general manager had a lot of responsibility. In fact, his main responsibility was making a profit. He couldn't set his own accounting scheme because accounting was done centrally, so the accounting people did not report to the production division. They reported to the corporate head who had a standard accounting system for everybody so they could compare people.

GH: Right, and so he couldn't fudge the accounting by deciding to do it a little bit differently.

CB: Well, he could put off the job of fixing the roof.

GH: Yes, he could do that sort of thing, yes. All right. So one of the things I wondered whether you could maybe describe in layman's terms so our general audience could understand it what the integrated data store was and a little bit of how it worked.

CB: Well, first of all one of our challenges is we wanted to do something that the good programmer in the field could learn and become proficient in quickly, so people were used to the programming at the record level, the financial programmer people, and so they would do batch processing of records sequentially. I says, "Oh, we- I want to preserve the programming milieu so that you- you need a record and you- and you'll command that it will bring you a record and there's your record just as if it had come off of magnetic tape except it's now going to come off the disc and how it knew to get off the disc is what's hidden back here you don't need to worry about." So then we provided a language basically said, well, we have records and we have one other critical-- well, three things. Records had relationships with other records, so if I look at a purchase order purchase order has things about a customer, so there's a relationship. We have customer records and purchase order records. And each purchase order has line items that people are going to buy. Well, the same thing they would have if they were buying it and were recording it on magnetic tape. Well, it was going on a disc that was going to be together again. When you bring those in you can bring in one record at a time, bring in the record header, then you can bring in the order header, then you can bring in the line item one, line item two, and so you arranged your processing to process all the items until you're done. Then essentially you know what the total of the bill is and you go back and update the header in the thing so that we were trying to make it comfortable for the programmer. Now in terms of access we had the ability to-- anything which had a primary key whether it's a purchase order record or an employee record or a factory machine-type record if you knew the primary key for that record you would just say, "Retrieve primary key," or-- excuse me. You would take that primary key you have and put it in the location for what the primary key for a purchase order record, it's called purchase order number, and then you'd say, "Retrieve purchase order record," and that very brief command it would go and look at the purchase order number and use that number to use whatever rule the database administrator applied to this and go find it based on the primary key and bring the record in and the programmer knew it's right there for him. And the fact that you had to go down through maybe 10 levels of subroutine to get to actual physical storage on it and bring it back through the subroutine levels and deliver it to the working storage area of a program where you would've gotten it off a magnetic tape also.

GH: Could you tell me in layman's terms what you perceive were the advances over previous ways of doing it that the integrated data store allowed users to accomplish or to do?

CB: Well, I think the most significant factor about IDS comparison to, say, all prior art was that it was designed to be a system that was adapted to many different targets, to many different applications, and it was not a one of a kind. And everything up to that point whether it was the American Airlines travel reservation system it was a one of a kind program at great cost. And the experience they had at GE they had a few systems that were maybe hand tailored. In fact, our first performance test against somebody else IDS would take two weeks to write the programs that we could run against that made the same thing as the people in Ohio were running on their laminated products and they had spent two years of hard labor trying to get something that would give them their disc-based order entry system. And we were talking to the GE in-house consulting group and they said, "Well, this is the- the best we can do. It's really a sharp system." And I said, "Well, we think we can do some of the same thing and it shouldn't take you two years." And so Sam Williams wrote his first IDS program in the two weeks' time that emulated the application that the laminated products people developed. And Bill Helgeson, who was really a tough guy, a nice guy but a tough guy, said, "If your guys are just half as good as what we did we'd rather do it your way because it's so-- it'd be so much cheaper to have a quick installation than to have- to program it the way we program it," and so we ran a test, and not that we ran half as fast; we ran twice as fast as they did. And they said, "How'd you do that?" And I said, "Well, we used virtual memory and we used this to do that." And they said, "Well, we- we don't know anything about those things." And I said, "Well, what we've accomplished is the ability to have a database system, a virtual memory system that you can use independent of the application and you can apply it because there's a data manipulation language you use that merges right with GCOM," which was the early version of COBOL, "and you can use it and run it and you don't have to spend your life on it." And so I think the most important thing about IDS is it was a system that was available to being used many places. And the history of installation, the first year IDS we said, "Well, it's good enough to use," so two different GE departments-- not the MYEX [ph?] people but GE International, IGE, installed it for their order processing thing and Wiring devices department who make little wall switches and things down in Providence, Rhode Island, they installed IDS and they were up and running that year, within the year it was first released. And how well had been debugged before that? Well, it was debugged as well as I debugged it, and it was pretty much bug-free because when you have only one programmer you can see the whole thing. Now we had two programmers. We had Homer Carney, too, so everything virtual memory down is Homer's territory. And so Homer had full control over that and I had full control over virtual memory. So I would, "Tell me where that record is, and I'll take it over- take it from there." So the generic solution was the most important part of it. This included the transaction control part, too, which is one of the less known parts of-- was it part of IDS or was it the problem controller as we talked about it, because you have to have something that will allow you to instruct the operating system, the transaction processing system, really, which 20 transactions or maybe 1,000 transactions you get backed up that you can run now based on the business's requirements. And so another business might have a totally different set of transactions, which are important versus not important. Now one example of this thing is when we first released IDS through the GE inside customers the problem controller would say, "You can have various classes of problems, translation type one, type two, type three, type four, type five, and if there were any type one transactions process those first. I there's none of those you could process the second ones next and the third one next." And that worked. In the second year we were running Weyerhaeuser Lumbar who were the first non-GE user said, "This is very nice, but we want to shift our priority from day to night and then shift it back the next day. So there are some transactions that are very important during the day but the-- because the results can go back to the sales office. It's open. But at night we don't- we don't worry about their-- what they want back tomorrow. We want what someone else wants back tonight for shipping purposes." So they corrected a system design flaw that I'm guilty of, something I've been told before many times from punched card days, that you never use a data field as a primary key if it's functionally meaningful. If it's just a number that's unique then we can find it based on the number, but if it has to have a meaning like both a unique problem code but it's also the third level of priority what if you want to make it the fourth level of priority? So that's a bad thing to do make one data field try to serve two purposes, and people do it all the time. So Weyerhaeuser added one more field to the transaction, a master record that was its priority number so that at night they could reshuffle these cards again and run it all night long, and then tomorrow they shovel it back the other way. But the ability to have a transaction control system that can respond to business requirements. It took them... well, about probably two days' time to make what would be a fundamental change to someone's hand-coded system.

GH: Well, I think that's a good... you know, in some sense, that's really a good summary of you know, what the fundamental advances were in the system. Can you talk a little bit now about the history of the system? It was originally set up to run so you could put statements for this system into a... the GE compiler, sort of their own version of COBOL compiler system?

CB: Yes, pre-COBOL.

GH: Pre-COBOL, yes. You eventually changed the system because of some of the system... of the computer requirements to run this, that it took the largest machine that GE made at the time and you switched to an interpretive system, could you talk about that and that transition and the thinking... you know, what happened there, tell that story?

