Oral History of David C. Walden

Interviewed by:
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Editor Notes:
The notes in square brackets are clarifications added by the interviewee during the process of reviewing for accuracy the typed transcript of the oral interview.

The interviewers met with a number of BBN and ex-BBN people during their couple-of-days 2009 visit to the company. This interview is in the context of those other interviews and, thus, the interviewers and interviewee naturally mentioned those other interviewees in this interview without providing additional context.

START OF TAPE 1

Marc Weber: I'm Marc Weber of the Computer History Museum and I'm here today with Dave Walden, who is an ARPANET pioneer and past president of BBN. And I'm here with Gardner Hendrie of the Computer History Museum and we're both interviewing Dave. We're at BBN itself, so Dave thank you for joining us. Just start by saying a little bit about where you were born, what got you interested in computers.

Gardner Hendrie: I would like to stop for a second here, one more adjustment, sorry.

Weber: So just start by saying a little bit about where you were born, where you grew up and what got you interested in computers or things that led you to computers.

David Walden: Okay. Two things before that. One is maybe I'll take off my glasses so there's not so much glare if there is glare. The other is I want to correct you. I was not president of BBN, the whole thing. I was president of BBN Technologies, the contract research and development division, president of some other divisions at other times but president of what you know as BBN Technologies. Where was I born? I was born in Longview, Washington. When I was two months old, my parents moved to California. They were schoolteachers north of Sacramento in a little town called Gridley. When I was four years old we moved to Pittsburg, California, where my father was a high schoolteacher and my mother was an elementary schoolteacher. If you don't know where Pittsburg is, it's in the San Joaquin Delta about 35-40 miles east of San Francisco. We lived there until I was in about the eighth grade at which time we moved to Antioch, the adjacent town, where by that time my mother was an elementary schoolteacher and I graduated from high school in Antioch.

Weber: What did your parents teach?

Walden: My mother, as I said, was an elementary schoolteacher. She taught Kindergarten and second grade mostly. In fact, many of my friends who I went to high school with had her for a reading teacher. They learned to read from my mother. My father was a high school chemistry and physics teacher in Pittsburg until he retired.

Weber: And then were you interested in technical things? When did you start getting interested in technical subjects?

Walden: Well, I was always. My father was a high school chemistry and physics teacher so I was interested in chemistry and physics pretty early. In fact, my father's approach the high school chemistry

and physics was that he had his kids grade the papers. They tended to be multiple choice or specific answers rather than vague answers and so my older sister started grading high school chemistry and physics papers. She was eight years older than I am. I started when I was quite young. [I think] my younger sister and younger brother ended up doing it. So I learned a lot about high school chemistry and physics before I got to high school. And I was good at math. It was pretty easy for me. If your question really is how did I get interested in computers, that took quite a long time because computers weren't a big deal in 1960. When I graduated from high school, I went off to Berkeley to architecture school at the University of California. I played a lot of [the card game] hearts and therefore got suspended from Berkeley. I didn't actually get suspended but I was told I couldn't stay in the architecture department. So I decided to go to Diablo Valley College, the junior college, in Concord or Pleasant Hill. I'm not sure which [it was Pleasant Hill]. I went there for a year and a half as a civil engineering major to try to get my grade point back up so I could get into a four-year school again—did very well. I was a civil engineering major there—that was as close as I could stay to architecture. By the time I got to San Francisco State, which is where I did transfer to, I was pretty bored with civil engineering. That didn't seem like an interesting subject, so I switched to structural engineering, still trying to stay close to architecture. That didn't seem very interesting and so in the second half of my junior year, I switched to math. The reason I switched to math it was the only subject I had been taking ever since I started in architecture and therefore the only way I could still graduate in four years. I graduated from San Francisco State. I was not a good math major. I graduated from San Francisco State with my grade point average in my major being lower than my overall grade point average. But in my second half of my senior year when I became a math major, I took a numerical analysis course, and the numerical analysis course had an exercise on the [IBM] 1620 computer in the school [actually a department] computer center and suddenly I got very interested in computers and I started spending lots of time, day and night, in the computer center. I had a sleeping bag at the computer center so that when I didn't go home to my apartment, I'd have a warm place to be.

Weber: Where would you put it?

Walden: Just on the floor. Stan Mazor who you may know of—Stan is one of the three inventors of the first Intel computer—was a staff assistant in the computer center—1620 center—at San Francisco State; and Stan was helping me, saw I was enthusiastic and so between my junior and senior year I got a phone call from Stan saying, "Would you like to be on the staff of the computer center helping other people next year in your senior year?" I said, "Yes," and spent the entire next year getting bad grades in math, getting good enough grades in other subjects to graduate, and spending most of my time in the computer center. As a result, it became pretty clear to me I couldn't be a math professional, but this computer thing seemed pretty interesting. So on the back of Scientific American there was a Lincoln Laboratories ad often, in those days (an L going one way and an L going the other way] and there was one for NSA. So I sent a resume to NSA and Lincoln Lab. They both said, "Come for an interview." I asked Lincoln Lab, "Will you pay for my trip?" And they said, "No, we don't pay for programmers' trips. [In effect saying that] they're not real scientists. They're not engineers or they're not mathematicians or physicists. They're just staff assistants so we don't pay for trips for them.) But if you can get there [to Boston], we'd love to interview you." NSA said they would pay for my trip, so I went to NSA. And then I called Lincoln Lab and said, "Will you pay for a trip from Baltimore to Boston?" And they said, "No, but if you get to Boston we'll put you up overnight." So I flew up to Boston. I was interviewed by Frank Heart and a few other people at Lincoln Lab. I guess they saw some enthusiasm. (I certainly didn't have good grades or anything [to go by].) And they offered me a job. I called Lincoln Lab and said, "Will you move me to Boston?" And they said, "No, we don't do that for staff assistants." I said, "Well, I'll go anyway" and, of course, that was the making of my career. Little did I know when I got to Lincoln Labs [that] I was at one of the great research laboratories in the world with all these very, very smart people. Will Crowther, whose name you may have heard, [later] invented the first computer game. I was given to him as his, basically his, to do with what he

wanted. There was a project called the Lincoln Experimental Terminal. I was his assistant. He was the [software] project leader. And there were other more senior people on the project. I basically followed him around, and he taught me stuff. And pretty soon, Frank Heart came around and said [in effect that]: You know we're treating you as a staff assistant. You're being paid as a staff assistant. Your title is a staff assistant but when I take you out of this three person office (which was what a Lincoln Lab staff assistant gets), I'll put you in an office with just Willie alone (a two person office which is what staff members get). And ever after, Frank treated me very nicely. He treated me like a staff member, although I wasn't one; and after I had been there probably six months he raised my pay. So I thought, "He's a pretty enlightened guy." He saw somebody who was interested, trying hard, enthusiastic, and he encouraged me; and that's really how I got into computing—the combination of at San Francisco State getting enticed by it, having the good luck to be invited by Lincoln Lab to go there, making the decision to pay my own way, being assigned to Frank, and having Willie really teach me how to do computer programming.

Weber: And how old was Will compared to you at the time?

Walden: I think Will is eight years older than I am.

Weber: And what year was it you came to Boston?

Walden: I came to Lincoln Lab in the summer of '64.

Weber: And so Will had already been at Lincoln Lab?

Walden: Yeah, Will had been at Lincoln Lab for some time. I can't quite remember Will's background. I mean he worked on the Whirlwind Project with Frank. I don't know if he was there before MITRE spun off [from Lincoln Lab] or not but in any case he was in Group 62, which was the Space Communications Division Group that Frank was the assistant group leader for (associate group leader I guess), which was doing the digital software and hardware and the interface to the analog world for pointing radar antennas, such as the Haystack antenna they just finished when I got there and the Lincoln Experimental Terminal which is what we worked on when I did get there.

Weber: And why were you so sure you preferred Lincoln Lab over NSA?

Walden: Well, I mean NSA asks you all kinds of questions that you really don't like to hear like, "Have you ever smoked marijuana?" Well I went to San Francisco State, and at San Francisco State at the time I was there . . . you remember the student uprisings were happening at San Francisco State even before they got famous at Berkeley, although at that point it tended to be civil rights rather than student rights. There were times when I was at San Francisco State when it was unclear which smell was more prevalent, marijuana or teargas. So it was a little bit of a tense thing with NSA. Lincoln Lab seemed like it was going to be a fun place. I had liked Frank. At NSA I didn't know who I would be working for. And Lincoln Lab called me up and said, "You'll be working for this guy Frank Heart." Frank (you interviewed him I believe yesterday) is a very enthusiastic, fun guy and that attracted me and perhaps my enthusiasm was attractive to him as well.

Weber: What was the culture like at Lincoln Lab at the time?

Walden: Well, it's very smart people working on interesting projects. It's an engineering place. They do engineering. The only trouble I had with the culture was that they didn't think computer programmers were real people at that time. They thought: physics, math, engineering – those are real subjects. Computer programming is not a real subject. Now they learned their lesson I believe. I came to BBN in 1967 following Frank here eventually (a little while after he left), and later Lincoln Lab tried to recruit me back saying, "We'll make you a staff member this time." So with the exception of the issue that they didn't think computer people (when computers were going to be about the biggest deal going) were real staff members, I thought the culture was great – loved it, day and night.

Weber: So Will was not officially a programmer then?

Walden: Well, Will was a Physics major.

Weber: Right, so he was a staff member?

