
# Oral History of William “Bill” Carrico Jr.

Part 1 of 2

Interviewed by:
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**David C. Brock:** Bill, thanks again for joining us, and I'd like to start at the very start and ask you when and where you were born.

**William "Bill" Carrico Jr.**: I was born in February of 1950, in Billings, Montana. My father had gone to school there, in fact, was born there too, along with my mother. Then around when I was four we moved to Donner Summit, [California], and then a couple years later moved to Sunnyvale, [California], and I've been here ever since.

**Brock:** What were the principle activities of your mother and father?

**Carrico**: My father was a schoolteacher and later on an assistant superintendent, actually, at the Los Lomitas school district right here in, just kind of by Menlo Park there, and my mother was a housewife and enjoyed being a housewife.

**Brock:** Did your father concentrate in a particular subject?

**Carrico**: I would say he was science–oriented, but he taught various grades as necessary, because, I mean, he taught in a one–room school house at Donner Summit.

**Brock:** <laughs>

**Carrico**: He had to teach the full curriculum, but he was a science guy—but completely different than the sciences I ended up in. He was a guy who was interested in biology, minerology, things like that. Taught slide rule. Wrote a book on how to use the slide rule, for elementary school kids. Pretty broad–minded but not at all interested in the things that I came to be interested in.

**Brock:** Did you attend the schools in which he worked?

**Carrico**: No.

**Brock:** Okay.

**Carrico**: Well, I shouldn't say that. At Donner Summit, I sat under the desk while he taught often.

**Brock:** <laughs>

**Brock:** Do you have siblings?

**Carrico**: I do. I have a brother and a sister.

**Brock:** I would imagine that, with your father's career, that education would've been a big theme of your household. Was that the case?

  

**Carrico**: I think not in the way that you imply. I think that he certainly thought you should be educated and was certainly interested in that, but there was never any pressure for that. Neither from my mother. There was an expectation of, “You better go get it right. You better go do it,” but there was never, “Oh, what was your grade on that?” kind of a thing. It was pretty straightforward.

On the other hand he did encourage any of my interests. I became interested in a lot of things very early on and he always encouraged it, but really not—no pressure the way people talk about kids being over–pressured today, sending me to tutoring or anything. Nah, nothing like that.

**Brock:** Was science or art, or religion or politics -- these are sometimes big themes in households, I wondered… <laughs>

**Carrico**: Let’s see. We never talked about politics. Ever. They were pretty much areligious. I wouldn’t say science either. I think they wanted you to be good people and go out and do something in the world, but there was not…it was kind of laid back in that sense.

**Brock:** You mentioned that you developed early interests in things that your parents, in a non–pressuring way, facilitated and encouraged. What were those?

**Carrico**: Really the first thing I got interested in was Egyptology. I thought at one point I’d be an archaeologist for sure. I went and read every single book on archaeology and the Egyptians at the Sunnyvale Public Library. This must’ve been, like 1960, something like that. Then later on, I don’t know exactly what the transition was, but I got very interested in chemistry. Then I was sure I was going to go into chemistry and be a chemist. I built a, kind of an enclosure on the side of the garage so I could put all the materials in and test things and try things and run experiments and so on.

Then a guy that I met, who I later went to school with, high school, somehow, and I don’t remember exactly how that happened, but got me interested in electronics, and I became just completely hooked. That was it, and I never really looked back. I thought—probably by the time I was in eighth grade, maybe a freshman in high school, something like that—that I planned to be an engineer and that’s the course I pursued.

**Brock**: In the chemistry era, any explosions?

**Carrico**: Yes.

**Brock:** Was it also the case that in this area the materials for doing electronics work as a youth were, I mean, just supplies were all over the place?

**Carrico**: Well, it was, as we were discussing previously, kind of a transition time. The first book I encountered was—a guy named [Alfred Powell] Morgan wrote several famous books on electricity and

  

radio. It was like *The First Book of Radio and Electricity* or *Radio and Electronics*, and of course, this was the day it was in.[1] It was for boys, not people, but boys, and all of the examples were tubes.

The first thing I ever built was a tube radio. I don't remember exactly where I got it, but I slowly scrounged things together and made it and got it to work. This was an era when still a lot of military surplus from World War II was available, so you could sometimes get parts at military surplus kinds of places. Old World War II electronic stuff.

**Brock:** Did you move your operation from attached to the side of the garage to inside the garage, or where did you do this?

**Carrico**: My father wanted a shop in the backyard, so we built a shop in the backyard. Big. It was probably 20–by–20. He had enough room on his lot to do that, and I used a little corner of that.

**Brock:** It was primarily a wood shop for him?

**Carrico**: Yes. He was primarily interested in woodworking kinds of things.

**Weber**: Were there a variety of the surplus electronics places like there were later?

**Carrico**: There were, but most of them were in San Francisco on Market Street. I would badger my father to take me up there. This is long before I could drive. I don't know if you've ever been to Halted Electronics. It was pretty much like that except for military surplus. You'd find things you could use that you couldn't easily find otherwise.

**Brock:** Can you characterize just what it was about electronics that seized your attention and your curiosity?

**Carrico**: I would say it was probably the variety of it. You could do a lot of things. It wasn't just limited to, for example, building a radio. You could also build an amplifier, you could build a doorbell. You could build an intercom, and of course it went on from there, as I learned more. Remember, at the time I knew really very little other than what those books said.

**Brock:** Right.

**Carrico**: It became, I would say, endlessly fascinating.

**Brock:** Were there other of your school peers who were similarly hooked into electronics?

[1] [Editor's note] Morgan, Alfred Powell. 1954. *The Boys' First Book of Radio and Electronics*. New York City, NY: Scribner. Added by Frances Corry on June 19, 2018.

  

**Carrico**: In high school, yes. There were a few. But even then that was a pretty small number. I don't remember how many but it was, you know, maybe 5, 10, at the most. At least that I was aware of.

**Brock:** Was there any kind of formal way that you all could pursue your interest, like an electronics club?

**Carrico**: There was a radio club.

**Brock:** A radio club.

**Carrico**: I participated in that, but not constantly, just on occasion. I didn't do too much. Other things start to take your interest in high school too. I worked a lot just to get money to buy a car and put gas in it, and so there was less free time than there might've been due to that.

**Brock:** I was wondering about your work experiences during high school. Could you tell us about those? Because the world of work in business features—

**Carrico**: Is different.

**Brock:** —prominently. <laughs>

**Carrico**: I worked as a janitor for my father in the summers. It was the primary thing I did to get money and then try to make enough to make it work all year. Then later on, right out of high school, this is the interesting thing, I got a summer job at Fairchild [Fairchild Semiconductor]. This is when I was 18, just after graduating. It was only intended as a summer job and I worked as, oh, I don't know what you'd call it exactly. Kind of a junior technician in one of the applications areas. Well, was the transistor, actually, application area.