CB: Okay, well, when we first developed IDS its mode is that you would start out as a COBOL programmer or as a GECOM, which is the General Electric Compiler Programmer and we added commands that allow you to store and retrieve and modify and delete records in this virtual memory. But modifying records and storing and deleting was not very unique so we did that in a very standard looking way. And so that... I set it up so that... first of all you could take your description of your data and code that and actually store it in the IDS database. What we would've called a data dictionary if we had thought about it. So there was a data dictionary which had all your description in it and then you put your store, retrieve, modify, delete commands in your COBOL program and ran that program against the database with your data description in it and what it would do it would take each of these ideas, commands and expand them into more GECOM language or in some cases into assembly language which GECOM couldn't handle the function. And then you put that whole thing through the GECOM compiler, then went through the similar... you had a program that was inline coded to do exactly what you wanted and nothing else for that program. Some other program would have... access different records, different functions that get expanded but even the point if you had two different places, this program you've stored the same kind of record, it would look and say, "Well I already expanded this once and so I'll package it into the program going out as a subroutine that I could call either place in the program and get the result." Well, a GECOM compiler... compilers tend to be bigger than assemblers and so a GECOM compiler used with a maximum-sized GE-200 computer which was 16K words and there were smaller words at that, there were 20K words... 20-bit words. And that also was considered by many GE departments as being very expensive to get a big GE-200, so we wanted a smaller one so we can save money and they were very... they were tight kids and so they said, "Well, can't you..." Bill Helgeson this guy who was a tough guy before said, "We'll buy if you want, but I want you to reprogram it as an interpretive system so you have all the subroutines you need to do all the store, retrieve, modify, delete, just you have to give it now, within a dictionary at runtime." So you can say, "I wanna store a payroll record." Okay then payroll record's got all the instructors in it and it'll expand and store that payroll record based upon what it needs. If you say, "Store a purchase on a record," it'll generate a different... it'll interpret a different code but based on the same subroutines that are record generating and so that was run in an 8K machine which was a great thing to have happen except that it turns out everyone bought a 16K 'cause they get more paging buffers in a 16K machine than it can in an 8K machine because the interpreter is still the same size, the program is still the same size so that they all wanted to buy 16K anyway and so we spent a year... I spent a year reprogramming that whole thing. That's the second program I wrote and so that... and it turns out... you know, I had not heard of Moore's Law. In fact, I looked up in the book the other day, Moore's Law was not spoken until two years later. So how do I know that I can get twice as big of memory next year and everyone think it's a bargain next year and this year it's too expensive. So that... I often wondered whether things would've taken a different course if we'd stayed on the inline coded version. But to my knowledge all the later versions of IDS and its lookalikes still run interpretively because it's clear how you do it, that's the way Charlie did it the last time.

GH: Alright, so that was a progression in IDS. At the time, IDS originally was just used in GE departments and you mentioned Weyerhaeuser was the first people who outside of a GE department that wanted to use it. Talk to me a little bit more about the evolution of IDS as a programming... as a product within GE and then I'd like you to talk a little bit about who the competitors were and what... you know what happened in that world especially what IBM did?

CB: Well in the evolution of IDS, the GE-200 version of it, which is the one I wrote both the inline coded one and the interpretive one was built for the GE-200 line of computers... the 215, the 225, the 235, and there was this junior-sized computer comparison with the IBM-704. There was coming along at

that time two other computers, GE-400, a GE-600. The GE-600 was much closer to what a 704 or what a 709 became in terms of being a 32K memory, being a 36-bit word and IDS was programmed both for the 400 line and the 600 line and that's the first place anyone except Weyerhaeuser got access to it. Well, that's not quite true. BF Goodrich Chemical in Cleveland, were a GE-225 user, they got a copy of it. They got one box of cards-- no, two box of cards, four-thousand cards.

GH: But that's essentially the limit of it at that point.

CB: That's important because that's what they reprogrammed is for the IBM-360. That's how IDS escaped into the IBM marketplace. So you could go to... go to Cullinane Database Systems and get IDS except it was called IDMS, integrated data management system, and depending on how close... how you leave people, they weren't close or they were close, but I have some of the manuals from... that came out of the...

GH: Did you say BF Goodrich?

CB: BF Goodrich, reprogrammed it for the 360 and that was taken over in IDMS by Cullinane and when Cullinane ended up hiring more people than they could pay their salaries and... so they weren't making money and their stock went "oops" and they were actually bought out by people down in Long Island.

GH: Yeah, the Computer Associates.

CB: Computer Associates or CA. They took over IDMS and I've got... had in fact, I sent off to the... sent off, excuse me, to the Charles Babbage Institute some tapes I have which shows that their data formats on the pages are the same exact design. So there's a lot of similarity there and they didn't understand some things when they recopied it so they've split some things I had joined together so it's lost a little power. But anyway, the BF Goodrich escape with the 200, was one early non-GE user of IDS.

GH: And so they did it for the 360, do you remember about what time? They must've done this sometime after 1964 when the 360 ,,,?

CB: Oh yeah that was done... I don't know exactly but late '60s.

GH: Some time in the late '60s... after the 360s were shipping?

CB: After they were shipping and after BF Goodrich Rubber Company which is a parent of BF Goodrich Chemical, said "We're gonna standardize on IBM" and so they said, "You can give up on IDS if you want to or you can reprogram it for us on the 360." And of course at that time you reprogram something on a different interior décor program machine, you're gonna get some... coding is gonna look somewhat different. Different programmers have different styles and obviously IDMS got some other things they copied from IBM to give them a broader marketplace for IDMS.

GH: So was this put into share so that any IBM installation, 360 installation could run IDS?

CB: No, you couldn't do that because the 360 version was a product owned by BF Goodrich which they licensed to Cullinane which eventually transferred the license and the rights went with it.

GH: Okay, so that's the history of how it got to Cullinane? How did it Cullinane get it? Do you remember what year? I don't remember when Cullinane started?

CB: I don't remember. And then... as soon as... it was up and operating really as two IDMSs and GE one year, the next year four and it went up almost double every year for quite a while, adopting a 200 version. In the meantime back in Phoenix where the headquarters for GE computer department were, they were reprogramming it for the GE-400 and the GE-600. They were done by two different teams but at one point, I said, "Look, you have the same randomization algorithm so while you can move a database from one computer to the other and the randomization works the same." So if you're doing that randomized access storage and retrieval, you don't lose that capability by moving from a 400 to a 600. And the rest that was protected by other software but the 400 and 600 were sold for a long time. In fact if you go to Google now and Google up what is Honeywell, Honeywell is not the Honeywell it was before that bought the GE stuff, so... but it's an aerospace company that bought Honeywell but kept the name. And then there's still IDS education classes going on at Honeywell... at least they were last year.

GH: My goodness, that's very... that's cool.