Walden: Yeah, yeah, sure, no, yeah. I mean all [actually most of] the computer programmers or all [most of] the people there who were programming computers were physics, math, engineering people. And then there were a few of us who were [only] computer people. I don't think they counted my math degree and they shouldn't have [as I was a weak math major]. We were [only] computer people, and therefore we were not staff.

Weber: Support function theoretically?

Walden: Yeah and so, again, Frank was terrific. Frank assigned me to Will. Will is not a hierarchical kind of guy. He took me everywhere. He'd give me a little piece of code to write. I'd write it. Or if I struggled, he'd show me how to get through it. He was the one putting this Lincoln Experimental Terminal system together—[with] programs from a number of people. I went with Will and watched him put it together. I helped him put it together. So by the time I'd been there a year, year-and-a-half, I had had amazing experience with doing system integration of very complicated systems with who I still believe is probably one of the smartest guys in the world at building real-time computer systems. And, as I said, we got to share a two person office. And I'd be sitting there struggling; and he'd say, "Hey, what's up Dave? You keep throwing pieces of paper away. What's going on?" And I'd say, "Well, here's what's happening." And he'd talk to me about it a little and send me back to work, and I'd work on it. It was a unique experience and a fantastic benefit of having two person offices. If you had your own private office maybe down at the other end of some hall, I never would have had that.

Weber: Describe the experimental terminal a little bit.

Walden: I can't remember too much about it. The Lincoln Experimental Terminal was some kind of a thing pulled on a little trailer with a little van with a radar antenna on the top that could either point at satellites or the moon and [some of] the particular software I wrote had to do with reading the ephemerae for the positions of the moon, and writing the math sub-routines, and then the integration [into the rest of the system]. But, basically, Lincoln at the time was experimenting with satellites for communication purposes, and so we did that. We built a real-time computer system that had a—I'm trying to remember. It was probably a Honeywell 1218 computer in this little van and pointed the radar antenna.

Weber: And you were only on the software side at that point?

Walden: Yeah, yeah, yeah. Will was integrating all the software. There were, as I said, three or four people writing software: Will; I was writing software; Art Mathiasen was writing software; John Drynan was writing software; and a couple of other people. There were a couple of other guys, Paul Smith and Steve Russell (a different Steve Russell than the Space War Steve Russell), who worked at the [analog/digital] interface. And then a different sub-department or a different—yeah, a different sub-department in our group or a different department in our group was actually doing the radio frequency stuff, if that's what you call it, with the radar antenna.

Weber: Just describe a little bit what Frank and Will were like at the time.

Walden: Well, Frank was about the way he probably is today. I haven't seen him in several months but he's still a quite dynamic person. He was a very dynamic person then. If he got excited he talked in a kind of [loud] squeaky voice. I already told you that Frank was a guy who saw something in me that he was willing to sort of violate the rules in mild ways to make my life better and to develop me. I mean I ended up working with Frank for many, many, many years, so I mean I have great experience with Frank. Frank is a guy who is pretty focused on getting the job done and finding the right small set of people or a small set of people who has the capability to get the job done. Frank, as you've probably heard other people say, tends to be a defensive systems designer: how can we think about what goes wrong and let's make sure that doesn't happen? So as we talk more about the ARPANET we'll probably come back to Frank. Frank is an outstanding manager in many ways. One thing that's true about Frank is that he can be a loud, kind of pushy manager. If he doesn't think you're doing the right thing, he'll tell you so and that could be off putting. The thing that eventually one figures out if one's going to get along well with Frank is he likes people who push back, especially if you turn out to be more or less right. So you don't have to be afraid of Frank. And, in particular, certainly on the ARPANET stuff, if we ganged up on him he would relent. If Will and Severo [Ornstein] and Ben [Barker] and I were all saying, "No, we ought to do this," and Frank was saying, "No, we ought to do that," Frank might say, "Well, I still think I'm right but okay let's do that [your way]." So he wasn't a hierarchical guy in the sense of saying, "I'm the boss. Do what I want to do." He was looking for good engineering solutions, and he understood that if he got smart engineers around him they were going to have ideas.

Will is a soft spoken guy who was an unbelievable mentor to me. He just worked with me like I was a regular person, like I was an experienced engineer. It was a joy to work with him – very smart, very clever, showed me a lot about debugging real time systems and putting them together and clever algorithms and so on. Such that when I got here and a year or so later we had the opportunity to bid on the ARPANET contract and we did bid on the ARPANET contract and I was working on the software design for our proposal which hadn't yet gone in, and it became clear to me it was going to be a pretty important, pretty complex system possibly over my head, I went to Frank and Severo and said, "Hey, it's time we get Will to come and join me here" because this project is going to be a lot better off if Will's here rather than I'm trying to do this myself. And so he effectively became the software leader for the project, although I was first on the project. He and I were a partnership too as was Bernie Cosell who was the third software guy on the ARPANET. Later on, I went off to Norway, worked for a year for Norsk Data, [and later] came back. Will was never going to be a great manager of people, and Frank put me in charge of the ARPANET team, software team, and Will worked for me but we still were a team. You don't tell Will how to do software. You ask him what he's doing. Ask how can you help? So we got along great all the time. Then he went out to Xerox Park and then he came back, and he was in the next office to me for several more years; but we worked with each other much less during that time.

Weber: So going back, so you were at Lincoln Labs.

Walden: Yeah.

Weber: So describe if there's more that you did there before coming here.

Walden: Sure. Well we worked of Lincoln Experimental Terminal, and then I worked with Ben Gold and Charlie Radar and people like that. Will and I both worked with them on speech signal processing, and then Frank left. He was enticed to come to BBN. And Frank was very good in the sense that he didn't try to poach people from Lincoln Lab. By this time, I was getting . . . And so what they [department management] did with me is they told me to go write Fortran programs for other engineers. Life changed for me quite a lot. Meantime, I had started working at getting a graduate degree in computer science at MIT. Frank had fixed it so that I could be a part-time graduate student even though MIT technically, I don't think, had part-time graduate students. So after awhile I went to the group leader and said, (this is after Frank had gone) said, "This isn't so great writing the Fortran programs for the engineers and I'd like to be a staff member." And he said, "Well if you finish your degree at MIT, your Master's degree at MIT, then you can be a staff member." I wasn't so enthusiastic about that although I did intend to finish. It seemed to me they weren't valuing me as much as they might and certainly weren't using me as cleverly as they might. So one day when I was driving back to Cambridge (I lived in Cambridge; Lincoln Lab was in Lexington), I looked up where BBN was [in Cambridge], and I stopped by with no appointment, knocked on the door and said, "Is Frank Heart here?" Frank came and showed me around and (as I said, Frank didn't poach but once you arrived on his doorstep he thought he'd done his part about not poaching) and he said, "Would you like to get a job offer?" And I said, "Sure, love to see one." I went back to Lincoln the next day and a couple days later got a job offer from BBN to be a staff member, not an assistant staff assistant, for a higher pay by a little bit. Back then a couple of thousand dollars was a lot more. I can't remember what I started at Lincoln Lab for but it was certainly under $10,000 in 1964 dollars. I accepted the [BBN] offer. I gave my notice [to Lincoln Lab]. Two weeks later I finished on Lincoln Lab on a Friday and Saturday morning I came and knocked on the door here [at BBN and got the janitor to let me in. They told me where my office was and I started programming on the time-shared computer which was here. So I started work on the weekend before I signed in. I was so enthusiastic about coming here and having a teletype with its own keyboard, and I could start learning to program the PDP-1. So that's what happened.

Weber: And that was this building then?

Walden: That was this building.

Weber: Where the IMP lab was, I mean where the IMP group was later?

Walden: The IMP group was in this building roughly, yes. My office was over there. It's in the middle of what's the set of cubicles behind Jenny [Connolly]'s office right now. There used to be a hall that way.

Weber: And did you share an office here?

Walden: No, I had an office of my own here. I was across the hall from Bernie Cosell. Will wasn't here yet, and I did a number of things for a year—various projects, with various people—met Bob Kahn and we went out and did a database management system study at one point for I don't remember who, the Air

Force maybe. Bob was in another division on the other side of this bridge [between buildings]. And then the opportunity came to bid on the ARPANET. Bob knew about that. Frank was appointed the proposal leader. He rounded up Severo who had been working with Wally Feurzeig on the Logo kinds of stuff but he was here. Severo Ornstein and me, Hawley Rising I guess. I think Hawley was helping, H-A-W-L-E-Y Rising. He died many years ago. We started learning about packet switching from Bob Kahn, who knew something about it already, and dreaming up what a proposal might be like.

Weber: So you were living in Cambridge, and what was your project?

Walden: Well by that time I may have actually been living in Allston, now that I think about it. I got married in '66, so by the time Frank was here [at BBN] I was either living in Cambridge or Allston. I can't remember which one but close.

Weber: And your wife was from back here?

Walden: My wife is from outside New York City, Westchester County, so that kept me in New England the rest of my life which is okay.

Weber: So there was the request for proposal and then—describe that.

Walden: Well, so we worked on it and because Bob [Kahn] was here he could tell us some stuff [before] the request for proposals [came out].[1] So we were thinking about packet switching before the request for proposals came out. Then the request for proposals came out. Then we addressed it, and we addressed it basically the way Frank and any of his teams (probably Bob too if he had been the leader; he didn't happen to be) would have addressed it—maybe the way any of us would have addressed it which is how do we do a good system design. If it didn't make so much sense (what they said in the proposal), let's propose something different that works better. And we did a very complete design. Sometime along the line we got Will [Crowther to join us from MIT Lincoln Laboratory], and Will and I, we, wrote the inner loop of the program and counted the instructions so we knew the performance of the system before we sent in our proposal.