Now, all of that was possible because behind us, where we lived in Sunnyvale, was a gentleman named Alan Ankerbrand, and Alan Ankerbrand had been a marketing guy for Fairchild in the Transistor Division for I'm not sure how long then, but several years. I came to talk to him on occasion about what I was interested in and about what was going on in transistors and we spent a lot of time together talking about it over time, so he knew my interest, and he was the one who actually pointed me to the job and I subsequently got it at Fairchild. The bulk of what I did was sit in front of a Fairchild 500 tester, and test transistors one by one and record the data and then draw graphs to try to understand correlations.

**Brock:** At this time, how automated was the tester? You'd be mounting the transistor into it and—

**Carrico**: The Fairchild 500 tester was pretty automated for its day. It was mostly electromechanical though. You put it in and it would go through a bunch of tests. The head was obviously electronic, but a lot of how it was sequenced was electromechanical, and to enter what you wanted to test then you used little rotary dials that, the little—you've seen them I'm sure.

**Brock:** Yes. Sure.

  

**Carrico**: Little black things with numbers on them and you would enter, “I want this one to be a hundred million amps,” or whatever it was.

**Brock:** And you were following kind of a prescribed recipe of tests for the different transistors?

**Carrico**: Yes. One of the engineers would say, “Go. Please gather this data.”

**Brock:** <laughs>

**Carrico**: It was a kind of interesting introduction.

**Brock:** I guess you would’ve been exposed to the variability of the parts.

**Carrico**: Oh, yes.

**Brock:** <laughs> An important lesson for later. What year would that have been? That was ’60—

**Carrico**: Would’ve been the summer of 1968.

**Brock:** 1968. So Fairchild’s integrated circuits had just helped with the early Apollo stuff. What was your impression of Fairchild as a company? Where were you working?

**Carrico**: It was the Transistor Division or what would’ve been the Transistor Division later. I’m not sure what they called it at the time, and I was in the Applications Engineering group.

**Brock:** In Mountain View.

**Carrico**: In Mountain View, in what was Building Four in Mountain View, which later on came to be one of my buildings.

**Brock:** <laughs>

**Carrico**: It was all big and new when you’re that age, right? I remember [C. Lester] Hogan coming around when Hogan took over Fairchild, coming around and shaking the hands of everybody, including my hand in the Applications Engineering department.

But other than that it was pretty much “Get the work done.” And I met people, that was interesting. But for the most part I’m not sure if any of them were there when I showed up again later. I can’t think of any, except Alan Ankerbrand.

**Brock:** But it certainly didn’t dissuade you from an interest in the semiconductor industry?

  

**Carrico**: No, no, no. No, I would say it was a good experience, but it was really kind of an 18–year–old experience—it was a narrow experience.

**Brock:** Were you aware of what was going on more generally in the area around semiconductor electronics and transistors?

**Carrico**: I would say vaguely. This was before I'd had any formal training, and while I did do projects, and I read lots of magazines—which is, of course, all that was available at the time—I wouldn't say broadly aware, no.

**Brock:** I was just curious if you had a sense that you knew that you were kind of at the center of the action in semiconductors?

**Carrico**: Well, I realized there were a lot of companies in Silicon Valley. I think we even called it Silicon Valley then, and there was a lot going on. Fairchild was quite prominent at that time and there were multiple buildings and multiple locations and multiple fabs all in the U.S. All of the manufacturing, of course, even then, was offshore. The actual assembly.

**Brock:** Right.

**Carrico**: No fabs though. Fairchild R&D was up over where Gunn High School is, and there was a lot going on there and I was aware of all of that, but I would say more just at Fairchild as opposed to broadly.

**Brock:** Well, it's an interesting time in an interesting place to be an 18–year–old <laughs> on the San Francisco Peninsula in 1968. How was that whole context of Cold War, Vietnam War, and the kind of cultural developments going on, how'd that figure in your life?

**Carrico**: Somewhat strongly. I graduated from high school at Fremont High School at the time, and I needed to go to college. I didn't have any money, and ended up going to De Anza Junior College for two years in the engineering program that they had, which I presume they still have, I don't know. Which meant that you took all of the first two years' courses that you would take pretty much at any engineering school. All the math, all the science, all the chemistry, all the physics. 'Course, the war was heating up during this time and I ended up with a very low draft number and I really wanted to finish school. So I then transferred to Santa Clara [University]. I was, again, very aware of it, so I worked really hard.

<laughter>

**Carrico**: In the middle of all this I got married, at 20, because that's what you did in those days. But by the time I graduated in '72, all of that had kind of dissipated. The war had wound down, the draft had been essentially eliminated, and so I didn't really have to deal with that after the fact. All I had to deal with then was finding a job.

**Brock:** Was it necessary for you to work during your college experience?

  

**Carrico**: Yes. I worked, in fact, in the summers and part–time during the year for a company called Orion Products. Orion was a small company that was off Central Expressway. I forget the street it was on. In one of the older buildings off Central Expressway about, I don't know, a quarter of a mile before you get to the now TI, formerly National [Semiconductor Corporation] building. They built high–speed digital tape recorders at the time and I worked basically as a technician on those.

It was only maybe 10 people total with 5 engineers and they got contracts from people and then built specialized tape recording for various, mostly government contracts. They had a specific kind of a tape drive mechanism that was kind of unique and they could record for very long times with it, and that was attractive in some application. I worked on the electronic stuff for that.

**Brock:** Would they have been used in conjunction with computers?

**Carrico**: Yes, but we didn't really do that. I mean, we built the tape recorder and the electronics to get the tape written and get the data back off, read back off again. But all we did is we met an interface. Presumably it was used somewhere else with a computer, but it was fairly compartmentalized what we did.

**Brock:** When did computers figure into your experience? When did you become aware of digital computing?

**Carrico**: <laughs> When I got to Santa Clara. I was aware of them, like anybody might've been, but I had never even touched a computer until I got to Santa Clara. The first class I took was Applied Mathematics and the first day of the first class he said, "Go write a FORTRAN program to calculate the Runge-Kutta of a differentiation method and turn it in tomorrow."

**Brock:** <laughs>

**Carrico**: "And you get to use an IBM 1130," which was, oh, IBM 1130 was transistorized but I don't know if it was silicon by then. So I had to go learn FORTRAN that night as well as write the program.

**Brock:** <laughs>

**Carrico**: This was a little bit unique for me because everybody else had had experience. All the non–transfer students had had experience. Not me. <laughs> So that was—

**Brock:** They were assuming that the other Santa Clara students had been exposed along the way.

**Carrico**: Right.

**Brock:** To that point.

  

**Carrico**: It was actually a good experience at Santa Clara because you went in and people would help you. It was still IBM cards at the time. But you could do your own stack, you could submit it yourself to the machine. They let the engineers have their own machine and you didn't have to deal with any IT priests or anything.