CB: A few years back when they... the Charles Babbage Institute was earlier in its life and had not quite settled down yet in Minneapolis where it is today, they had a trustee group that kinda helped in its funding and I went to a meeting they had in San Francisco or the Bay Area and I met a man there that I didn't know but I knew his father who had been one of the share people from the University of Michigan, from the head of the computer department at the University of Michigan but his son was head of the IMS department at IBM and we were talking about IDS and IDMS and he said well he was managing the IMS group and they still had 4000 IBM mainframes running IMS worldwide. And I had previously heard that... IBM... can't say it... Computer Associates, I went to one of their user meetings, they had user meetings... still having user meetings and they said they had 1000 IBM mainframes still running IDMS and if you look at the largest transaction processing systems in the world, they rank number two or number three which is British Telecom which is now BT.

And I had a chance to call on them and they're still running IDMS, I don't know how many hundreds of thousands of transactions a day because if you have a tough, demanding performance-oriented system, there's nothing better and I think we've proven you can't do a hand-carved one and get a better either 'cause you don't know enough... all the tricks. So IDS as IDMS, there's still a thousand of those plus there are Honeywell machines still running it. The banking system in Geno, in Norway, runs it for online banking.

GH: Wow, that's pretty good... that really is. Now what was IBMs... did they eventually come up with an answer? What did they do?

CB: Well, there's a yes and a no to that question. In the 1960s, IDS came in and the very late 60s, early 70s, IMS came in... came out of the aerospace industry and there's indexed sequential, or it was, information management system, IMS, which they said was good enough for them, they didn't need an IDS and they were still running 4,000 of 'em against 1,000. Of course they're a lot bigger organization than Cullinane... bigger marketing group. And their final solution was to go to DB2, a relational database system, which does some things nicely but the fact that people have migrated in masses for their major systems, the major systems are still sitting on IMS or IDMS because they were the best of their class that were offered to their customers. And so the long-life things... well things that are running well, leave 'em alone, don't fix it.

GH: Right, well-known engineering that if it isn't broken...

CB: Don't fix it.

GH: Don't touch it, yes. I have a couple of general questions I'd like to divert to right now and then we can go back a little bit more in the... to the historical moment. Who during your career were... would you say were your role models?

CB: I don't think there is a person that comes... there's some people that I worked with that I feel were very important and they're contemporaries of mine. Russ McGee was one of the people that came out of GE Hanford and became the share data processing chairman after I left and he and I worked together on various things a number of times and I always felt I'd learned lots of things from Russ McGee and Stan Williams who again is a contemporary. In fact the three of us are all within the same... within one year of the same age. That means we're all... well if Stan, if he was living, would be 90 now. I'm 90 now and Russ will be 90 later this spring. But those are my closest compatriots and role models I'd say also and so that's like... I feel I could always learn from them.

GH: Another sort of general question, looking back what were the turning points for you in making your life decisions that sort of led you to where you are?

CB: Well I think, I'll go back to your words where I made my life decisions, it seems to me in most cases, the situation seized me instead of my seizing the situation. I kinda rolled with the blows that went along and then with maybe some of the things like when I said I signed up... I didn't sign up I just went and took Wharton School classes on the daytime with no official authorization, I just registered for 'em. Maybe because I was...

GH: 'Cause you were free at that time, and you were curious.

CB: Yeah, and I didn't make the opportunity, it fell on me in spite of myself. And so leaving Dow Chemical to go to the project for ISP2 was a situation where I had inquired around the GE network I knew about and didn't find anything and didn't take the job with Thompson Ramo Wooldridge and so then that Harry Tellier told a friend in New York said, "You wanna hire this guy," and he came and got me and the jobs that came up at Dow Chemical were... kinda came there and I guess I may have done things that made other people select me for a job. In fact, one thing we haven't talked about at all is the data communication work I did with the Open System Interconnection group.

GH: I wanna get to that, but yes...

CB: It's an example of an opportunity that kinda came up and... well I think I... maybe I maneuvered that one more than any other one because when they were going to form this new international committee, the ISO SC16 committee, the Honeywell staff group back in Minneapolis said, "We're not gonna spend any time on this." And I had been working on communications more than I had been working on databases at that time at Honeywell so I thought we should get in on it so that... what I did, the man who had been our... helped us on the IDS CODASYL work that we haven't talked about yet. But from US Steel on the CODASYL committee people and I said, "If you nominate me as chairman of the SC16 committee, the Honeywell management probably would be too embarrassed to say no" and that's exactly the way it worked out. That's how I got in to be the chairman of the International Standards committee, number 16.

GH: So another question, a generic question, is what is your biggest regret in terms of decisions you made?

CB: Well, the discussion we had about the interpretive versus inline coded one, was a... is a real clear case of a decision we made which we know is not a bad decision, it worked. And the other one was intellectually they're more advanced because everything was buried on compilers and a lot less manual fiddling around because we had to regress back to assembly language to get it in the 8K machine. So that was one of the decisions I always wondered whether that was... the other decision that I think... an opportunity that I didn't appreciate at that time is that... in terms of what I've talked about as being the problem controller, the operating system for transaction processing was a late bloomer, so to speak, because we had been working with one of the GE divisions, the aerospace division, and they were gonna build us a little small compact transaction processing operating system. And when they said, "Oh we got it, it's ready to go now, it's got between 2000 and 3000 instructions" and we said, "We only allowed 4000 for everything" and then we just said, "Well that was very nice but thank you very much." So only in the last year did we get around to worrying about what we were gonna do for an operating system. I said, "Well, an operating system, this is like a storing forward message system and we got... we're gonna store and retrieve and forward... it sounds like a database problem." So the problem controller stored the transaction database records... the transaction records in the database along with everything else and we just treat it as another subroutine to call and called it... loaded the data, selected which transaction type to use, took the first transaction of the transaction type, loaded the program that went with it or if it wasn't already loaded and turn over control of it and get out of the way. So we had our operating system, transaction and controller is probably less than 70 instructions 'cause they're all IDS instructions... we're storing and retrieving records and we're not looking inside of the records... so it's just one more thing to store and retrieve. The other thing that came along with this because it was being done with IDS that if you had an application program that needed to create a new transaction in the transaction world, it's... all the data description is there you need to store a transaction record with all of its data. So the way we had a level structuring in the parts explosion was that we just start at the highest level doing parts explosion and they have record of the next thing in order to explode and actually had a transaction code was slightly not as good so we wouldn't get to it until after we got rid of these guys. So I later said, "Well why didn't we..." let me stop here for a moment. The question here it says, why didn't we go back to GE instead when you're doing IDS, but appreciate what you're kind of getting along with it and I'm not sure how much they ever knew about it 'cause I lost touch with that workgroup.

GH: Okay but in a sense, you know, that's a regret that they did not... that you didn't sort of point out to them and sell a little bit what it was doing?