Weber: How long did it take to write that?

Walden: I can't remember. It's a few months, a few months. It was at that time the most expensive proposal BBN had ever done I believe.[2] I can't remember—maybe $50,000 it cost BBN or something. I don't remember. Anyway, so we were awarded the contract and there's different stories of why we were awarded it. I certainly think one component of that is that we had a very good overall system design, integrated system design, with very high performance, compared probably to what some of the big companies did which were probably more typical system integration with much lower performance. Or there are some tiny companies like [Jacoby Systems where] Steve Crocker and Vince Cerf [helped] bid on the ARPANET and they probably weren't realistic bidders. One of the rumors is that Wes Clark told Larry Roberts that Frank Heart was the guy to lead this and BBN should get the contract because Frank and his team could pull it off. Bob Taylor says that he was the one that told Larry Roberts that he had to choose BBN because Larry was going to choose Raytheon. Who knows which of those is true. In any

[1] The request for proposal is available at http://walden-family.com/bbn/arpanet-rfq.pdf
[2] Our proposal is available at http://walden-family.com/bbn/arpanet-prop-ocr.pdf

case, what I said before I think is certainly true. We put in a really good proposal, very tightly integrated, very detailed, so when we won the contract we were in effect doing our second design iteration which I think probably was part of the reason [we won]: a) we had done so much already; and, b) we got to refine it so much in those first months before we had to deliver any systems I think it's part of the reason the system, a pretty complicated system, got running in quite such a short time.

Weber: And the fact that you had done some of the software as part of the proposal.

Walden: No, we hadn't done any of the software [coding] as part of the proposal, not significant. What we did do is [code] the inner loop, and the inner loop is a few hundred instructions so it's not much of the many thousands of instructions but it's the instructions which run all the time. So if you sketch that inner loop out and count the cycles the system is going to run only a little bit slower than that because the other stuff is going to run more seldom or really more seldom. [We also did include an overall block diagram of our software architecture.]

Weber: Right so that's your basic limit?

Walden: Yeah. So we knew how many packets per second we could basically process.

Weber: And describe that. I mean what was some of your thinking in the design? I mean at a technical level why did you make the choices you did in developing the proposal? I mean there wasn't a lot of experience with this before that.

Walden: Well, I don't think there was any.

Hendrie: Maybe a way to approach, I think, where you're going is, when you got the proposal, what were the biggest things that you sort of scratched your head and said, "Oh how are we going to do this?"

Walden: Well, let me talk a little bit and we'll see what comes out. I think that in some sense there was nothing so hard. It hadn't been done before. It was a real time system. We had written real time systems before. You write the code so that it takes in a packet. It ships out a packet. So it wasn't so hard in some sense especially since there was no [pre-specified] answer. What we did would be good enough if it was good enough. Today, if somebody wanted to build a router, I don't know how many million lines of code you probably have to write to handle all the protocols and stuff. There weren't any protocols. We had to handle IMP to IMP, IMP to user computer, end-IMP to source-IMP. There wasn't very much to do: thousands of instructions, of course, but in some sense not so hard. Now, we did one thing which is we modified the Honeywell computer so that it had a hardware interrupt that the program could set and that turned out to matter a good bit because you didn't have to be checking all the time, "Is there one of these background tasks that needs to run" such as routing or whatever?

Weber: Frank said the other day the Honeywell was particularly suited to that right?

Walden: Well, let me digress a second. We chose the Honeywell computer probably because Alex McKenzie and I had analyzed a whole bunch of mini computers for another project and had come up with the fact that the Honeywell machine was probably the best minicomputer around in terms of flexibility, performance, price, and so on at that time. So for some other project we had done a study. So then we

brought the Honeywell computer to the decision making process and Severo and Frank and the others who were thinking about the hardware side (and me thinking about the software side) concluded, sure enough, it could do the job especially if we modified the hardware and the hardware was modifiable, so we wrote—Severo implemented hardware on the host side and hardware on the modem side to handle the special functions and then we wrote the code to use that hardware. And another thing we did was this software settable hardware interrupt that we thought would be very useful. This is back to my point that we had a very tightly integrated system. We weren't doing system integration in the sense where you take this box and this box and you put them together with alligator clips. We were deciding what needs to be done in hardware because you need the speed and let's build the hardware if necessary to do that. And what can be done in software because it's general and doesn't have to be done in software [prior word should be hardware] and let's do the software to do that. So we wanted to modify the Honeywell machine and did modify the Honeywell machine in these several ways. So that's an issue we thought about the whole time was what should be in hardware—what should be in software? For instance, the CRC checksum for the modem line clearly had to be in hardware and Bob Kahn specified it and Severo and eventually Ben Barker with him implemented it. So that was another area of focus of our design was how we make this high performance; do real system design as opposed to superficial system integration. Now another question was how we did routing, and Will came up with a routing algorithm (I helped him a bit) which eventually has been implemented all over the world. Things like that are called rip, R-I-P. It's so-called distance vector routing, and it was the first, as far as I know, dynamic network routing that was going. In fact, the proposal—the request for proposal—proposed a central control routing system. It said, "We don't know how you're going to do routing but here's one way you might do it. There's a central system. It sends out updates of routing to places." So we implemented this dynamic routing algorithm which is probably one of the first actual distributed algorithms, because there weren't so many distributed algorithms running [then] on quite this scale.

Weber: And how did Will come up with that?

Walden: He's a smart guy. Somebody, I don't know who said it but somebody said, that anything profound is obvious once you see it which is probably true because if it's all complex and hairy then it's probably not actually profound. If it's profound it's probably sort of simple and it's pretty obvious, and Will has a knack for seeing the profound. And, in fact, it's so obvious that the academics in later years, the mathematicians, have said it was not original and it was invented by Bellman and Ford and somebody else [Moore] and it's just a trivial expansion of a shortest path method done in a single computer. Well it turns out it's not such a trivial expansion, and it was original. And maybe it's not original, but we didn't know about any of those, so we implemented that and we had that. Another area which was an area of great discussion was the end-to-end source-IMP to destination-IMP storage allocation with Bob Kahn and Will arguing all the time and Will pretty convinced that the algorithm he came up with was a good one and the rest of us going along with Will because we knew Will well, and we knew Will was smart. Bob was the theoretician, and Bob was right and that algorithm didn't work. Bob and I went out to California as soon as the first four IMPs were in. We ran the experiment. It locked up immediately, and we came back and Will and Bob had some more meetings, and then Will implemented a big change on that to make the source-IMP to destination-IMP stuff work. So there's an example where there was a lot of discussion, and we got the wrong answer. Now it took awhile to implement that because the network was growing very rapidly, [but] because the way the network worked in those early days it wasn't a very big problem. We basically said to all the IMP sites, "We know that you can send traffic in a way that locks up the network. Please don't do it while we fix it." I don't know if it was [as much as] a year to fix it but quite a long time. So one can make the argument (I will make the argument) that it was probably better to get the thing implemented, running, even with this bug (that Bob would have forecast—[to] do the second round of engineering and put out the fix) than to have struggled too long to find a solution which didn't have this

end-to-end problem because the experiments were going on from the time there were almost no IMPs and all the time this bug was still in the system.

Weber: And describe the end-to-end problem and the solution.

Walden: Well the end-to-end problem is basically . . . it's a little complicated to describe and there are a bunch of papers. Look for papers by Will Crowther and Bob Kahn. Len Kleinrock has written many papers in which he loves to point out how the BBN guys got it wrong. Basically the thing is we invented some concept called the virtual link from the source to the destination and said there could only be so many packets on a link from one source-IMP to one destination-IMP. But it turns out there's packets coming from many places and you're having to reassemble eight-packet messages at the destination IMP. If they're coming from several different places, that's simply not enough storage, and you get in a deadlock situation where you've got incomplete messages from multiple sources and you're locked up. So you had to go to a system where there was . . . in fact, an explicit allocation that this machine is going to send eight packets to this machine. You better allocate eight packets of storage so that when the packets eventually get there they can be reassembled, and then you can tell the other source it can throw them away and then the destination can empty out. So it's basically a storage competition lockup issue.

Weber: And the solution is to reserve the space.

Walden: Reserve the space. And I don't really know what goes on in the Internet after the ARPANET days and the TCP/IP days and stuff; but I think none of that exists anymore because it's all been moved up to the host level. Because different networks have different size messages in terms of numbers of packets, once you start having multiple networks you really can't have the network reassembling messages from packets. You have to be reassembling whatever it is at the higher level.

Weber: Can we pause?

Walden: Sure.

Weber: Great.

END OF TAPE 1

START OF TAPE 2

Walden: Just as, you know, at the break you mentioned, you know, if you wanted to have any disclaimer or anything, feel free, that anything I say is how I remember it. And each of us remembers it differently. So I may sound very authoritative and facile, but that doesn't <laughs> mean I'm remembering it correctly. And I remember, when Katie Hafner was working on her book I, one of the things she did is, if she found a discrepancy, she had the different people at BBN and throughout the Internet (and she [had] interviewed basically everybody) exchange email messages until they sorted out their inconsistent memories. And inevitably, all of us were a little bit wrong, or at least what we came to <laughs>, which might still be wrong, was not what any particular person exactly remembered. So I remember it as I remember it <laughs>.