**Brock:** What was that kind of trial–by–fire like for you? Did you like computers after that or... <laughs>

**Carrico**: I did but I, I mean, I thought it was interesting, and I got it. I got exactly what it was, what it could do and so on, but I was just—it didn't figure prominently in what happened at all until much later.

**Brock:** Some other people I've interviewed who went to Santa Clara did it on a kind of a commuting basis. Was that—

**Carrico**: Commuting, what do you mean?

**Brock:** Well, living in a different—not living on campus. Commuting down to take their courses, you know.

**Carrico**: Oh. Well, I was married by then. We lived in a little apartment about, I don't know, half a mile away from Santa Clara, and I walked.

**Brock:** <laughs> And was your wife a student? What was she doing?

**Carrico**: No. She had graduated with me at Fremont High School and she went and got a—I don't know what. It was some kind of a degree that allowed her to be a nursing assistant, an x–ray technician, and that's what she did. She basically kept us in food.

**Brock:** <laughs> At a hospital nearby or...

**Carrico**: No, at a small clinic with a few doctors.

**Brock:** I was just thinking about your interest in electronics and your previous voracious reading about Egyptology. What sorts of things were you reading for pleasure? Were you reading science fiction?

**Carrico**: Oh, of course.

**Brock:** Okay.

**Carrico**: Of course! <laughs>

**Brock:** What sort of science fiction were you reading?

  

**Carrico**: Pretty much anything and everything. 'Course, I read all of Heinlein, Asimov, Doc Smith. Pretty much everything that was available at the time that people would consider probably the classics now. Yes, all of it.

**Brock:** Was there a particular—

**Carrico**: *Lord of the Rings*, of course. Which is not exactly science fiction but was very popular at the time.

**Brock:** The Venn diagram of interest is almost a circle, I think.

**Carrico**: Mm–hm.

**Brock:** Was there a particular book shop or do you recall where you were finding that stuff?

**Carrico**: No, I don't think so. I don't remember where I bought it. I mean, pretty much wherever I found it, I think. Sometimes I got stuff from the library again, of course. But no, not really. I really was busy. <laughs> Like in college, I was working as well as going to school, so my free time was relatively limited.

**Brock:** <laughs>

**Carrico**: I didn't get the college experience that people experience now or a lot of them even experienced then. No. It was kind of a little bit nose–to–the–grindstone at the time.

**Brock:** Mm–hm.

**Weber**: I mean, the counterculture was still going full blast.

**Carrico:** Oh, yes. I was right in the middle of that too.

**Weber:** Okay.

**Carrico**: But being somewhat of a conservative guy then and somewhat of a conservative guy now, I am, I was, I mean, I was appalled by what was going on in San Francisco, and I knew a lot of people who were partaking of it. <laughs> Certainly have met a lot of people since who did.

**Weber:** But, I mean—you were busy with your life. You were not part of that scene.

**Carrico**: No. No. Not in the slightest, no. But again, even if I had been interested, I wouldn't have had the time.

**Brock:** <laughs> So you're at Santa Clara for two years. How did your particular interest in electrical engineering evolve? Did you come to really be attracted to one particular area or...

  

**Carrico**: Well, no. Really because of the electronics things I mentioned earlier, I really knew I wanted to be an electrical engineer. I never had any doubt, so I was always on that electrical engineering course, and no. That was the program I stayed in.

**Brock:** Within that, was there something that was really pulling you, you know…

**Carrico**: At the time, there wasn't as broad of an opportunity as there is now. There wasn't really too much. You pretty much were, as they would've defined, an electrical engineer; you're going to be a civil engineer; or a mechanical engineer. There wasn't much more differentiation at the time. And they taught computer stuff in it. I had basic digital electronics with 7400–type ICs [integrated circuits]. You're familiar with those?

**Brock:** Those are the TTLs [transistor–transistor logic]?

**Carrico**: TTL, right.

**Brock:** Yes.

**Carrico**: Right. Everything we did we did with TTL and wireless breadboards and so on, and I took those classes. But I also took—they required a kind of a core curriculum. You still had to take classes in like electrical machinery; things like motor generators. I don't know if they still do that, but it's much more of a narrower field today. Maybe not so much even narrower, but there's much more broad opportunity overall. You had to take those and you had to take some civil engineering kinds of things, statics and dynamics, those kind of things. But my goal was some kind of electrical engineering when I graduated.

**Brock:** Were local companies recruiting on campus?

**Carrico**: We're coming to one of the more humorous parts of my story.

**Brock:** <laughs>

**Carrico**: It was a tough time economically in the Valley. '72 was not your greatest time in the Valley. I don't remember exactly why it was, but it was true, and many of the people who were attending Santa Clara did get intern jobs at HP. HP, of course, was very big here then. Perhaps there were other people who got interns other places, but the ones that stick in my head were several of my friends who got HP internships.

I didn't really pursue that because I was already working at Orion and getting paid for it and so I wanted to not lose that, so I stuck with that. As things worked out it probably wasn't, but it could've been a mistake. When I graduated in '72—you know, before you graduate you start thinking about it, perhaps in December of 1971, maybe sometime in there, I was probably thinking about it—and I was having a hard time finding people who were interviewing. Now, the guys who had been interns got pretty much, "You can start July 1," or whatever it was, and all of them did. All of them went to HP, including, like, one of the

  

guys I worked very closely with in junior college, that he and I'd spent a lot of time together. He went to San Jose State and he immediately got a job at HP because he'd done the same thing.

I struggled to find a job and in fact flat did not find a job. Now, I had graduated pretty well in the class and I couldn't find one, so it wasn't that. This same gentleman, Alan Ankerbrand, said, "Well, there is a product marketing engineering job open at Fairchild," and I said, "What's product marketing engineering?"

<laughter>

**Carrico**: And he says, "Well, it's this, that and so on," and he described it as well as he could, and I said, "Well, I guess I need a job. Sounds something like engineering." I went and got the job, interviewed and got the job.

What they meant by that is that you were essentially the interface between the factory and the salespeople. In addition to giving input, for example, to the operations and engineering in terms of what are customers asking for, you had to restate that in a way that the salespeople could understand. But it also meant you had to deal with all the sales side of things, not the sales itself, but the sales input to the factory, and make that so the engineers could understand it. Also you were involved, for example, in quoting pricing, in solving product problems. You were, in some way almost like a tiny little operational manager on your own for your territory, and that turned out to be very interesting.

I went there, and on my first day I was given a stack of paper this high, and these were customer specifications for transistors. This was in the Transistor Division. These were customer specifications for transistors and they said, "All right. Go through them and review them all and assign one of our internal part numbers to them."