CB: Well it was a big thing to do to do transaction processing 'cause people were having to hand code transaction processors and here you got one off the shelf, 'cause this is what... Weyerhaeuser took that thing and fixed it so they could change the priorities... day to night or over the weekend. And talking about storing forward in this thing, the transaction that once I had a visit back to Weyerhaeuser to see what they were doing and they said, "You know, we had a funny experience, we had a point some months earlier where they were getting... the orders flow was going up and they were getting more transactions coming in and they were getting enough transactions so that when the Monday transactions had been processed and at the end of the day it was ready for the next day's transactions, there were still some leftover transactions from Monday and on Tuesday there was more Tuesday transactions left over for Wednesday. And so the... these orders which were pretty important to the business were getting pushed down in a pushed-down stack and so that when it got around to Friday night they got rid of their highest priority things and then they started working off this backlog of things. Yet in the meantime all these things were being backed up on orders, you could get a new customer code for a new customer for the system in a matter of a few seconds 'cause its priority was always higher than an order's priority. So this thing would back up enough orders so it took 'em until sometime on Sunday to work 'em all off. And this... one thing about this that drove the operators crazy is that the 635 computer that Weyerhaeuser had to the operations center had no local I/O devices on it. No card reader, no punch, no printer, no typewriter, it just sat there and ran and it drove the operators wild, "How do we know it's doing the right thing? How come... what if I'm in a loop here, I'm dealing with a loop. We have loops all the time." Well IDS didn't have loops and so they said, "Well, what we'll do we'll take a IBM electronic..." whatever those IBM typewriters are,

GH: Yeah, Selectric typewriter?

CB: "Selectric typewriter and we'll program it," so once an hour it reports the length of the queue and so once an hour you go look at it and it goes, da-da-da-da... "Okay, that's different than it was last hour, it must mean it's okay" and we leave it alone because they would want to shut it down because they didn't know what's going on.

GH: They were afraid it was... they had gotten into some loop.

CB: One thing that fits in here at the moment, add it in, Weyerhaeuser was a very aggressive information processing group, a very aggressive company and then a lumber business and so it didn't take too long before staying up all night on Sunday to get your work out was not a very happy solution because what happens when Sundays run out of time and you're in Monday.

GH: And you still haven't gotten the last week's work done.

CB: So they wanted a version of IDS they could run with the new 600s. So it had the bigger computer and the 600 had some extra memory capacity and whatnot. They said, "We want it also so we can run transactions in parallel, shared access to IDS." So we put together a team of GE Phoenix people with Weyerhaeuser Tacoma, Washington, people, a team operating up in Tacoma, Washington. The Russ McGee who I've mentioned is one of my-- I started the project and he took it over. Russ always has a hard-- he has the deliverables. I could wave my arms, you know, it's easy.

GH: It's like the architect. You never have to build mobility.

CB: That's right. Don't have to worry about it. Well anyway, they've got it running so they ran multiple transactions, deadlock detection. If you deadlock it, back everything out and rearrange the sequence and start it up again, so it's automatic recovery and restart, which ran for years until they finally got the IBM itch. Well, Honeywell was by then taking over the company and they had the same faith in Honeywell they did with GE.

GH: Right. I don't think Honeywell supported the 600 series the same way.

CB: Well, they were still being done in Phoenix, call it a 6000 now.

GH: Right.

CB: But anyway, that was the first shared access database also in the industry.

GH: Very interesting.

CB: In fact, one of the interesting things we learned from it, they programmed it because they said, "We don't know whether we want to lock memory, for someone to access something, to unlock it at the logical record level or lock it at the page level, the big block level." It turns out if you lock a block, because you're locking actually one record in it, you've got upwards of 60 records locked. So you get more deadlocks, some of which are not real. Well, the deadlock's real but the cause is not there.

GH: Logically, it didn't have to be deadlocked.

CB: Didn't have to be.

GH: The hardware worked that way.

CB: That's right. Hardware worked that way. So they ran it both ways and it turns out, you get far fewer deadlocks that operated the logical level, but the system ran slower, because you've got a lot more stuff to search to decide whether we've got-- a lot more units were locked, because somebody might have this page locked, but he's got a purchase order with ten purchase items on it, which might be on ten different pages. So it turns out they end up locking at the page level, because that's got their greatest production. That's what they wanted. As long as it could stop and recover itself, we'll just stand back, guys, and stay out of the way, let it go.

GH: Whichever goes fastest is bestest.

CB: Fastest is bestest, right.

GH: Okay, very good. I have a few more generic ones. One is, what were your most important life lessons?

CB: Most important life lessons.

GH: Yes.

CB: Let me think about that. Let's go to the next one.

GH: Okay, very good. What was your proudest moment?

CB: Proudest moment. I guess when I got married.

GH: Very good. Did you have--

CB: Oh, let me tell you this first.

GH: Okay, you're going to tell me the story about that. That's good.

CB: Well, just a bit about that. When the first child arrived, it was Chandini, who you've met.

GH: Yes.

CB: This was back in the days when fathers were not allowed anywhere near the delivery room. You could either go look through the glass to the room where the babies were. The Dr. went in and reached down with his two fingers out like this, and Chandini would grab it. This is my first daughter, for those of reference. The little baby girl, hanging on two fingers and picked her up out of the crib like that and said, "When they're first born, the first day, they all hang on and they won't fall." That strength goes away very quickly, but he put her back down in the crib.

GH: Oh.

CB: So that was quite a shock, if you like.

GH: Yes, wow. She's holding herself up.

CB: She's holding herself up. She's got her little hand hanging around there.

GH: Oh my goodness. All right, that's wonderful. Let me ask you one more. What advice would you give to young people thinking of entering the computing field?

CB: Well, the only one really unusual thing I did was mix business school classes with engineering classes. I fell into it. I think it's worthwhile for people trying to get a course in economics, a course in accounting, as part of your engineering education. A course in marketing. It could be a course in management. Things which are skills that can be very important or can be critical to your success, or your company's success in what you're doing for them. I think that one of the things we're here today is business, because of the National Medal for Technology and Information-- excuse me-- Innovation that I won. I'm one of the few people in that group who was not a PhD. I say, well that's really for engineers. Engineers have different requirements than scientists do. Scientists don't very often have to worry about accounting or marketing strategies and things like that, that they get with some management courses. So people ought to think about training themselves not just as scientists or just as engineers, but as people who have to live in an organization with people, and the people problems along with it, technical problems.

GH: Okay, good. I have to ask you this question, one more generic question. What contributions to computing are you proudest of?

CB: I think the most interesting and maybe the most significant contribution came at the time the disks had physically arrived. People could store things. The costs were coming down and the whole new world of things, if you could have a shorter and shorter response time from the computer action that you were working with. IDS provided the means, you could get some very short response times to problem solving. So you were ordering transactions, some which might be just a few seconds long. Others could be mixed in with things that might take minutes. But in the transaction world, you don't want anything that takes an hour. If it takes an hour, you want to find a way to break it up into pieces, which you could with the problem controller we had. You could break it up and have each piece leave it a message for the next piece to start up. So you could break it into vertical sets as you progressed through time. The best kept secret is the problem controller part of the system. And I like all parts of it. One thing I brought here, something I want to show you. Would you bring that white box? Not white box, that's a blue box.

GH: Shall I open the box or do you want to open it?

CB: Let's bring it here. Is the camera running?

GH: The camera is running but I need to broaden out so people can see the box. They're just seeing your head. All right, there you go.