Weber: Well, it sounds good.

Walden: It does—that's very important. I remember when I was in high school band. The band director gave us this very important instruction I've tried to live by the rest of my life, which is, you know, if the drum major says "Band left" and you happen to go right, march with your knees high and keep marching until you get back into position in the band; they'll never know <laughs> that it wasn't part of the formation.

Weber: <laughs> That's good. In the chronology when you're talking about how you got the proposal accepted and you were developing the system, what was the—

Walden: Well, we went to work <laughs> basically on I think January 1st of 1969. I think that's when the contract began, I'm not completely sure, but I think that's it. We were notified late in 1968; we went to work on January 1st of 1969. And, you know, we'd begun to think about it already. And shortly a couple of other people were added to the team, Bernie Cosell and Ben Barker on the hardware and software sides, in the reverse [order]; it was Ben Barker on hardware, Bernie Cosell on the software. And we coded <laughs> and we engineered, and Bob Kahn worked on CRC designs, 24-bit checksum designs. And Bob Kahn talked to the common carriers, or I guess—I can't remember who he talked to, he talked to an Air Force base somewhere, which was the group that was doing the procurement of the 303 modems for the 50-kilobit lines. Bob Kahn talked to them and got the modems put in. And we had meetings typically; we wrote things called "IMP Guys Memos." It's a famous series; unfortunately nobody seems to have kept a set. One of the things we did was we tended to document what we were thinking about. I [you] have an idea, you'd write it out, you'd give it a number, it's IMP Guys Memo Number 7 or 18 or whatever. Everybody in the group would read it, maybe somebody would respond. It was the working notes, it ended up being—I don't know—a binder this thick or maybe two binders. And we've never been able to find a copy after a certain point. And that was in the old days. It was all before it was on a computer, you know. It was mostly . . . it was done on a electric typewriter, penciled-in drawings. So we did a system design; we did a system implementation. As the Honeywell 516s came in modified, we started putting software in them and having them talk to each other. And eventually shipped them to California and shipped one to SRI and then one to Santa Barbara and then one to Utah. With each of those, somebody went to the site to meet the airplane freighter and meet the moving company, which was gonna take it from the freight company. And then went and put the program in the software [previous word should be computer] and ran it. So basically we just worked basically day and night from January to—was it October 1st I think the first IMP went in at UCLA, something like that? September 1st?

Weber: Yeah, the first message to SRI was the 29th I think.

Walden: Of what?

Weber: Of October, does that sound right?

Walden: That might have been, so that's almost the beginning of November, which means maybe SRI had gotten in by that time.

Weber: Yeah, the first message between UCLA and SRI.

Walden: Yeah, so the 1st of October-ish, or maybe the 1st of September, Memorial Day, it was the 1st of September. Because I think Steve Crocker's story is something about they thought the holiday was going to save them. <laughs> They weren't ready. Is Memorial Day in September?

Weber: Yeah.

Hendrie: No, Labor Day.

Walden: No, Labor Day, they thought Labor Day was going to save them <laughs>. And the machine came. And they were still getting ready.

Weber: Did you go out with any of—?

Walden: Ben Barker went with the first machine. My memory is that some days later I went out. I certainly was the guy who met the Utah machine. And I ended up being the software maintainer, so when we had a new release before we had the 5th IMP here (there were only four [all on the West coast]), I would get on an airplane and fly to Utah and put it in and then fly to SRI and then fly to Santa Barbara and then fly to UCLA. And then as soon as we had one here, we could do cross-net loading. The listing was on the table beside my telephone in Allston; people would call me at any time of the day or night. So I was very hands-on. My home phone number was on the front of the IMPs until I went away to Norway in September of 1970. I was the—

Weber: <laughs> Technical Support.

Walden: I was Technical Support.

Weber: Do you remember any funny stories—?

Walden: Oh no, not particularly. I mean, certainly interesting things happened probably during that period, some famous things like the bit being dropped in the Harvard machine that caused all packets in the whole network to be routed to Harvard. And as a result we put software checksums on the routing messages so that wouldn't happen again. So sure, some stuff happened, but I don't remember anything in particular.

Weber: What was it like? It must've been excited to have all this start up?

Walden: Well, the question that people always ask me when they find out I was involved in the early days of the Internet is "Did you know it was going to be a big deal then?" And my answer is somebody might have, you know, maybe Bob Kahn would claim he did or maybe Larry Roberts anticipated it. I don't know. What I knew was it was an interesting project, an interesting engineering project. And in time it sort of dawned on me it was pretty important. Because it was a good improvement on either message switching or circuit switching and the telephone companies hated it so much. The telephone companies kept saying it couldn't work. We had it running in the field, and they were saying it wouldn't work. Well, my intuition at the time was if the establishment is saying this is a bad thing, <laughs> maybe it's an important thing. But the real realization I had was after Ray Tomlinson did the demonstration of email, and email took off. And

then from that moment on, I was convinced the ARPANET or packet switching or what became the Internet was going to be everywhere in the world. And my surprise was it didn't come 15 years earlier. You know, it really only hit the world with the World Wide Web. It'd been all over the place, but it really got to be ubiquitous then. And we used to talk about—shortly after Ray did the first network email (by the way, email already existed) but network email demonstration—we used to talk about there being a packet switch that would get smaller and there'd soon some day would be one in every doorknob and toaster. And then sure enough, that's been happening. Bob Bressler, who worked at BBN for a number of years, sends me messages once in a while saying "Here's a toaster with a <laughs> with a router in it." Or <laughs> "Here I am controlling my doorknob with packets." The other thing of course—what the world has become impressed with—was the Internet. And one could argue the ARPANET was the beginning of that; I think it's a good argument. The bigger change, of course, was packets. And packets are used well beyond the Internet; I mean, they're everywhere. So packet switching was the . . . in some sense, the more important technology that we were participating [in] and demonstrating feasibility for.

Weber: And how much were you guys aware of The National Physical Laboratory in England?

Walden: Oh, we were aware of them, absolutely.

Weber: 'Cause I mean, they were doing very parallel things.

Walden: Yeah, sure, yeah, we thought it was pretty fortunate that we had this <laughs> neat ARPA contract, and there was a plan for deploying 19 IMPs, while those guys were trying to get their three prototypes running. Yeah, we were absolutely—knew of them and we were in contact with them. I mean, I wasn't personally. Eventually I was.

Weber: Who was?

Walden: Frank … Larry Roberts—

Weber: So you didn't meet Donald Davies until later?

Walden: But pretty early, yeah, you know, sometimes I was on a trip to the UK and I went and visited The National Physic Laboratory, and Derek Barber, Donald Davies and Roger Scantlebury were there, and they took me around. Sure, we were pretty aware of it.

Weber: And they used a Honeywell as well?

Walden: I don't remember.

Weber: And Louis Pouzin and—?

Walden: Well, I had a lot to do with—Alex and I had a lot to do with Louis. Louis Pouzin hired BBN and in particular I was given the little consulting contract to visit them periodically, quarterly basically, to tell them about the ARPANET technology. And they had people came here to study it as well. Gerard Lelann certainly came here, I can't remember if Hubert Zimmerman came here or not.

Weber: And you went there?

Walden: Hmm?

Weber: When did you first go there?

Walden: I don't remember the date, but I went there four times a year for a while until I got tired, and then Alex began going in my place. But the important thing about that is what Louis's goal was in having us consult to him. His goal was to make sure he didn't do anything we were doing. I asked him one time "Well, why are you building things all different? We've got this technology running", by then running in substantially many places. And he said "Well, you've got it running there [in the ARPANET]; if we do the same thing, it'll become the de facto standard of the world. If we do something different, than maybe the French way will become the standard." <laughs> And that had to be—that was probably, I don't know, when Cyclades happened, but certainly after I came back from my year in Norway. So it had to be '72, '73, sometimes in there.

Weber: So you went to Norway—?

Walden: Well, my wife and I had wanted to live in Europe. I got married and we talked about living in Europe, and I worked day and night for quite a while on the Internet, I mean on the ARPANET. We had a child. I can't remember exactly how tied into my draft deferment this was, certainly I went to Lincoln Labs to keep a draft deferment, and I forgot to mention that when I was talking about NSA and Lincoln Labs. I was trying to go to Government places. Well, first, if I can digress back to San Francisco State, I couldn't get a job doing R&D-ish stuff in San Francisco. It was only business programming there. I could've gone down the peninsula to the Palo Alto area, but I wanted to live in a big city. So I applied for Baltimore and Cambridge.

Weber: Where did you live in San Francisco?

Walden: I lived in three places during my time in San Francisco State. On Clayton Street, high up on Twin Peaks overlooking the San Francisco Bay. I lived on Laguna down at the foot of the Fillmore district, and I lived on Fell between Steiner and Pierce right in the heart of the Fillmore district. So anyway, when I came to Lincoln Lab, I got a draft deferment so I didn't have to go to Vietnam, which I was anxious not to do. Then we had a child in 1970, and that probably made it possible for us to go to Norway. I haven't thought about that in years, but otherwise how could I have, huh? Probably I couldn't have. So—

Weber: Having a child?

Walden: Having a child made you draft deferred.