**Brock:** <laughs>

**Carrico**: I did, and it was very helpful. It was a good thing to do in general, but it was very helpful to me. I learned a lot just doing that. Then the other thing that happened is one of the gentlemen that I work for—I guess he was the guy I worked for at the time—pulled me aside and started giving me kind of tutelage on basic business. You know, "How do we do costing here? How do the P&Ls work here, how does a balance sheet work here," and so on. Bear in mind, I knew nothing about anything like this. I mean, I had graduated as an engineer. I'd never really had any interest in it. I found that I kind of enjoyed the diversity. It was kind of your little deal to manage and your little deal to get right or wrong, and I worked on it and enjoyed it and things kept moving along.

**Brock:** Did you enjoy the analytical aspect of the finance business?

**Carrico**: Not pure finance. Only in the service of the business itself. I wasn't really tremendously interested in finance, per se, but I had to understand enough, particularly there in terms of costing. How do product costs work? How do we assign costs? How do we determine what something really should sell for? Those kind of issues. Generally the PMEs weren't given this kind of tutelage at all. Many of them

  

didn't have a technical background, and so that was a problem in and of itself. Some of them just weren't interested. There was a pretty wide spectrum of capability, I would say, among the people who were PMEs.

**Brock:** Right. How were you interfacing? Was it mostly through documents or were the salespeople coming back and saying, like, the customers need something new or—

**Carrico**: All of the above. I spent a lot of time on the phone with salespeople, and as time progressed, as I got my feet on the ground in terms of knowledge about what I was doing, I started going and visiting customers myself. I would visit customers, spend a lot of time with the salespeople, and then spend a lot of time trying to resolve whatever the issue might be internally. I would go to the engineering manager, one of the product engineers, and say—or process engineers even and say, "Look, this needs to be done," or, "This is not working out so well." I think because of my interest and I guess, the knowledge I acquired, I started moving up in the ranks, and fairly shortly, I guess it took about two and a half years, I was essentially the marketing manager for Transistors.

**Brock:** Period.

**Carrico**: Yes. I had the PMEs and a variety of other people to then work for me, and then became responsible internally for the bookings, the orders, if you will, for that Transistor Division.

**Brock:** Now, while we were chatting before the camera was running, I mean, Fairchild is putting out millions of transistors, what, a month? No.

**Carrico**: No. We were talking about shipping transistors to the computer companies at that time, which included people like Univac, CDC, IBM, NCR, these kind of people, all made their own what they would've called mainframes at the time. The primary component for that was us, NPN switching transistor, and we were shipping as many as a million a week of the NPN switching transistor that was the key component to make their gates on their little PC boards.

**Brock:** Right. So you're shipping a million transistors a week out of, I guess, out of assembly. But I was just wondering about what the landscape was like. Was it the case that there were maybe, oh, a dozen customers that accounted for the vast bulk of that and then it was kind of assorted cats and dogs? <laughs>

**Carrico**: Yes. There were maybe 8 or 10 computer makers who could buy anything near that kind of quantities, and again, they also bought things like core drivers. I mentioned to you before, PNP transistors that were used in certain applications to complement the NPNs. We also sold things like hammer drivers for the IBM printers. The hammer drivers on the printers, that was a good business for us. Power transistors for the power supplies, which were not switching at the time. They were all linear, essentially all linear. All of this stuff.

  

By the way, the other thing I haven't mentioned, during the course of my tenure at Fairchild, the diodes were in and out of being part of that same Transistor Division. Fairchild did very well on the diode business. I think all the time that I was there, the diodes were made up in San Rafael, [California]. There was a fab up there.

**Brock:** Right.

**Carrico:** We shipped millions of diodes, millions of diodes, along with this, because a lot of the usage of the transistors was in a DTL [diode–transistor logic] kind of logic. All that together, it was a big business at the time, and remained a big business pretty much the entire time I was there. It was declining as they picked up TTL and added what we would call like MSI [medium–scale integration] parts, small TTL parts, MSI parts and so on into their computers over the course of the '70s. But it wasn't as fast as you might think—took a long time to get them introduced into production.

**Weber:** You were the Marketing Manager for the Transistor Division, Diodes was big—how many divisions were there, and what were their rankings?

**Carrico:** Oh, boy, I don't know if I can remember all this, but—

**Weber:** I mean, around.

**Carrico:** This, by the way, was not constant. It kind of modulated in and out. There was a Transistor Division. Diodes, again, sometimes part of Transistors. There was Linear, there was what they called Digital, but was the TTL for business at the time. This is that 7400 TTL part, which was just ubiquitous, invented by TI. There was also later on bipolar memory, where Fairchild had been very good at doing bipolar processes, and they came out with this isolated memory technology to build bipolar RAM, primarily. And PROM [programmable read–only memory] to some degree. Later on, they also did MOS [metal–oxide semiconductors], and had that as a separate division, M–O–S.

Then other things happened in the course of time. There was also a Hybrids Division that primarily sold ignition modules to the car companies. Later on, one of the things I did was build power transistors for the ignition module to actually switch the coil. The biggest division was probably most of the time the Digital Division, the TTL; I would say probably then Linear and then probably Transistor and Diode, sort of depending on when you measured it. This was changing rapidly at the time. Things like op–amps came into Linear, and that became a very big business.

**Brock:** You said it would have been then by 1975 that you were playing this role of Marketing Manager for Transistors?

**Carrico:** Roughly, yes.

**Brock:** In that, who in the company were you interacting with? Who you were reporting to, and were you—?

  

**Carrico:** There was a General Manager of the Transistor Division. And again, this changed on and off. At the end, it was a guy named Manny [Manuel] Fernandez. There were other people in–between. I don't even remember all their names. My job was really to “How do we get the maximum sales for the Transistor Division?” It really meant the same thing still: interfacing with the outside sales force, solving applications problems, visiting customers to get them to commit, figuring out how to make the pricing work.

For example, a lot of the things I ended up doing had to do with—Fairchild was not as big as Motorola, by far, in the transistor business. Motorola was the dominant transistor supplier by the mid–'70s. And they could be cheaper, basically because they were bigger—more volume. We had to try to find a way to get in and still retain our share as we saw it of IBM's transistor business, for example, and I had to figure out how to do that. Things, like that. In many ways it was—as much as marketing anything, because we really didn't market that aggressively, it was more, "How do we promote the sales?"

**Brock:** I've always been interested in the complicated problem of pricing in semiconductors. Because it really seems like you're looking at what is the—where is the product in its life cycle? Is it a standard product? And then, what am I going to be looking at in the this—kind of the lifetime of the sales of the product to the customer? It just has always seemed like a complex optimization.