CB: This box, you're looking where it says Tiffany box. Now Tiffany was not just my opinion, but other people think it's one of the best jewelry stores in the country, in the world. And in here is a nice shiny bowl. And this bowl on here says, if I switch around here quickly, it says, Charles W. Bachman, ACM Turing Award, 1973. Well, this was one of the thrills of my life to receive this silver bowl as a gift from the ACM and for winning the Turing prize. Now the thing I think is interesting, makes this thing consistent with the computer world we live in, and this is the fact that I also won a monetary prize of $1,000 for winning this prize. And this year, if you win the prize, the Turing award, the prize is $1 million. It just shows that the prize money takes the prize for, what's the word I want to say?

GH: The prize for the award? The Moore's Law?

CB: Moore's Law, yes, Gordon Moore.

GH: Exponentially?

CB: Exponentially, in terms of the speed and reduction in size and cost. Well, that's gone from $1,000 to $1 million, but this is the same bowl, loving cup…

GH: The same bowl they give today.

CB: Same old thing as today and some people say that's a Revere bowl, first done by Paul Revere in Philadelphia and Boston. So thank you very much.

GH: Good. At some point, you moved from working in New York City for GE's overall corporate organization to moving out to Phoenix to join the computer division.

CB: Right.

GH: Could you just tell us a little bit of the story, how that happened? What was that transition? How did you end up there?

CB: Well if the integrated data store was going to become a product, it eventually had to be owned by Phoenix and the computer department out there. So it was a matter of, when is the right time to go? We had a neighborhood situation where the man next door had been threatening his wife with a gun. My wife wanted to get out of there. So we probably moved faster than we would normally.

GH: So Connie was a little bit of an incentive there.

CB: Well, was a big incentive. She wanted to move.

GH: All right.

CB: So we moved that summer. I think it was slightly premature for the best yield, product wise, because I lost control over the 200 line and never gained control over the 400 or 600 product lines. So I had to go out there and find a job for myself. Most of the time I spent, for a while, couple of years, was trying to promote IDS to the industry, on the assumption if we couldn't patent it-- in fact, we had enquired through the GE patent department. They said, the patent department doesn't pattern software these days.

GH: Yes. Took them quite a while to eventually come around to doing that.

CB: Well, they came around when the Supreme Court told them to do it. And it turns out that there were two patents the same Honeywell attorney had submitted and both had been written and rejected as being software. He picked one of them, which wasn't mine. The other one was mine. I would have been that guy's name on that patent, which I would have been delighted to have had happen. But this lawyer whose name I can't remember at the moment--

GH: It wasn't Regan was it?

CB: What?

GH: Regan?

CB: No.

GH: No, because there was a patent lawyer by that name.

CB: But who had a habit of making several disclosures of embodiments of the patent and he would do a hardware embodiment as well as a software embodiment, under the assumption that you're not patenting an embodiment. That's an example. So he would give an example, one that was legal and had been approved, sold for a patent. Sold for embodiment. The Supreme Court ruled on his behalf and we all got our patents by and by. But that time went by, the time when we were-- so I said, "There's two things you can do with this thingy. You can either turn it loose or you can get everyone to try to get established as a national standard, that you have a whole bunch of field people who know how to use it and sell it, and the rest have to catch up with you." So as long as we were not going to be able to control it, let's see if we can get it approved as a CODASYL patent. We went through several years of work with committee meetings every two or three months. Finally, IBM put enough weight on that there's no way it would get passed as a codicil standard. So that just kind of petered out. So that's the way that went.

GH: All right. So you spent a couple of years out at Phoenix working on that?

CB: Yes. And I think that someone, in fact, in the papers for the national medal for technology and innovation, one of the recommendations listed, I think ten or 12 different companies who had embodiments of IDS that they used, so they'd got broad use, plus IBM through IDMS. So it got spread across a lot of people.

GH: But GE never made a huge amount of money.

CB: Well, I would say they stayed in business longer than they would otherwise.

GH: All right.

CB: I'd say they made a lot of money.

GH: When did you move to Phoenix?

CB: Summer of 1964. Out there until summer of 1970, after Honeywell had bought-- or after GE had sold themselves to Honeywell.

GH: Yes, okay. Was there any other interesting things that you managed to work on while you were out at Phoenix, besides this CODASYL effort to standardize?

CB: That and also I was working on the communication oriented extensions in the opposite direction of the database which was data storage and retrieval. So I was looking for ways to expand the programming role in the same sense there would be a set of commands and descriptors and whatnot, to let people do computer to computer order processing, whatnot. There was a lot of work going on at that time about computer aided business, inter-business or between businesses, business to business communications. So I was putting my effort in that at the same time. Then we got into the thing through where the British thought we should have an international standard for computer communications. They're the ones who stirred up the interest that led to the creation of the ISO, International Standards Organization, subcommittee 16 with the responsibility for computer to computer communications.

GH: Now that didn't happen until after you moved, you became part of Honeywell?

CB: That's right. It was activated after Honeywell got involved with it.

GH: So in 1970, after the acquisition, is that when you moved?

CB: That's when I moved back to Lexington then.

GH: Okay.

CB: And the kids all said-- this deal came up about the pending merger, it came up in the spring. It was something it said it would be finalized on the first of October, and the kids all said, "We've moved enough times here. If you can't be there by the first day of school, we're not going." Because if you don't get there the first day of school, you're a new kid all year.

GH: Yes.

CB: You're there the first day of school, you're just one of like everybody else. So in fact, I moved the family back here before the merger was finalized, having talked to the people here at Honeywell, because Honeywell headquarters are just-- well, they're very close to where we are now. They're just down the road. Did you come in here by way of....?

GH: I came in down from Peller Road.

CB: To Peller Road, okay. Well, on the road just beyond that, if you came through Peller Road....

GH: Right.

CB: Not Tottenband [ph?].

GH: No, not Tottenband.

CB: Tripello [ph?]. Anyway, right straight through here to the west is where Honeywell's computer business centralized. You've been to that location.

GH: Yes, I remember. There were certainly some main offices. Were they Wellesley?

CB: That was the marketing offices.

GH: That was marketing.

CB: That was marketing in Wellesley, there by the pillar house.

GH: Right, yes, exactly. Yeah, I remember that.

CB: I think that's where I met you, down there.

GH: That could be. I think that's when that was after Honeywell. Well actually, yeah, you may have met me down there, but Honeywell bought Computer Control Company in the mid '60s.

CB: Yeah.

GH: So that's when I first spent some time down in Wellesley. So anyway, so you came here. What were you going to work on?

CB: Work on the communications.

GH: You decided to continue working on communications.

CB: That was what was missing a piece.

GH: Okay, yes.

CB: At least from my point of view. So I managed to stir myself into the mixture.

GH: Yes. Who did you end up working for when you came here? Was it the same GE group you'd been with in Phoenix and they got transferred?

CB: No. I was head of a group of software people who came here and we worked in the software department.

GH: All right. These were people from GE?

CB: No. Well, I brought a group with me from Phoenix.

GH: Yes, okay.

CB: But the men that I worked for-- the man I would have worked for died suddenly.

GH: Oh, my goodness.