Weber: Right. <inaudible>

Walden: You know, I didn't have to work for a government place anymore. And by this time the Vietnam War was tailing off as I remember, and so my draft board in Martinez, California, wasn't anxious to grab me, so I needed a good reason so they didn't have to grab me [i.e., having a child]. So we went off to

Norway, I went off to Norway to work for Norsk Data from September of ’70 to September of ’71. I stayed in good contact with BBN, in fact we did a couple of joint proposals, Norsk Data and BBN, on packet switching networks, one for SAS while I was there. Severo and Hawley [Rising] came and visited me and we wrote the proposal. And then I came back [to BBN]. I wrote Frank a letter and said “OK, I'm ready to come back now.” And he said “You're hired” basically. And I came back and rejoined the ARPANET team.

Weber: And you enjoyed Norway?

Walden: Well, it was great. Norsk Data was great, it's a beautiful country, it’s fun people, smart people. It was a—I was a bigger fish in a smaller pond and it was a little scary. Here, you know, I tended to have, you know, an idea a minute, figuratively speaking. And somebody like Will or Bernie or somebody else would tell me nine times out of ten “That’s a dumb idea.” Over there they'd want to start implementing my idea, and that was a little frightening <laughs>.

Weber: What was your position?

Walden: I was a programmer, I built the second packet switching network while I was there, which was modeled on the ARPANET because that’s what I knew. And Nils Liaaen and I wrote a paper for the IEEE Annals of the History of Computing a few years ago on that. It's called The LFK Network or eL-eF-Koh in Norwegian, but LFK, which stands for something like the Air Force Research Network [prior word should have been Institute].

Weber: And it was for their military?

Walden: It was for their military and other pieces and it connected up to other pieces of NATO.

Weber: Did you work at all with The Norwegian Defense Research Establishment, The NDRE?

Walden: NDRE, well, the installation was at Kjeller, which is where NDRE is—a little bit east of Oslo. But mostly we worked in our <laughs> offices and lab at Norsk Data in Oslo. We certainly went out there for meetings. Raytheon was the prime contractor for that…I'm sorry, Siemens was the prime contractor for that and provided the computers. No, we provided Norsk Data computers, so Siemens was the prime contractor for that, and I don't know what they <laughs> did. But they were the prime contractor, you know, 'cause they're part of the Norwegian defense establishment I guess. And they provided the communications equipment, modem and things like that.

Weber: 'Cause NDRE was later involved in the internetworking experiments.

Walden: Sure. Well, two things happened there, were early before the Internet experiments, the seismic data was coming back to Alexandria, Virginia over the satellite links in the ARPANET, and it wasn’t yet internetted. And then they were involved in the early Internet experiments with the ground station being in Tanum, Sweden.

Hendrie: Could we roll back to before you got the contract for the IMPs and did the installation, are there any events, stories or surprises that come to mind when you were going through that?

Walden: This is in the interval between when we got the contract and we delivered the first IMP or the first four?

Hendrie: Yeah, when you're doing that nine months of development.

Walden: Not really is the answer. I mean, problems would come up and we'd solve 'em. Sometimes we—took they us a long time to debug, sometimes less. And we, you know, some things happened, such as pretty early on we were compiling in the—my memory is we originally compiled in the Honeywell assembly language. And then punched out paper tapes, which we loaded into the—let me get this straight—my memory is that we originally punched out paper tapes, which we compiled on the 516 in the Honeywell assembly language. And then Bernie modified the PDP-1 assembler to take in Honeywell 516 symbolic assembly language and compile a punched paper tape or assembled punch paper tape. That was a very important step in making our lives a lot easier. So, you know, there were decisions being made like that. There is the example where—my guess is—I have a vague memory that Frank probably wouldn't have approved of making that change. Frank was always against tool-building. He thought that if you started building computer tools, you tended to get focused on building the tools rather than getting the job done. So we built a certain number of tools, but we always just went ahead and did it and didn't seek permission <laughs>.

Hendrie: You just said "I can't get from here to there—"

Walden: Well, Bernie would start working on it some weekend, early the next week we'd have it working, and then we'd tell Frank we'd made an important step. So there were things like that that happened. But it was an engineering project. In retrospect it was a high visibility engineering project. At the time we had a contract we were trying to get done and get implemented.

Hendrie: So the special hardware worked <interrupted>?

Walden: No, there were troubles there that you really need to ask Severo or Ben [about] and it's all been documented a lot. If you read Severo's little memoir, which is available from Amazon called *Computing in the Middle Ages*, he talks about that. Wes Clark and Severo, when they were at Washington University, had come up with this problem called the Synchronizer Problem. And they had diagnosed it and understood it. The Honeywell machine had it. Honeywell refused to believe it, you know, there were arguments back and forth. It was demonstrated that—you know, they didn't refuse it for very long—it was demonstrated it was there; the flip-flops could get in an undefined state <laughs> and, you know, they fixed it. Ben, again, you can find out what he says about this, but I think both Ben and Severo were interviewed for the Babbage Institute, so you can read about what they wrote there. You know, he ended up rewiring one of the boards after it got here in some crunch time. But I wasn't really following all that very much, you know, they had their job; they had to press through whatever difficulties they came across. We had our problems; we had to press through whatever difficulties came across. It was a pretty—in some sense, it was a pretty straightforward real time system engineering project, which we all worked on. I'd only worked on a couple; the other guys [had] worked on a lot. People have asked "Well, you know, were you frightened?" No, you know, we thought we could build this thing. We proposed it; we designed it. Sure it was going to be hard work for a number of months, but I don't think we ever had any question we couldn't do it.

Weber: What was day-to-day life like in the team?

Walden: Very congenial I would say, very team-like, except Bob and Will perhaps arguing about <laughs> end to end storage allocation. I can't remember if Bob also thought that the routing algorithm, that Will had come up with, was too simplistic. I think maybe he had his doubts. And ultimately he was proved right about that too. And John McQuillan, a number of years later, implemented link-state routing, which is what's all through the world now. And once again, it was worth getting it [the original routing algorithm] out there. It was a monumental change <laughs> to get it changed. It was a big research project to get it changed; it was hard work. We would never have gotten it [the IMP system] implemented if one had come up [the word "originally" at the end of the sentence should be here] with as perfect a routing algorithm as link state routing is originally. Coming up with the distance vector routing [for the initial IMP release] was a great thing to do.

Weber: And you guys were all in that sort of corner there by the bridge, sitting near each other?

Walden: Yeah, we were all sitting near each other. We were all right in this area right here, on that [i.e., this] side of this bridge. Right around here. The first machines were in a room right over here. So we were—basically the area which is now the library, the offices near Jenny's [Jenny Connolly who supported the CHM interviewers visit] office, maybe not going that far but maybe going that far, let's say from Jenny's office in the front here, almost, not quite, not the first few offices, but one of 'em. From Jenny's office to the bridge here and back to the back of the cafeteria was where we were. That included the PDP-1 computer room, which was being used for other things as well, but became the original Network Control Center. And so people had offices here, we were mingled with other parts of the division who were here; the hardware was being dealt with back there. The initial IMP connecting to the west coast was here. So yeah, we were all very close together.

Weber: And on a typical day, you worked different hours, right?

Walden: Yeah, sure, you came in when you . . . in my life as a person at BBN, I was never able to really distinguish between work and not work. They all sort of mingled together. You know, I'd work at home. I'd work here. If I started my detective story at home and I had two chapters to finish, I'd bring the book to work and I'd read it before I started working here. They were completely integrated for me, home and work. Different people did different things. You know, Frank was probably more the 9 to 5 guy or an 8:30 to 6:30 guy.

Weber: And he described that he would wear a jacket and be more—?

Walden: Yeah, he'd wear a jacket. He was a more official kind of person.

Weber: But the rest of you were—?

Walden: I think this is pretty typical. In the summer I wore shorts. Bob Brooks didn't wear shoes (he was our documentation guy, our editor) ever. Yeah, very casual.

Weber: And you guys hung out together socially?

Walden: Not really, not really, no. There was a lot of socializing when at work in the sense of talking about chess or games or we all got juggling at one point. But no, I would say there was not a lot of

socializing outside of work. Bernie did what he did, Ben did what he did. Oh sure, if I had a party I might invite Ben or Alex, and Frank invited many of us to his house because that's what the leader does is invite people to his house for a party. But no, I would say there was not so much socializing. They were interested in different things. I mean, probably what's true <laughs> about why when people are such intense engineers is they're intense about whatever else they're interested in. You know, Will would go off rock-climbing or caving or skiing down some expert slope on one ski with his spare time. And I was involved in musical theatre for a good bit of time, and then other things.

Weber: Performing?

Walden: Yeah. I was in the boy's chorus and I ended up producer of some shows at MIT and met my wife there at MIT doing Guys and Dolls [with the MIT Classical Musical Society, which another guy and I founded.

Weber: And is your wife a technical person as well?

Walden: No, she was an English major. She was working as a secretary for the Dean of the Harvard Medical School when I met her.

Weber: And her career is in—?

Walden: Her career has been—well, raising our child, but when she worked, she tended to be in school administration. Secretary to the Dean at Harvard Medical; I don't know, Admissions Director and other kinds of things at an elementary day school; Alumni Director, Concert Director, organizer of the Centennial Year for the New England Conservatory of Music. So she's tended to administrative functions at schools. Plus she writes a lot, not necessarily for publication, although she's had some things published. She tends to be the one that takes the notes for whatever group she's in or she writes the newsletter for the group.

Weber: What are some of Frank's interests?

Walden: Well, he had three kids; that surely kept him busy. And [daughter] Rachel was a handful <laughs>, so—probably still is, Rachel's a very determined person. He sailed a boat named Calliope. I still think he has the sailboat, so they would go sailing. I don't know what else they did out there in Lincoln. We visited them once in a while. Been on Calliope a couple of times.