**Carrico:** Yes, but at least in my experience, it's very hard to sit down and try to make a 10–year plan about that. You pretty much have to go day–by–day, and operate it day–by–day. You're going to be surprised by what customers buy, and by what customers decide not to buy anymore. The spectrum was just unbelievable! I remember when handheld calculators came out, I was in a little South Side of Chicago building. I was scared to walk from the car into the building. Inside were card tables, basically, with many, many, many, many women. Hand–putting together the parts to make a little handheld calculator. I was there to try to sell them the transistor drivers to drive the LED displays, so that they would manipulate the LED displays current at the behest of the calculator. He didn't care what the—spec that you had to meet was just, it works.

I had another guy would come about, I'd say, about every six months from the Far East. And he wanted to buy all of our transistor—our screening rejects. I had to take him down in the basement. We built a lot of transistors, so we had a lot that would fall out of even the lowest bin of the screening.

**Brock:** Right.

**Carrico:** And they weren't necessarily not transistors, but they weren't transistors that most people would buy. They may be the breakdown voltage was too low, the beta was too high, or too low. They maybe had a little bit too much saturation voltage. Whatever it was, and so we had these cardboard barrels. They were bigger than 55–gallon barrels. He brought himself like a candy scoop, and we gave him a curve tracer on wheels. He would sit there and he'd scoop in, go down real low, and scoop them out and test them. Just like this, just taking a look, sampling, right? And then he and would negotiate for how much he would pay for them.

  

**Brock:** For the entire canister.

**Carrico:** Yes, or multiple. I can remember like one time, I think we had, I don't know three or four big canisters, and I got him to pay $50,000 for it. It was a big deal at the time, because $50,000—it was pure profit!

**Brock:** Yes.

**Carrico:** I mean, this was completely written off. At best you would have got a little bit of money maybe out of recovering materials. Maybe. It was just all over the map! The kinds of things that you would run into.

**Brock:** What was he using them for?

**Carrico:** He wouldn't say. But they got shipped to the Far East, and I suspect they were going into very cheap transistor radios. Built in Taiwan, China, anywhere over there. Because this was a time when handheld transistor radios were a pretty big thing.

**Brock:** Absolutely. On the sales side, it would have been mostly other engineers would have been the salesforce for Fairchild. You know, was it really engineer–to–engineer?

**Carrico:** No, <laughs>

**Brock:** No. I'm sorry. Maybe that was—

**Carrico:** No, the—

**Brock:** It was initially and then it changed?

**Carrico:** No, there were certainly some salesmen who probably had an engineering background, but most of them were really people who either were trained to be, or had somehow come into some kind of a sales role, and found that they could sell transistors and diodes and integrated circuits pretty much just as easily as they could sell whatever they sold before! <laughter>

No, they were real salesmen in whatever—however you want to call that. Some of them could really sell, in the sense of they could really make the customer…the way any great salesman can be. Some of them were great, some of them not so great, it's the way it always is.

It tended to be the best if you could go out there and work with them on a problem. If you could go out and—so, for example, I had to go myself to IBM, and make the arrangement with IBM. Because the sales guy, while he was pretty good, and while the IBM liked him, seemed to have a good relationship with him, they wanted somebody from the factory to come and— they wanted to have their hands shaken.

  

**Brock:** Right.

**Carrico:** This happened fairly often. We were trying to get business from Chrysler for the ignition module at Chrysler; Chrysler was building its own. I flew to Huntsville, Alabama, and spent time with the engineers at Chrysler. I mean, pretty much everywhere you ended up going. It was a broad spectrum. <laughs>

**Brock:** Within your area of Fairchild, did you divide things up for kind of who had primary responsibility for these big customers, transistor customers?

**Carrico:** Yes, it was by salesman, right?

**Brock:** Right, okay.

**Carrico:** It was a territorial—

**Brock:** Okay, so it was—

**Carrico:** Yes, pretty much territorial. For all products. One of the problems that the transistor business had at the time was that as Linear and Digital were starting to get bigger and bigger and being more and more important, it was harder and harder to get the salesman's attention on transistors and diodes. This was one of the conundrums, and one of the reasons ultimately I left the company is that it was pretty clear to me that there was a long–term business here. It wasn't going to be in small signal transistors. It was going to be in power transistors, VMOS [V–groove MOS], power MOSFETs [metal–oxide–semiconductor field–effect transistors], and a lot of other things that are now pretty much standard in everything.

The Fairchild senior management was all focused on, "Wow, LSI!" [large–scale integration]. All focused on linear and digital and those kind of areas, and kind of didn't really want to—and they only had so much money, too, to spread around. Didn't have the money to go invest in this area. I guess we were just unable to convince them. It was at a time when it was very, very snazzy to be in linear or digital or LSI.

**Brock:** Sure. And when did—you left in '79.

**Carrico:** Mm–hm.

**Brock:** When did Schlumberger buy Fairchild?

**Carrico:** After I left. I don't exactly, but it was after I left.

**Brock:** Right after, yes.

**Carrico:** So at Fairchild, two things happened. One, eventually I went over and for a while was marketing their MOS memory products. It was their dynamic RAM products working for Gil Amelio.

  

**Brock:** Okay.

**Carrico:** I did that for maybe nine months or a year. Then I went back and became General Manager of the power transistor business.

**Brock:** Okay.

**Carrico:** That was my first General Manager experience. I was responsible for everything as it related to the power transistors at that point. Marketing, building, and making sure they got sold.

**Brock:** How do you connect that to your later entrepreneurial efforts? Was that your first time where you were dealing with all the components of the business and putting it together?

**Carrico:** Yes, yes. It was a very good experience from that perspective, and we did pretty well with it. The problem is really what I alluded to a minute ago. To make it go somewhere, we needed to make some investments, which I was unable to get anybody interested in making. It's not that they necessarily didn't believe, but if I got money to invest here, or in this thing that I think is really cool, that's how it got invested. The irony of it is, again, there are approximately 60 power MOSFETs in every car right now.

**Brock:** Right.

**Carrico:** I had already made a deal to actually resell Supertex FETs, the MOSFETs under the Fairchild label by buying wafers from them and packaging them ourselves and so on. But I just couldn't get the money to do pretty much anything.

**Brock:** With the investment, did you need a different process or did you just need allocation of the fab?

**Carrico:** Oh, no, we just needed a little bit of money. We didn't even need that. We needed some money to improve one process. We needed money to do what needed to be done to get a MOSFET business into business. But this was all, relatively speaking, small. Probably $100,000 in total.

**Brock:** Wow.

**Carrico:** This wasn't millions of dollars, right? But there was a lot of demands all over for cash.

**Brock:** Taking that General Manager role for power transistors, were you still—where was Manny Fernandez in that? Was he in a different area, or was that moving back to—

**Carrico:** No, my memory fails me at this point, because I can't remember exactly how this all ended up working. I think Manny had left.