CB: I forget what his name was. He died even before I got here. And I forget who the man who took over, but he was in charge of all software. There was a new product line going out at that time, so there was software for the new product line.

GH: Oh yes. They were trying to invent a new product line.

CB: NPL.

GH: Yes, and there was an Italian fellow, Ugo Gagliardi.

CB: Gagliardi, yes.

GH: Yes. I think he was in charge of that in some sense.

CB: Yeah, he was there, I worked for him for a while. In fact, he's the only man I know of who reduced my salary.

GH: Really?

CB: He said, "You and Jacques Bouvard are both overpaid."

GH: Oh my goodness.

CB: He cut both our salaries.

GH: Wow. Now was Jacques native to Honeywell?

CB: Yes.

GH: He'd been there. He was there when you arrived.

CB: Yes.

GH: He was not a GE transplant. Okay. All right. So did both of you work on the software?

CB: Yes.

GH: Did you work on NPL?

CB: On the new product line, yes.

GH: Okay.

CB: Phoenix was involved with this too. Phoenix was going to be able to do the three sizes. Wallace had got the medium sized machine. Phoenix got the big machine. I guess the small machine was divided between Paris and Milan.

GH: Okay between Boole and yes, Milan.

CB: So that went on for a while.

GH: So what happened there?

CB: Well, what happened there?

GH: Yes, what happened to that project?

CB: Things just kind of bubbled along. I guess in the end, they created an advanced research group which Jacques and I were in, which Ugo was in charge of. But between us and Ugo, there was an Italian man, whose name now is lost. I should say, I can't find it. That's what they say. You don't lose names, because when you hear it, you say, "Sure, that's the name." It's just that you don't know how to locate it.

GH: It's a search mechanism problem, not a memory problem.

CB: Right. Eventually, after about ten years with Honeywell, I said, "It's not going anywhere." We've got some new ideas down on the table, but they weren't going anywhere. In fact, I was never very good at selling up to the managers. There were all kinds of opportunities I could have gone and sat down with management, and even been thrown out the door, but I was too passive, I guess is the word. So there are opportunities that I had that I didn't recognize then or maybe ever. They came and went.

GH: Do you have any examples of those that come to mind?

CB: Well, I think the most important one is the one about the problem controller, because GE was saying that they have a three dimensional system. We do time sharing, we do batch and we do something else. I forget, the three different dimensions. Well, transaction processing would be a highly qualified fourth dimension, which would have made a good marketing spiel for four dimensional systems. People desperately needed a transaction control system.

GH: Mm-hmm.

CB: And I worked on the international thing for the last three years I was with Honeywell. I worked on it for a year while I was at Cullinane, as a part time activity. Then I decided, this is not in Cullinane's best interests that I spend my time here, so I resigned the position, which, as chairman of the group, I would have been automatically replaced at the end of five years, five year term. But at four years, I thought it's time to go now.

GH: Let's talk some more about that. Let's roll back. I think you're speaking of your chairmanship, leadership in the OSI, development of the OSI model for computer communications.

CB: Yes. The seven-level architecture.

GH: Yes. Could you go back and tell us the story of when you first started working on that or thinking about that at Honeywell and then the story about it moving to a standardization process and how you became the chairman?

CB: Well, when they-- I was working with my own definitions about the adding on the communication extension to COBOL and some place along the line I saw an IBM presentation of their six level architectural structure for communications, which was very similar to the one I had been constructing for Honeywell.

GH: This was SNA?

CB: Yes.

GH: Yes, they’re System Network Architecture.

CB: Now, SNA had some fundamental problems. First of all it was a hierarchical system and not a network system. I always assumed some place there's a mainframe that controls all of this for company A or for company B. Also one of the things that-- well, we haven't even talked about came from an IDS is it hit what we call a level of data independence. So your program you're writing may have a certain view of what information looks like. And somebody else's program has a different view of that but there is a canonical form which is in the database and so you can define how reach of these maps onto the canonical form. So that you can bring something that's already existing and as long as you map it on to the canonical form you can make a compatible as you-- when you move the data in to your working storage it will be reformatted to be compatible for that program. Well, the IBM six-level architecture did not have a data independence level. And I thought well this is just exactly the same kind of thing that we had at IDS. It had the ability that-- you would have two different things that you know in terms of a canonical form that you can transform one into the other. In fact, in the group working at Honeywell we expect at a committee to carry out CODASYL group that was looking at how to handle that problem of data independence. And the general picture we had was that you got someone sitting at a terminal with one view of data, accessing data which is in another representation, the same information. And we should be able to via the mapping, these two both on to the canonical form then I could transform from one to the other. And so I said let's just move that layer over into what IBM is doing because the basic problem is every place around. And there was a report out from the written by a computer science professor up in University of Montreal on the solution that our committee created for data independence. So that was part of what I thought I could add. In fact, did add to my-- now, six level became seven levels and I said I accept what IBM has set for the other levels as long as they all work together and that independence level fits in here. And you could either implement so I could convert it in the receiving end or the sending end or some place in between depending on how you implement it. But at least intellectually we know what has to map on to what.

GH: Yes.

CB: And so when this proposal came out of an Australian meeting of TC 97, technical committee 97 I think it is to create a new SC 16, to do the communications standards. And it was voted on-- well, one man who is here lecturing now John Day who I see quite often who was on that international committee and stayed with it and is still actively pursuing the longer term view that we worked on and contrasted what the current Internet is. In fact, as someone said very carefully the Internet is a Uni-net because it only supports one network.

GH: Right.

CB: It doesn't support any other networks. Where the seven layer model didn't have a-- it did node conversion between two layers, I mean, between the two networks. Again, based on some canonical form but translated from one to the other. Maybe it's only the control characters you have to change or at some level down you have to play with the content of the message. But at least you had to gain control of it. So there's an ongoing effort right now to resurrect some of the TC 97 work coming out of Europe. And a lot of that work came from Europe in the first place.

GH: Right. So going back, though, to this time at Honeywell, I understand the work you did a little bit at Honeywell.

CB: Now, we're working with the committee-- well, as I said, a certain point came that I could see that Honeywell wasn't going to do anything about it. They didn't do advance database implementation and really was not-- had their heart in communications. I said well I'll go and see if I could get a job with John Cullinet.

GH: Can we go back? I mean you're skipping ahead. I want to hear about how you got on the OSI committee, and what you did there.

CB: Okay. You want to hear that, again.

GH: I want it on tape.

CB: Yeah, okay.

GH: I've heard it before. There's two issues here. I know it…

CB: That's true. The tape doesn't know it.

GH: Yes, exactly. Thank you.

CB: Well, I heard about this new committee coming up and I enquired around Honeywell up in corporate headquarters where this issue would have been talked about and they said they were not going to support it because they were not interested in that communications. Now at what level up there they decided that or who all agreed with that, I don't know. But their existed a man named Warren Simmons who worked for U.S. Steel, who was one of the old CODASYL committee members and who had also been chairman of that extension of the CODASYL committee that tried to standardize IDS and could not get a majority on it. And I called Warren and said, Honeywell is not going to support this activity which you're interested in but if you got me appointed chairman of it I don't think they'd have the guts to say no, you can't work on that. As it turned out I forecast correctly. They wrote me a letter, offered me the job, if I could find time to work on it and I passed a letter back up management levels at Honeywell and they said, okay, that's in Honeywell's interest to have you there, assuming they felt they could control me and therefore control the committee.