Weber: And Severo—what was he like in that period?

Walden: He's an engineer. He was married to Elizabeth at that time. They had I don't know how many kids, a couple of kids. And then he and Laura met. And then he—I don't quite know what happened. I guess he was still here for a while after he and Laura got together. Then they went up to Xerox Park, which she was from California. He's kind of an outdoors guy. He tends to go on hiking trips and stuff, but this is all hearsay. You know, Bernie Cosell did car rallies for a while and he and his wife did competitive weaving I think: he was doing group theory on workstations of designing patterns for weaving I think. And they eventually retired to—or moved to Virginia where they have a sheep farm. But different people did

different things. As I said, we didn't socialize that much. There was a certain amount of, you know, people got to know each other here, like Paul Castleman and Sally Teitelbaum got married, but—

Weber: So then you went to Norway and then you came back here?

Walden: Yeah, and rejoined the IMP group. Became leader of the software part of it.

Weber: And the terminal IMPs were—?

Walden: Terminal IMPs were happening while I was in Norway. When I came back, I became responsible for the software part. Will was beginning to think about the Pluribus by that time. And so I sort of took over the—and the hardware was running, Tony Michel had the—and Ben I guess probably, Ben and Tony probably did the hardware for the terminal IMP. They had that running so it was really mostly a software project. And as I said, you know, I took it over, but what did I work on? I wrote the manual, because somebody had to write the manual.

Weber: And Tony Michel came into the project when?

Walden: Well, he was certainly joined—I think he joined the TIP Project while I was in Norway. When I left for Norway, he was working over in the TENEX group, with Ray and Jerry and those people. I think Tony got here because he knew Jerry from MIT, Jerry Burchfiel. That's my memory.

Weber: You wrote the manual, and then Pluribus was the next thing?

Walden: Pluribus IMP was happening with a different set of people. Frank was sort of managing that. I can't remember what else happened. Eventually Frank made me Assistant Division Director along with Paul Castleman, Paul might've been one already. And I sort of was the Assistant Division Director for the communication stuff, and Paul for the medical stuff. And then, you know, the project grew. Frank always remained the principle investigator for a long time. He didn't give that up, but I was managing the projects day by day of more and more of the pieces of the communication stuff in the division. And my role in that—it's never one I expressed to Frank, and it's never one he expressed to me—was to basically, in some sense, take stuff away from him. I mean to manage it too, but ultimately to take it away. Frank probably manages stuff a little too closely. More than . . . you know, it can't grow so much if Frank is holding it trying to manage it himself, he's only one guy, a very special guy, but only one guy. So I would take responsibility for it day-to-day, while he ultimately was responsible for it. And he'd come to trust what was going on with me, because I'd report into him everything, I mean, we had a very good relationship. I would go tell him "Hey, here's what I'm about to do." And then I'd do it. Or "Here's what I'm about to do" and he'd argue with me a little bit and I'd do something different. But once I sorta had it under my hands, then I would delegate it to somebody else. So Frank was, let's say, responsible—the Principal Investigator for ARPA and I was sort of his day-to-day manager of the project, until I made Bob Bressler the Principal Investigator <laughs>. And I did that multiple times. I don't know if Frank sees it that way, but that's what happened, is that I helped Frank grow the division by taking stuff—becoming responsible for stuff and delegating it more than he probably would've been willing to delegate.

Weber: And beyond the IMP, there were other—?

Walden: Yeah, there was other stuff going on in the division, sure, there was a whole bunch of medical stuff, ultimately the database management programming language system, known as Prophet, which just before the ARPANET proposal, I worked on that with Paul Castleman for a while and got that going. Frank knew Bill Raub and NIH very well, Bill Raub was the guy who funded that—the Government Contract Technical Representative or something—at NIH. So Paul and I worked on that, basically until the ARPANET contract came in. Frank put me on different things that he probably wanted done. And in fact, let me digress a second. When Frank got to BBN, it was a pretty wild and wooly place in terms of engineers kind of doing what they wanted. And Frank I think saw it as—this is before I got here—saw it as his job to sort of get things under control. <laughs> And make it all sort of do more what the division management wanted it to do. And Paul Castleman will tell you the story of, basically, he was running the division—Dick Bolt was the nominal head—Paul was running the division. Paul was "just a kid" and interviewed his boss-to-be, Frank. You know, to hire him to be his boss so that there'd be somebody. You know, probably Paul's parts were running okay, but it was a little bit, you know, it's kind of like a hippie place. And hippie's not bad, but maybe it's not the way you want your engineering R&D group to work completely. And so I think I was—you know, bringing in a person like me was adding a little bit of stability in some sense, you know, I wanted to work. Chan Russell—I don't know if you've heard Chan Russell's name—he and Paul have worked together for decades, and they were involved in several startups after they left BBN. <laughs> Chan Russell used to say to me "I want to hire people for whom work is their business, not their hobby." And I think that's an accurate way of saying it. Frank was <laughs> looking for people who wanted engineering to be what they wanted to do rather than a hobby they did among their other stuff.

END OF TAPE 2

START OF TAPE 3

Walden: Well so I got to be an assistant division director, in time a senior vice president of the company as kind of a rank rather than a day-to-day position. Frank pushed me as a competent person in both of those areas to the rest of the management of the company. At some point, I decided I wanted to be on my own and John McQuillan and I convinced the corporation that we should do a start-up and we did a start-up called Infomail, which was a very early networked email product company and I believe the first email system that worked on multiple platforms. It ran on Unix. It ran on TENEX. It ran under CICS on the IBM machine. It ran on the 360s. We sold a good number of those but not enough to actually make money. At that point somewhere in there BBN, what became BBN Communications, originally was spun off as BBN Computer with Ben Barker as its president. That was having some trouble so I was moved from Infomail to BBN Communications as the executive vice president and general manager with Mike LaVigna as the president and CEO.

Weber: What year roughly?

Walden: Oh, gosh, 1988 maybe we went to Infomail. Is that possible? No, no, no, 1978 we went to Infomail. In 1980 we went to BBN Communications—Computer, turned it into BBN Communications. It became a very big deal then, did lots and lots of the early networks. And then I moved back to what is now BBN Technologies. We called it BBN Laboratories and became the general manager of that and eventually it was spun out as a subsidiary sort of on paper so I was the president of BBN Technologies or BBN Laboratories. It's changed its name a number of times. I was the first one to call it BBN Technologies and Systems. Then later Tad [Elmer] removed "and systems." I stayed with that until 1990

and in 1990 I became the chief quality officer for the company and then in 1992 Ben Barker and I went back to BBN Communications, which by this time was in trouble again. Ben took the new stuff, which was eventually spun off as the Lightstream switch and sold to Cisco, and I took the old stuff, which was eventually folded back into BBN Technologies which was the T-10 router. And then George Conrades joined the company sometime in ’94 and by late ’94—well he asked Frank (who was by that time president of BBN Laboratories or BBN Technologies), me (I was working on BBN Communications),. Ian Rankin (who was running BBN Software Products) and somebody else (I can’t remember, there were four of us who were leading pieces, that other person will come to me shortly)—basically asked us all to leave because we weren’t the kind of marketing people he thought should be running divisions, subsidiaries. Ben and I stayed on for another year. (I guess it was Frank and Ian. There wasn’t anybody. I mentioned them all.) Frank and Ian left. Ben and I stayed on while we cleaned up BBN Computer [Communications] and then we left so I stayed on for many, many, many months, the better part of a year winding down BBN Computer before I left.

Weber: Cleaning up in what sense?

Walden: Well, I mean the thing was losing money. They had to sell the piece that Ben was working on. We had to fold the piece that I was working on back into things, had to RIF a bunch of people, all of that. So, cleaning up in a business sense—liquidating, having it disappear. Meanwhile, another Internet piece was growing into what became BBN Planet and eventually Genuity and that came out of some of the work Alex was doing in Frank’s division.

Weber: Which was?

Walden: I can’t remember if it was the Computer Science Net or the NEARNET or several of those but it was the regional ISPs so that’s what happened. And then I left and worked for another several years part time at MIT and part time with the Center for Quality of Management writing books and teaching management courses.

Weber: And you had become interested in quality?

Walden: Well what happened was BBN was one of seven companies which started something called the Center for Quality of Management which was a group whose purpose was to share experiences and learnings about improving business processes. And two people from each company were sent to sort of help form that. Ralph Goldwasser who was the CFO of BBN at the time and I had been the—I was at the time the president of BBN Technologies so I left that job to become the chief quality officer. Ralph went back to being chief financial officer and then I was the chief technology officer for two years, not technology chief, quality officer for two years and then got sent back to BBN Computer [Communications]. Frank hated every moment of it. If you read his paper in these issues [of the IEEE Annals of the History of Computing], he thought that all the quality stuff was nonsense and he came to me when I went back to BBN Computer and said, “This is a very good thing for the company that you’re stopping all this quality stuff and are now going to work on technical stuff again.”

Weber: But what interested you about the quality?