**Brock:** Okay.

  

**Carrico:** Manny left to go and work for Zilog. Somewhere in there time when I was at power transistors. He had gone—he'd actually gone somewhere else first. He had gone to—I don't recall. What's the name of the company that does fiber optics back East? It's right on the tip of my tongue. But anyway, there's a company that is very fam—Corning.

**Brock:** Yes, Corning.

**Carrico:** Corning, he had been working for Corning in their fiber drawing business to build optical fibers, glass–based optical fibers. Then I guess he got recruited into Exxon, and then Exxon put him into Zilog.

**Brock:** Oh, okay.

**Carrico:** That's ultimately how I ended up at Zilog.

**Brock:** Before we get to his recruitment of you to Zilog, if you will, could you talk a little bit about him? Because I recently became acquainted with him from some materials we have in our collection around Gavilan Computers.

**Carrico:** Yes, Gavilan! I know Gavilan.

**Brock:** He just seemed like quite an interesting and dynamic character, so I wanted to hear from you about that.

**Carrico:** He is. I knew Manny very well. I worked on and off for Manny for several years. I would say what you said is true. I mean, he was dynamic. He tried to get things done. I think he's a good guy, I really do. I didn't have any qualms working for him. I don't really actually know what his background was, though. Personally, I don't know if he had an engineering degree or not.

**Brock:** I think so.

**Carrico:** But yes, all around good guy. I know the Gavilan story pretty well, but only lefthandedly. I didn't have any direct involvement. That was too big of a bite is what it basically was, just too much to try to do all at once.

**Brock:** Right. The sort of graphical user interface stuff, and a portable computer. It was—

**Carrico:** Yes, and they were trying to do all of it. It was just—printers! Everything.

**Brock:** Oh, yes, the integrated printer in the back of the thing. Yes. How did he get in touch with you about Zilog?

**Carrico:** I think maybe I got in touch with him because I felt that I needed to do something different. After the seven years at Fairchild, I'd enjoyed most of it very much, but I realized I wasn't going to be able to

  

get anybody to agree to put the money where I thought it was needed. I thought maybe just a good time to go and do something different.

I was interested in potentially getting into more exposure to the computer business. I had a little bit of that working on the MOSFET memories, the dynamic RAMs. He said, "Well, you can come over and we have a job opening for a strategic planning guy." And I said, "That sounds fine," and so I basically went in 1979 over to Zilog over on Bubb Road. He wanted me to try to organize all the different activities that were going on, try to make some sense of them. There was a lot going on at Zilog at the time. Because remember, Zilog was building components, building development systems for components, building computers, building a network, and was about to embark on building a minicomputer! This was all for a fairly small company, so it was a lot.

**Brock:** How many people would you say there were, order of magnitude?

**Carrico:** <sighs> I honestly don't remember, but if I had to guess, I'd say three– or four–hundred.

**Brock:** Okay. So it's a lot of activity for a group of that size. <laughs>

**Carrico:** Right. It's funny, when I got there, one of my favorite stories is that I quickly understood that engineers, software engineers, in particular, were not the same breed of engineers I was used to. You would walk around in the engineering building. The administrative building was on one side of Bubb Road. On the other side of the road, was the engineering building for all of Systems Engineering. The Components Engineering was in a third building over here. You'd walk around and you'd see guys sleeping under their desks, right? No shoes. Things like this. Which is, by the way, pretty much how it still is! <laughter> I remember the first time Manny came over and started walking through that building, he saw all these people sleeping under their desks with no shoes, and went home for the day! <laughter> It was just too much.

**Weber:** Yes, there was some story about the person with no shirt who was a manager or something?

**Carrico:** Oh, yes, yes. There are some characters there! All very smart people. The thing you have to understand about Zilog at the time, is that Zilog was another place I saw where the potential was gigantic. There's been many Zilog spinoffs. Trying to get it to come together and get everybody working on one thing was always a trial. A lot of egos, but a lot of capability. I mean, the Z80, by and of itself did fabulously well, given it was, you know, basically two men and a dog who put it together. The chips that we did as peripherals for the Z80 did better than the Z80 did! <laughter>

We did an SIO, what was called, and a PIO and a DMA chip. The SI was a serial interface; PIO, parallel interface; and a DMA [direct memory access] chip, and these could be used in association, and they were connected to the bus of the Z80 in an easier way, and so on. We made more money and sold just boatloads of those things! So the components did pretty well. The problem that we had at Zilog is, "Where do we go now? Z80's doing real well, what do we do?" They were going to build a Z8, which is essentially a microcomputer. Single chip, for like controllers and stuff.

  

**Brock:** Okay, yes, a microcontroller based on the Z80.

**Carrico:** Then the big issue was the Z8000.

**Brock:** Right.

**Carrico:** The Z8000 that turned out to be somewhat of a problem.

**Brock:** It took longer than people had hoped?

**Carrico:** It wasn't so much that, it was that the Z8000, it did what it was promised to do, but it had segmented memory. Now I don't know how technical you guys are, but—

**Brock:** I don't understand the significance of it. <laughs>

**Carrico:** Segmented memory just means that they have—they built in a hardware memory protection mechanism so that you had to change segments, in a hard way, if you wanted to, for example, maybe switch from one task to another, or switch from one user to another. Now on the face of it, that sounds good, but that's not what customers wanted. The customers, particularly the kind of customers who were going to use this kind of a chip, which was basically people who were going to try to build minicomputers, wanted a linear address base.

**Brock:** Okay.

**Carrico:** Because it's just much easier to deal with. That meant that they would have to put their memory protection into the computer, or into the operating system, they were okay with that.

**Brock:** They would rather figure it out their own way but have that much more flexible kind of use of memory.

**Weber:** Segmented memory of size limits on each segment, too.

**Carrico:** Yes, and they had some clever ways to try to connect them and hook them up and so on, but it was much more complicated to get between segments. You had to keep track of that, and believe me, nobody wanted to do that. It was not popular. One of the problems they ran into was this whole segmented issue versus the Motorola 68000. It wasn't really versus Intel. Intel came out with the 8186, and then the 8286, and so on.[2] Those were, more or less, had some of the same problem that the Z8000 did. But the real winner for the average smaller business was the 68000 from Motorola.

**Brock:** So you're coming into that landscape, you're also coming into where Exxon had just made, or taken the majority stake, and it's Exxon Office Systems, so they're—

[2] [Editor's note] Intel 80186 and Intel 80286. Added by Frances Corry on June 27, 2018.