GH: Right. The first premise might have been a little off that they could control you.

CB: A little off. Well, I thought I was doing what was the best in Honeywell's interest and I knew more about it than anyone else did.

GH: Especially people in Minneapolis.

CB: Yes, staff people there-- well, probably the man who said Honeywell well wouldn't do anything about it was probably the most right because they didn't do anything about it. They were trying to get themselves out of the business and take as much money out as they could at the same time. But anyway I was duly appointed first of all as the chairman of the American committee working on it so that when they had a meeting of the international group all in one place I wouldn't be chairman of the group, not until that group appointed me to be their chairman. But the American group could appointment head of the American group. And so I wrote one more draft of what I had been working on for Honeywell and made it more neutral sounding. This is an American position, now. It's not a Honeywell position, and which was quite thorough and quite complete. And so everyone got together and said this is the best draft we've got. So they accepted that as which they wanted to do some work on, of course. Everybody wants to put some of their own love or truth or whatnot into every standard.

GH: Absolutely.

CB: They want to make it their own.

GH: Yes.

CB: But we made it our own. The American proposal and then at the meeting we got together and voted on it, accepted it and I got myself appointed as chairman of the American ANSI group, American National Standards Institute which is the American side of the standards. And then at the international meeting everyone provided their drafts from their country. And the American draft was the-- one other thing I need to backup. One of the rules of that ISO is that whatever country is going to be the rapporteur, the official secretary for an ISO committee has to have the chairmanship too which is probably good practice. So that the meeting in Australia had appointed the American ANSI as the official reporter of this new committee, chairman unknown. And therefore, having gotten around in America said okay the American standards group chairman is Charlie Bachman and then he obviously ought to be the ISO standard so we don't have any conflict up here.

GH: Right.

CB: So I got appointed chairman of the ANSI group and ISO group. I started on several years of world travel and trying to perfect this written specification.

GH: And negotiate a compromise that would…

CB: And along the way I tried to introduce into the specification data structure diagrams as part of the formal specification. And it went in, the next committee it went out and the next committee it went back in again and then it went out. So it never ended up in the final report. But one of the things that you get side effects. I had a group of delegates from Japan that were in a meeting and the data structure diagram has boxes and lines and it turns out a box looks like four lines. So they said well why don't you put a little extra line around two sides and make it a shadow because boxes can make shadows. Lines don't make shadows.

So when we got around to-- we drew all of our editing boxes, a box with shadowed on the right side and across the bottom. So it very clearly made a distinct symbol out of the box where before it was confused with four lines.

GH: Okay.

CB: So thanks to the Japanese we have shadow boxes. But that went on for four years. And the last meeting we took the draft which had come through the meeting to Paris. I forget where the prior meeting was but we did some little trimming here and there and got it retyped what needed retyping. And then we all piled into a deux chevaux, do you know what a deux chevaux is?

GH: No, I do not.

CB: That's a two cylinder Austin-- not Austin car a…

GH: Renault car.

CB: Renault. It was one of these canvas top things to drive down to the IBM office so that we could duplicate the copy here so we could all take home copies that had been signed as an accepted standard. That was the big point. I think we had seven people in that deux chevaux which is probably good for four people.

GH: Yes, that must have been funny.

CB: I think deux chevaux means two valves or two cylinders. It was the lowest priced car you could buy in France but it was transportation. And it was shortly thereafter that I had a meeting in Tokyo that I resigned my position as chairman to go back and spend fulltime working for Honeywell—not Honeywell, excuse me, for Cullinet. And I shortly after I got laid off by Cullinet because they felt that they had to put a relational database out. They couldn't imagine me helping me put out a relational database. Although, this brings me to missed opportunities that you'd asked about earlier. One of the things that I had observed when I was in Phoenix a couple of visits earlier than this is that one of the men out there who had worked on the relational database system for Molnex [ph?] had found a way that he could take a relational query and translate it an automated way into an IDS program. And, in fact, he explored moving back and forth. He said, "There's a great deal of similarity, different in style of how to do it." But the objects they're dealing with can be considered the same. Records and entities are the same thing. They have primary keys. We don't talk about primary keys but we have primary keys. And so he had demonstrable package of this that ran on the 600. He was in the advanced research group in phoenix and that wasn't going anywhere and I knew about it and I wasn't smart enough to suggest to John Cullinet that we know the solution to your problem. People want a relational database. SQL is just as-- SQL query language.

GH: Yes.

CB: It's a query language. It's not a database system. And so people have been struggling to try to find a database system to fit under it. And I said well all we want do to-- being SQL compatible is what our goal should be. So you could say you want SQL, here's what you type in the terminal and you're into the SQL world and you could run it against your existing databases. Or work at separate databases when you want to. And if I had been clever enough or subtle enough or smart enough not to be prejudiced against SQL and said what's the opportunity? If I had been an independent contractor say what do we do and do-- say what I knew I would have said you should put an SQL front end on IDS. It never passed my mind. I'd seen it demonstrated, it worked.

GH: And it still didn't-- it just didn't…

CB: Well, people get prejudiced about things.

GH: Yes. Okay.

CB: And I didn't stop and say SQL, what's SQL stand for? Query language.

GH: I want to say system query language but I don't know that.

CB: It doesn't sound right. It would have been a beautiful solution for John Cullinet because it would have enhanced his product offering. He could charge more because you've got this extra interface you've got to buy if you want it. Instead of falling on his nose because people stop buying IDS because they wanted SQL. You ought to sell them SQL with IDS for a higher price.

GH: That would have been good, definitely.

CB: And he could have gotten there-- and IBM didn't go the other way. They just waited until-- it was 20 years later after IDS's running before they had a DB II as a mainframe product. So there's plenty of time to maneuver in there. Structured query language.

GH: Thank you.

CB: SQL.

GH: Good. Very good. Good recall.

CB: Yes.

GH: The search mechanism worked.

CB: It worked. Yes.

GH: So you stayed for a while at Bachman. And then you left. You weren't really-- I mean not at Bachman at Cullinet. Sorry, I'm using the wrong words. So what did you do next? Where did the idea for starting your own company come from? How long had you been thinking about that?

CB: Well, I had been thinking for a long time about wanting to have a computer aided design tool to help people draw data structure diagrams and more important than drawing them is being able to modify them without having to redraw them all over again because people have been drawing them with pen and pencil for twenty years. In fact, I've seen big huge rooms with all four walls with this one big diagram at Boeing Aircraft. And so I'd always been kind of working on the side how are we to do this? And I've been spending some of my time actually at Cullinet trying to build an automated data structure diagram for their business because their customers could have used it. But they decided their need for an SQL was more important than their ability to do data structure diagrams. So when I left Cullinet and they were, I thought, generous enough to give me a sizeable-- they didn't give me a lump sum payment. They gave me a consulting contract for over a year at a rate that I could live comfortably and have some money to do some development work. And so I left almost immediately after. On April's Fool Day we had incorporated Bachman Information Systems which started out with myself and I hired my son John who was selling automobiles then because the chemical business was not hiring. As a chemical engineer out of school he could not find a job in his field. He came to work for me. And then we got a contract with a Norwegian consulting firm. It did some operations work for other companies and also had people they hired out in a traditional consulting way doing IDS or IDMS consulting. And that gave us an extra $5,000 a month revenue and I told John that I could pay him enough a month to handle his social requirements to keep his girlfriend happy and keep him happy with his girlfriend. And he got engaged in that period of time, by the way.