Walden: Well I was always a person who was interested in learning new stuff. I mean different people are motivated by different things, right? I tend to be motivated by learning some new thing. You work in some area for several years and pretty soon you know quite a lot about it and then I was ready to go do something else. So if the company wanted me to go do something else, I was happy to go do something else. I was also pretty tired of being the head of BBN Technologies by the time. This was very much the height of the government-contractors-are-bad era or whatever it was; the $100 hammer or the $400 toilet seat, all these things, which of course were mostly the application of government accounting rules. They weren't as silly as they sound. So I was a little bit tired of all of that and so when Steve [Levy] said, "Do you want to do this" I said "Sure, that will be fun" and I didn't know anything about it so I got interested in it by doing it. By the time I was done with that I had written a book on it.

Weber: And you were going around. You gave talks.

Walden: Well we had courses. We had talks. We implemented TQM around the company. As happens everywhere, the salespeople and the manufacturing people take to it most readily and the marketing people and the engineering people hate it because the marketing and the engineering people are loosey-goosey people. They pride themselves on that and the manufacturing and the salespeople are measured by results. So if there's something that's going to let them make a bigger commission, they're happy to do it. The admin people were sort of in between. Admin people could take to it too. But Frank probably would argue it just doesn't apply in the technology area. I would argue it certainly didn't apply at BBN because he never let it apply. Plenty of companies do apply it in technology areas.

Weber: Going back to the mail start-up or even before, you said you helped set up a number of networks in that period.

Walden: I'm not sure I said that. BBN consulted to a number of other network groups in the early days in France and England, another one in France. People came here and studied what we were doing such as the Japanese. Peter Kirstein—we had him on a little, tiny bit of a retainer to hunt for work in Europe for us.

Weber: What years was this?

Walden: The mid-'70s probably. Then at some point BBN Communications got set up, Computer then Communications, the DDN, I'm sorry the AUTODIN II [mentioning AUTODIN II was a mistake—that was canceled and didn't come to BBN] network came to BBN. DDN was done by BBN. We had working products that went into lots of bank networks, like National Westminster, the Visa Network, the MasterCard Network. They were all BBN networks at one point.

Weber: What were the products?

Walden: Packet switches and networks. They were networks, packet switches with network analysis, network monitoring, packet switching networks and that was done by BBN Communications and then that began to fall apart for two reasons I think. One was they did a contract for Japan Airlines which just cost a ton of money and didn't get done so well. And I think maybe the government business was on a downturn by that time. Maybe the government had enough. I don't quite remember what the deal was because I got there just after it when a lot of people—there were too many people in the division. We could look it up

what that was about. So BBN did a lot of networks. I was involved in a few of them but certainly not most of them.

Weber: And the mail product, describe it in more detail.

Walden: Well it was before we had visual graphics terminals, GUIs that is it [was] before we had graphical user interfaces. Even if we had a display it was showing characters. The things about it that were interesting were it was multi-platform so you could buy this mail system and install it on different computers in your institution and it had a very early screen-based, let's call it, but text-based model of a desktop and files and things like that. I have all of the archives for the Infomail thing and my intention was at some point maybe to write an article for the IEEE Annals and then see if they wanted it [the files] out there in Minneapolis, but if you guys wanted it I'd be glad to send my boxes. I have the entire Infomail set of stuff. I've kept it.

Weber: And the code?

Walden: I don't know if I have the code. I probably have a listing chances are, but I could probably find somebody who has a listing of the people who were involved in that project I know but I'm still probably going to write a paper at some point. What I'll probably do is write an anecdote, not a full-sized paper. [In] the IEEE Annals they're under 3,000 words. They're not peer reviewed; and if they're over 3,000 words, then they are peer reviewed and they're expected to be more scholarly. My guess is I would round up some of the people that worked on that system, and we would write an anecdote telling our experiences on it.

Weber: Great.

Walden: I'm the anecdotes editor for the *IEEE Annals of the History of Computing* and I've been holding this for some point, some quarter I don't have another paper. Then I'll do this one. But, so if you want that, let me send the Infomail stuff to you maybe right after I write the paper.

Weber: Wonderful.

Hendrie: That's wonderful, thank you.

Walden: And what ended up happening with that, it's probably still running in the world, what ended up happening with that is the Infomail group, which was really ahead of its time and [not] having a sufficient market share to sustain itself got folded into BBN Communications and Infomail got distributed all over these military networks. If you talk to people who knew the early military networks like DDN, a surprising number of them will say, "Oh, Infomail that was a really good mail system for its time."

Weber: And it first came out when roughly?

Walden: Well probably, as I said, '78 we started so probably '79 it came out. It took us a year probably.

Weber: Great.

Walden: This is all—

Weber: That's all in there.

Walden: Well, I can look it all up. I [can] look up my CV [for] when I got to be the president of Infomail. BBN Information Management Corporation it was called, BBN IMC.

Weber: And where was it located?

Walden: It was located, if you go down the street here, there's a parking lot at the end of these buildings on your right and across that parking lot back from the street is a cinder block building that BBN was renting at that time, and we had space in that building.

Weber: So not too far?

Walden: Very close, very close, part of the campus.

Weber: And all the Internetting work in the mid and late '70s you were not directly involved in that though?

Walden: I would say I was not. Well let's say in '78 I went off with BBN IMC so up until then I was pretty directly involved but I was managing the groups that were doing it. So I wasn't making technical contributions myself anymore. I wrote the occasional paper when somebody would invite me to a conference or something. I'd find a co-author and write a paper, learn enough about what that was going to be about, what we were doing, to write the paper, but I've always been a writer and I write easily, not necessarily well but easily, and oftentimes it's a struggle to get people to write stuff, so I often did the writing. And something Will Crowther told me. He wrote just enough. He didn't write easily I think but he wrote just enough. He told me when I got to Lincoln Lab, probably within the first year, "The guy who controls the pen probably controls 80 percent of what the project's going to be." It was easy for me to write so if we have a design meeting I'd volunteer to write the notes and therefore influence things. Did I get 100 percent? Of course not and if somebody wanted to change something, of course, I was willing to change it especially if it's better, but I often did writing.

Weber: Yeah, well that's big.

Walden: Oh, and another thing I learned by the way as a software developer, the whole idea you spec-the-system/you-implement-the-system/you document the system/[you-write-the-users' manual] is a bad idea. You should probably write the users' manual before you start implementation because if you can't write down easily what it's going to do you probably can't implement it very well.

Hendrie: How it's going to work.

Walden: And the user is not going to like it, so I've worked on the user manual, the spec, whatever.

Weber: I wish more people did that. I agree. And Jerry Burchfiel, so he was Ginny Strasizar's boss?

Walden: Yeah. Jerry came from MIT. Michael Athens I think was his thesis supervisor in the control theory area. He joined Danny Bobrow's group when they were building the TENEX system – maybe he got there just before. So he and Ray and Dan Murphy and Danny were the four guys who were building the TENEX system. There were others who were participating, like Tony [Michel], John Barnaby. John Barnaby, do you know who he is or Rob Barnaby? He's the guy who wrote Word Star. Well he worked on implementing the user interface for TENEX and he saw the word processing software called RUNOFF which came from MIT. It was modified to be MRUNOFF here and Word Star was a lot like that when he went to California. So Burchfiel came as part of that group. In time, Danny went off to Xerox Park and Ray Nickerson got to be the division director of the Information Sciences Division or whatever they were called while Frank was the division director of the Computer Systems Division. Ray made in time Jerry and Shelly Baron be his two assistant directors and probably they got to be corporate vice presidents at the same time Castleman and I did, so those were the two parallel structures. There was Frank, Paul, and me and there was Ray, Jerry, and Shelly who used to say BBN stood for Barren, Burchfiel and Nickerson. Then when I came back from BBN Communications to become the general manager of BBN Laboratories, eventually BBN Technologies, I had seen for years the competition between those two divisions. There was a lot of competition. We wished we could get to implement all the stuff. Why did Ginny get to work on routers when we should be working on routers and so on? We worked together as well but it was a lot of close [closely related] work but there was also competition. And the ARPA people didn't like that and Bob Kahn was at ARPA at that time and so I went to Bob and said, "I'm going to put the two divisions together so they'll all be part of one division" and did and so put Ray Nickerson as the assistant or the deputy division director and senior vice president, Frank as the division director and senior vice president. Jerry became the chief scientist or something. I can't quite remember what Jerry's role was and [but] super valuable. Jerry is an unbelievably smart guy who just kind of goes from project to project helping them think. He's very valuable at that. He was a good manager. He was not a bad manager but when we combined the divisions we couldn't have too many managers. He was very valuable. We paid him very well for a non-management position as he went around. But Jerry, while he was the assistant division director of that, had the packet radio stuff. He had the Jericho workstation. We built probably one of the earliest workstations. Ray [Tomlinson] and Jerry built Jericho. Who else was working on that? Jim Calvin probably worked on that. I should probably send you now the PDF of my paper on the computer devices for their own sake, as opposed to computer applications at BBN. That didn't go in these two special issues because of room but I have it, and I'll send that to you.

Weber: Please, excellent.

Hendrie: That's very good.

Walden: In fact, I brought my external hard drive with me with everything on it. We can just copy it onto your computer before I go.

Weber: Excellent.

Walden: That would be easier. I figured if you asked me for anything I have it all here.

Weber: Perfect, that's wonderful.

Walden: These are such wonderful devices.

Weber: Well you merged the two divisions.

Walden: Yeah and that worked quite well.

Weber: Merging the two divisions.

Walden: Yeah that worked well I think. Eventually Ray left because he was disappointed to be the deputy director to Frank, but I thought they got along well. Ray was certainly supportive of Frank the whole time Ray stayed.

Weber: What was Alex McKenzie's role?