  

**Carrico:** Owned by Exxon, though, right?

**Brock:** Right. But it's also Exxon starting to have a new ambition to—

**Carrico:** Right, this is Exxon Office Systems, who had already bought a bunch of companies that they were trying to cobble together to basically make an office of the future kind of offering. They bought, well, see if I can remember them: Qwip, Qyx and Vydec, three companies. I can't remember which is which. One of them was a fax company. One of them was a hard–coded word processor, so a word processing machine—

**Brock:** Wang.

**Carrico:** Wang, yes. But you had to upgrade hardware to change functionality. It's not the brightest idea. And then I forget what the third company did. But then they were trying to then somehow fit Zilog into that.

**Brock:** So they were really looking at Xerox then.

**Carrico:** Well, I think they probably thought that, but even Xerox wasn't really focusing on that very much, as you probably know depending on what interviews you've done with Xerox PARC.

**Brock:** Right.

**Carrico:** By the way, I can't overstate enough how much interaction there was between, for example, the Zilog people and the PARC people. Everybody knew everybody. And there was a lot of back and forth, informal, not really formal. Very early on, I went and saw everything that Xerox PARC had, and saw the Star workstations and saw their early version of Ethernet and all this stuff.

**Brock:** Soon after joining Zilog.

**Carrico:** Yes, I don't remember exactly when, but pretty quickly, yes.

**Weber:** And there were the parties that I guess Judy Estrin had with Xerox people where people talked about networking.

**Carrico:** There were a lot of parties! Yeah! <laughter> No, it was almost collegial, I would say in terms of particular those two companies, and maybe others, too, I don't know. Well, I don't know. Do you know Judy?

**Weber:** I've exchanged email. But I was just reading the interview the two of you did 25 years ago. So—

**Carrico:** Well, Judy's best friend worked at Xerox PARC, Barbara Koalkin, well, her name's different now, but that's what it was at the time.

  

**Weber:** They were housemates, right?

**Carrico:** Yes, actually they were for a time!

**Weber:** Because what I think you both talked about and I'd read somewhere else is that there were a number of parties in which some of the people that were really interested in networking kind of came together as well. I guess it was the systems development part of Zilog was kind of almost a PARC in miniature with beanbag chairs and the whole—as you said, very, very different from the other part of the company.

**Carrico:** Yes, yes. All that's true. Absolutely. There was a lot of informal interaction. But everybody sort of knew that all of this was where the world was going. It was pretty hard if you were aware of what computing was all about to not look at Xerox and say, "That's pretty much where this is going to go." It was pretty hard not to do that. Now, by the way, that was a lot harder to get to than it looked like. But it was pretty clear that it would get there.

**Weber:** So at the time, Federico Faggin was still, I mean after the sale, or Exxon taking such a big share, Federico was—

**Carrico:** So Ralph left, who was the co–founder. And Federico stayed—I think all the time that I was there.

**Weber:** Okay.

**Carrico:** Federico was—I don't know what his title was, but he acted kind of like CTO.

**Weber:** What was Bernard Peuto's role at that time?

**Carrico:** Bernard was the architect. He was the chief architect. Bernard and I had interactions. <laughter> Particularly about this whole linear versus segmented address space.

**Weber:** Okay, tell that story.

**Carrico:** No, there's no particular story to tell. But we went around and around on this, because he had decided he wanted to do the segmented address space, and that's pretty much what was coded into the masks, and I said, "Bernard, these people are going to want linear address spaces!" And we went back and forth many times on that. <laughter>

**Weber:** Did you have much to do with Federico?

**Carrico:** As I recall he wasn't really that involved in the day–to–day things. No, I can't say that I did. You know, [Masatoshi] Shima was there, of course when I was there. Shima is just overwhelming. There's

  

very few people that you meet that are overwhelming in life, but this guy could literally, from the schematic in his head, draw the features on the rubylith as they were going to be. Just amazing.

**Weber:** At this point the ZNet was already around as a project.

**Carrico:** Yes, when I got there.

**Weber:** And it had come out of the Ariel project.

**Carrico:** They were kind of all the same. That was just a code name. There had been this thing called the MCZ Series, which was the 8–bit microcomputer systems. They existed. They had a five–and–a–quarter floppy disk. No, eight–inch! I'm sorry, eight–inch floppy disk. They had a Zilog bus inside, a card bus in side; there was a CPU card; there was SIO card, which could, using serial connectivity, talk to a CDC hard drive. That was really a big thing, by the way, at the time. Then you could put more memory, and then a printer card and so on. These ran Zilog's operating system, which was called RIO, I think it stood for real time input/output. That worked pretty well. It just needed some application software, and it's one of the things we started working on.

Because of all of this, as you pointed out, the networking floating around, we started working on ZNet. ZNet was intended to be essentially a low–speed version of what had been done at PARC. Remember, there were no standards at the time, so you could pretty much do what you wanted. I actually hired a guy to do the transceiver for us. We pretty much got it going. We had to have a team of people to write the protocols. And we did them. We called them Vanilla, Chocolate and Strawberry. <laughter> We pretty much got the whole thing running so that you could share data back and forth; you could have a server and so on. Pretty much the kinds of things that you would expect to see like 5 or 10 years later among a variety of computers. But it was probably all a little bit too soon. Overall, that was called the Ariel project.

Judy, when I got there, she was in charge of that from an engineering point of view. I ended up, at Manny's request, becoming the general manager for the Z80–based systems. There was another guy who became responsible for building a Z8000 system. There, they were trying to build a full–on minicomputer replacement, using that Z8000 we talked about, which, by the way, certainly could be done, and if you're doing it yourself, it probably is okay to do it that way. But it was pretty hard to sell that architecture to somebody. So they were off doing that.

Then there was a third piece of the business, which was still doing the developments systems for the chips. Because at the time you had to really provide development systems to customers. That's kind of how it was organized, and we worked on that, and slowly tried to pull the pieces together, and get it to all work and be a viable thing. It was a very tough time, though, because there was very little software that you could even pay somebody to port with.

The software that was available was really, if you think about it, minicomputer software. So the first person we thought of to go to was Microsoft. We tried to get Microsoft to port their COBOL or their Microsoft BASIC onto RIO, and they really didn't want to do that. One of the ideas that Judy and I had is

  

we went and found this guy who did WordStar up in, he was in San Rafael somewhere, and we got them to agree to sell it to us and port for us. But Exxon wouldn't let us do it, because they didn't want to screw up whatever their hard–coded word processor was going to be. They were afraid that it would cannibalize that. It could have done very well with that, I think, but we couldn't get them to agree to it.

**Weber:** You meant microcomputer software, not mini. You were looking for micro.

**Carrico:** Yes, we were looking for microcomputer software, yes.

**Weber:** Had this gone ahead as you hoped you would have had microcomputers running—networked fully together with good software at that point.

**Carrico:** Yes, that was the direction we were going. It was probably a bridge too far at the time, simply because there were a lot of cooks here. There was the Exxon cooks, and there were still a lot of issues. You know, where does the money go? How much do you put into this Z8000 versus how much do you put into the Z80? All of these issues were all hanging around.