GH: Oh wow.

CB: I'm serious. And so he came to work for me and we started working and we made four or five trips to Norway and their group came over to visit us in Boston, in Lexington trying to construct something that would help them in their work with IDMS. And these are people I had met through the Cullinet European user meeting. And so that kept John and hired… and we were struggling because we were being charged by a company out here west of town and we found out that their bills didn't reflect what came-- at the end of every compilation, for example, they would print out the time and charge.

GH: Yeah, you were using a service bureau.

CB: A service bureau, yes. But they said well there's some other bills you're not seeing on that listing and I said, why should I pay a bill that I'm not seeing and you tell me I owe you $40,000 now. And so we went back and forth and instead of being smart and just not paying them and letting them do whatever they wanted to do about it I somehow peeled out into the savings and wrote them a check for $40,000 which left us in pinched conditions. At which point we were put in touch with some venture capitalists. One of the people who had been at Cullinet and had sold Cullinet his product company said, "Well, I can help you with Vim Rock" which is the Rockefeller family venture fund.

GH: Who was this person that sold this company to Cullinet?

CB: I can't think of the name at the moment?

GH: Cooper?

CB: Yes.

GH: Yes. Okay.

CB: Phil Cooper. That's exactly who it was.

GH: Yes, I know Phil Cooper.

CB: And he also had an in with Kleiner Perkins Caulfield and Byers, the people who had loaned him money for his company. And so he put us in contact that helped us package it up so we're able to get some venture capital funding for them and got it so we could move out of our house where we had been working and move down into not Kendal Square but down closer to the bridge.

GH: Yes, somewhere there.

CB: He was in one building and he had some extra space in that building for a while that he rented us so he cut his costs. And then we got too big for that are and then we took a space out at Burlington Mall. There was an industrial park out there. And by that time we needed two floors and we were growing.

GH: And you were still working on the design tools for…

CB: Yeah, in fact, the entire period of time that Bachman information Systems existed it was all computer aided software design tools for database design, for communications, for process control.

GH: Okay. Alright.

CB: And well, one important thing that I don't think anyone ever whispered to me or even shouted at me about is that one thing you're supposed to learn is that you're supposed to spend less money than you make. And if you spend less money than you make you'll just do fine forever. But if you're saying well I've got to grow this product more, I've got to add more parts on it, after you put on three or four porches and what not all of a sudden you're short of money. And the next round of money you raise you get less money for your shares. And we went through several rounds of shares that way. And also we were at the point where they didn't want shares. They wanted preferred shares. So they wanted to get paid whether they rest do or not. So we had a couple of rounds of preferred stock. But now I should tell you I think we had something like eight or nine quarters of profitability in between. So at one time our market share, our market valuation was one third of a billion dollars but I couldn't sell stock.

GH: Right, because you're locked up.

CB: I was locked up.

GH: I know.

CB: So my career within it lasted fourteen years. It was an interesting fourteen years. Exciting, kept me alive and well and well paid. And sold a lot of versions of the data structure diagram drawer. So it was a good idea. It kept us away from the bread line for fifteen years.

GH: Right. That's pretty good.

CB: Long enough that we could buy a house in retirement and buy a house in Tucson Arizona and then sell it for twice what we paid for it.

GH: There's nothing wrong with that.

CB: So the time we put that money in and other money we'd been saving we had a lot of bond stocks. I mean shares of bond we owned, mostly government bonds which has taken care of us to get us here.

GH: Good. What happened in the end to Bachman and the tools that helped you with data structure diagrams?

CB: Well, the tools-- I guess that people work habits changed they weren't designing the big databases anymore. And so that the structured going back to the words I can't remember. Structure query language, SQL, people were doing smaller things, quick and dirty or they weren't investing in long term production of a database. Performance was not important or didn't have the same level of importance. And also processors are faster and cheaper and memory is larger.

GH: Yeah, Moore's law was meaning you could use less and less efficient software technologies and still get the results you needed for the price and speed.

CB: Yes.

GH: Sloppier and sloppier software still worked just fine.

CB: That's right. Still worked absolutely. And it was the right solution for the customers. I don't fault them for doing that because they wanted results. People wanted their results faster and faster too. They didn't spend two years on a system or a three years on a system.

GH: Right. And that's why the relational model became more popular.

CB: Yes.

GH: You didn't have to do all of the planning that you had to do.

CB: Right. Well, it turns out and people keep telling me that the thing you're missing Charlie is looking at the database managers add-ons. They go in behind what you do with your SQL. You can declare something. But they'll set up what the indexes are and what not. So you get things that are very much like IDS behind the scenes.

GH: Mm-hmm.

CB: Because if they know this is a big operation, it's going to go on for—- they will invest time in packaging the actual storage for performance reasons. Even behind the scenes on something which apparently has no storage structure.

GH: Yes.

CB: The query user doesn't have to know about it, because it'll run faster or slower depending on how well the database administrator has made his contribution to the definitions.

GH: Okay. Good. And so is the structuring product still available? Does somebody still sell it?

CB: No one's selling it anymore.

GH: No one's selling it.

CB: I'm still using it and I give it to people.

GH: Yes? You should make it shareware, yes, be available. What happened to the company? It got bought, didn't it?

CB: Yeah, bought by the Texas people who eventually got bought by Computer Associates.

GH: Oh, okay. So it ended up at Computer Associates?

CB: It ended up at Computer Associates.

GH: Okay. Yeah well, that wouldn't be the worst place because they also, as you just mentioned a few minutes ago, they support an awful lot of legacy databases.

CB: Yes.

GH: Yes. That are hierarchical and can use, you know...

CB: Well there apparently are a lot of tools out there that do things very much like data structure diagrams. Peter Chen drew one, it's... made a reputation for himself for a slightly different version... and has won a lot of prizes for himself.

GH: Okay, alright. So there's still people.

CB: Still people out there, yes.

GH: Yes, trying to solve the same problem you were.

CB: Right.

GH: Right. Do you have any other things you'd like to leave with our viewers or our transcript readers, before we end this video?

CB: No, I think I'm pooped.

GH: I think you've done extremely well.

CB: Well I thank you for that.

GH: Okay, well thank you very much Charlie, for taking the time and effort to go and do this. It's been wonderful.

CB: Well, it's been a fun experience. I don't think of it as being work, I just think it's been exciting.

GH: Okay, good. Well thank you on behalf of the Computer History Museum…

END OF INTERVIEW