Walden: Alex was one of the assistant division directors or some such thing to Frank in the computer area, sort of the role I had had when I was working for Frank but now a number of years later.

Weber: They worked together for many years.

Walden: Many years, yeah. Frank and Alex, well Frank got here in probably '65 and they worked together until Frank left in probably '94. Frank and I worked together all that same time except I was gone to Norway for one year and for several years I was elsewhere in the company. But Frank was involved. Frank was on the board of directors of Infomail. He was on the board of directors of the Communications division [that last word should have been company. The Communications division [company] was working with his stuff and so on. So we worked together for a very long time.

Weber: One miscellaneous question, the code for the IMP as Frank pointed out it's probably still in the core memory, but source code—who has it?

Walden: I believe Bernie Cosell has one listing. I don't know of any other listings. And Bernie's listing is not the original listing of September of '69. It's several years later but it probably hasn't changed that much by then. It changed some. It's got things like the end-to-end stuff working better and by that time McQuillan and Bernie and I had made the decision and probably Bernie was the one that actually did the addition to do some processing on the code to show the interrupt levels to keep us from having interrupt bugs so that's in this listing which wouldn't have been in the first listing.

Weber: Certainly we're interested in—

Walden: I mean so Bernie is Bernie@fantasyfarm.com and he's got a listing. Maybe you could take a facsimile. I know that within probably four weeks ago a guy from Germany working on a thesis was asking me about this issue of end-to-end stuff and I asked Bernie and he looked it up in the listing.

Weber: Great, excellent.

Walden: So that's the only one I know of and that's one that Paul Wexelblat had which I got from Paul when I started working on these special issues and then forwarded it onto Bernie for long-term safekeeping.

Weber: Excellent. Stepping back to the beginning when you first came to BBN, you described it as a kind of freewheeling atmosphere and kind of like start-ups today with dogs running around.

Walden: Well the dogs were gone by the time I got here because Frank had taken care of that or somebody had taken care of that. They had made the decisions we weren't going to have the dogs running around which was good because I don't like dogs that much. It was a place like it is now, little carpets on the floor. It was concrete floors with carpets I think. Maybe there was tile, the asphalt tile of some kind but I think it was carpets. It was little offices. My office didn't have any windows because there are a lot of interior offices. It was in this old building. Each of us had a teletype terminal, Model 33 Teletype. Bob Gardine was the division teletype repairman, maybe the company teletype repairman. He had learned teletype repair in the army so he was on the staff so when your teletype needed oiling or it broke Bob would bring another one and take that one. We would type on the PDP-1 computer—into it. Somewhere they had a terminal concentrator. I don't know where. It was a bunch of mostly young people, many of them college graduates. Some of them didn't quite graduate from college, like Bernie hadn't finished MIT. He eventually got a Master's degree at Boston University, finished his Bachelor's degree in math and then got a Master's degree in astrophysics or something just because he's the math guy and was interested in it. It was a bunch of people just working together. Joyce Chen [—have you ever heard of Joyce Chan? Joyce Chen's was the original Chinese restaurant in the Boston area. Her restaurant is the little building over here on the far side of BBN so you could walk out the back door and have lunch for almost no money, the lunchtime special at Joyce Chen. We did a lot of that so it was just an engineering place. We were working on government contracts. This was pre any days of stock options and all that stuff. There was a little bit of a profit sharing plan. Eventually, BBN had stock options and so it was a great place to work. You got to work on good projects. It was interesting work. Well, we were working on government contracts primarily and the way government contracts work, especially the ARPA ones, is you talk to their contracts person, their technical contracts person and you agree on what he's interested in and what you're interested in and then you put in an unsolicited proposal and justify why it should be a sole source procurement and then it came to you. And ARPA's approach was "if we [ARPA] find good people we'll give them a contract. If they do good work, we'll give them another contract. If they don't do good work, we won't hire them anymore." So as long as we [BBN] kept putting forward good ideas, we kept getting hired so there was new stuff to work on all the time and especially with the beginning of the Internet. There was a ton of new stuff and there had been before, before I got here, the early timesharing work and so on, a lot of LISP work so it was a fun place to be, not particularly political, people enjoying themselves. The other thing was always that we tended to be in touch with the people at Harvard and MIT. We tended to know their thesis supervisors down there. We would hear about good graduate students before they finished their degrees. They would come to work here part time or summer. We'd get to see how good they were. Once they finally graduated they could keep their bicycle and their apartment on Broadway [in Cambridge] and didn't have to change their lives and then they'd come here and we paid them pretty well and it was fun work and they tended not to leave. There was very little turnover. Once I got to be the president of BBN Technologies I thought about that quite a lot and decided that it's a little bit like baseball. You can't build your baseball team from free agency. It costs you too much. You don't know if the people are still going to be good. You have to build it through your farm system. Well, MIT and Harvard were kind of like a farm system and we would hire… Maybe only one in 20 or two in 20 became superstars. The rest were just very smart and very good. But you had to recruit those 20 to get those, plus you needed them, to get those one or two, and you'd learn in a while. If later on you tried to recruit one of those people, you didn't know why they left that other place. What was wrong there? They had

some different corporate culture in mind. It often didn't work out so well. It was much better to hire the new college graduates. We went to other places too. We went to Illinois. We went to Stanford, went to Purdue. But we cared a great deal about college recruiting basically trying to get the people into our organization and grow them here rather than trying to get the free agent. It [trying to hire the free agent] never worked well enough—[maybe] once in awhile—except in the area of the military people. We certainly did hire the person who had been 20 years in the military, retired as a colonel, who had connections. We hired those people some later on, not in the early days, but certainly deep into the Internet times we were hiring those kind of people and they were very helpful.

Weber: Great, anything else you want to cover?

Hendrie: I have a question.

Walden: Sure.

Hendrie: Some people outside of BBN have observed that some great technology has gotten developed at BBN but every so often BBN tries to make a product.

Walden: Yeah.

Hendrie: And they've had real difficulty doing that when they've switched and tried to produce a product and get into a product oriented business. I'd be interested in your reflections or observations from inside on that.

Walden: Sure. Well, I think first I commend to you the paper by Steve Levy in one of these two special issues where he goes through all of the different start-ups and spinouts and so on and I think makes the point that on balance they made money for the company quite a lot and for the shareholders. What I would say is that I would agree with that. I mean for instance BBN Communications at a certain time was the leading provider of packet switches in the world. Now times changed and it was time for routers. BBN missed the router. We invented it but we missed the router wave just like Digital missed the workstation wave and Apollo missed the minicomputer wave. It's very hard to do the next one. So for a period BBN made a lot of money. It grew. It did extraordinarily well. And BBN by the way made the mistake on [not] moving from packet switches to routers. That is the traditional mistake of not eating its own product. One of the statements was by the president of BBN Communications at the time is "Why would I want to build a device [a router] that sells for this little money when I can build a device [a packet switch] that sells for this bigger amount of money." Cannibalizing its own products—that's the phrase. We didn't do it. Many people have not done it. So what I would say is that we had a number of successes. We didn't have the good fortune to become Cisco but only one company became Cisco. Only one company became Sun and now they're not doing so well anymore. Things go up and then they go down. None of ours got quite as big as some of the really big ones. So that's one thing I'd say. The other is we were there at the very early days before there was the real opportunity in some sense and, if you're not going to cannibalize your own technology, that's definitely a problem. If you're moving from the Internet to the really big Internet and you're not willing to build the router, you're not going to succeed. Let me say another thing which this reminds me of which is interesting which is how does the technology get from BBN to ARPA, to the government I mean? ARPA sponsors it. How does it get to there? This is my observation. I'm not sure if Tad Elmer [BBN president at the time] would agree with me. My observation is that the services, the military services, always hated the money ARPA was spending on BBN contracts. They always wanted to

buy another ship, another tank, another airplane. ARPA would give the money to BBN which the military people would say, “Well, that’s all so blue sky,” and BBN would invent something, like – co-invent timesharing, or invent packet switching or, whatever. Some years later, time would have passed and it’s now the right time for that to go into the military. Hughes or Martin Marietta or one of the big aerospace contractors would look up “what is the technology that’s available that helps us address whatever that need is” and then they’d propose it. Maybe they’d involve BBN, maybe they didn’t involve BBN but the technology that BBN developed seldom got to the military directly. (Now the current thing they’re doing with the acoustic sensors in Iraq, of course, is completely different than that. It’s gotten very directly to the military.) But typically time went by and then eventually somebody else proposed it to the military. My point is BBN tended to be at a very early time with all of these technologies. That’s the kind of stuff we did. We did advanced development not downstream development. Ours was almost R&D but not quite.

Weber: Right.

Walden: So I think the stuff we were developing wasn’t so well suited in its time and some of it worked pretty well for awhile.

Hendrie: Yeah and often the market hadn’t developed enough so you could make money.

Walden: That’s my point. It certainly happened with Infomail.

Hendrie: Yeah you couldn’t make money on it.

Walden: No, no. And we did make money with BBN Communications and the communications network, made a lot of money and grew BBN and eventually developed the Planet stuff which Conrades was able to sell to GTE.

Weber: So we should wrap up.

Walden: Okay. It’s been a pleasure for me to talk to you today.

Weber: It’s been wonderful, really appreciate it, excellent.

Hendrie: Yes, thank you very much for doing this oral history for the Computer History Museum. Thank you.

Weber: Thank you.

Walden: You’re welcome.

END OF TAPE 3

END OF INTERVIEW