**Weber:** But I take it though this would have been a much lower price point than say the Star, which was obviously Xerox's emerging entry for doing something similar, but at a much higher price point, right?

**Carrico:** Yes, it would have been, and we did sell them. It's not like we didn't sell some. I'm not sure we actually ever sold any with the ZNet on it, but we did sell MCZs. I don't remember the volumes right now. It was small, but we did sell them to people who did use them with COBOL. We eventually got some kind of COBOL on them for small business accounting, things like that.

**Weber:** How is it different from—because obviously Xerox was the one—

**Carrico:** But Xerox really wasn't selling anything. This is—

**Weber:** '80.

**Carrico:** There wasn't—huh?

**Weber:** The Star was—

**Brock:** The Star was in 1980, right?

**Carrico:** Yes, but what was Xerox selling? The Star was never sold—I don't think!

**Weber:** Oh, yes, but not very much.

**Carrico:** I mean, yes. <laughter>

  

**Brock:** It was, but maybe not until a year later—

**Carrico:** But it would have been, like you point out, ten times the price of something!

**Brock:** Yes, yes.

**Weber:** It was part of a hundred–thousand dollar kind of—

**Carrico:** Yes.

**Weber:** Okay, so you were looking at a different market—I mean, almost competing with clusters at that time.

**Carrico:** Yes, maybe more like Datapoint is the way to think about it.

**Weber:** Ah!

**Carrico:** From my perspective, it was unclear what was going to happen. It was, once again, a case where there were so many people in charge, with so many agendas that it was hard to sort issues out. All of this led to—at one point, I, for the company, went to a—I'm trying to think of what you'd call it, I guess a roundtable, sponsored by one of the magazines at the time on Multibus. Because we had used Multibus inside Zilog for the development systems and some other things, and it was one of those things where everybody just talks, and the magazine records it, and they write up an article about it.

I sat next to a guy who had his own little Multibus company over off of San Antonio Road on this side of 101. I went and visited with him just out of curiosity one day, and it was very interesting. He had a small company. Probably the whole company was as big as this room. He was building boards and shipping them to customers because he had found a little niche for these boards. They did this, that, and the other thing, and customers seemed to appreciate it. I became very enamored of this. And I'm thinking 'If this guy can do it…' That's exactly what went through my head. In a large way, he was the sponsor of it. He gave me some food for thought that I eventually pursued.

Now about this time, Judy left the company and went to work with Ralph Ungermann at Ungermann–Bass. And we had talked about it. She went to work—I think she was their marketing person at Ungermann–Bass. She did that for a while, and there, she wasn't really terrifically happy. But she did it. I worked at Zilog for a while longer and finally suggested that we go build our own company. This was, in fact, then the genesis of Bridge.

**Weber:** The two of you were going out or friends?

**Carrico:** Yes. No, we were going out at the time.

  

**Brock:** I just wanted to ask just a couple—maybe take a couple steps back just to ask some follow–ups. After you got to Zilog, and you got into Xerox PARC, and you saw what was going on in there, could you describe your reaction to it? Many people who we've spoken with kind of had an a–ha moment or just kind of "This is clearly the way that things should go."

**Carrico:** Yes, I absolutely felt the same way. I realized that it was an a–ha moment, but it was a very expensive one. I realized how that thing was built. The Star workstations were very expensive and not at all built for production. I was a little bit unclear in who would be the customer for something so expensive at the time. But yes, the idea of having a network on which you share printers and disk drives and so on, and of course the graphical user interface, was all just absolutely the way to go. It just fed our view.

This is one of the reasons we kept working forward on ZNet at the time. There was no way we had the wherewithal to go build graphical workstations. That just is a whole other level of investment. But we could do all the other stuff. In fact, that's sort of what Ungermann–Bass and then, later on, Bridge did. They built products that allowed you to connect things, disparate things, together.

**Brock:** Marc, did you have—

**Weber:** It made me wonder just—the microcomputers, PCs, are taking off in this period at the opposite end, the low end. Were you excited by those as well?

**Carrico:** Well, this was pretty much before that except for maybe the Apple and things that you could buy at the computer store here. I think we probably, at the time, viewed them more as toys than real products that you could sell to most companies.

What we did is we didn't try to revolutionize initially. Bridge meant bridge, to connect things together. Our original idea was basically to build bridges that would bridge networks, internetwork products, connect networks through long distances through, at the time, things like X.25, connect different kinds of networks together. Those were the basic ideas of what that company was about. We weren't trying so much to build anything like a Star competitor. It was more that we were doing what you were going to need as infrastructure down there to bring in everything else you had into that kind of an environment.

Whenever you get into a new business, you have to find who is your natural customer. The natural customer turned out to be, for Bridge and to certain extent Ungermann–Bass too, somebody who had one or more mini–computers and wanted to share access just for plain old RS–232 terminals to those mini–computers. That turned out to be a really important thing to people, and that's where we ended up focusing on. We tried to go out and offer people gateways, routers, and so on early on. And they said, "What's that?" It was too soon. So, what we sold them were terminal servers. Then later on, as their knowledge built and appetite built, then we started selling them routers, bridges, gateways, those things.

**Brock:** I just had a footnote kind of a question about—I'm racking my brains, but I seem to remember something about there were people working at Zilog on the development systems, apparently on—you know, there's always this kind of magnetic force drawing a development system to be a full–fledged

  

computer. I believe there was a story about people were developing something of a graphical user interface sort of system on the development systems for maybe the Z8000? Do you have any recollection of this?

**Carrico:** Oh, I know what you're talking about.

**Brock:** And they went and worked, I can't remember where, VisiOn or one of these…

**Carrico:** There was a group of people who we did talk about building essentially a Star–like computer, but it never really went anywhere inside Zilog. There was a guy named Dave Folger. Dave Folger was a PhD in computer architecture, and he made a presentation at one point to basically build a very high–power computer with a very fancy user interface. As far as I know, that never happened.

Now, him and maybe some of his friends went off and did this, but I don't think it ever happened at Zilog itself. At Zilog, we had done some clever things, but they were really more simple–minded. We had, for example, a what–you–see–is–what–you–get editor called Eddie Freddie. It was a full 2D editor, and it worked just like any modern word processor would on just a CRT screen. It worked very well and very nicely, but it wasn't ever finished as a product.

**Brock:** Was that on RIO?

**Carrico:** Yes.

**Brock:** Okay. So there is again very much that kind of PARC idiom mixing through all of this. I did want to, before we drill down into the story about Bridge, I was very surprised to learn in preparing for this interview, I hate to admit—but I was very surprised to learn about how many of these LAN companies or networking companies came out of Zilog. I was actually really shocked about that. I just wondered if you could talk about that.

**Carrico:** Well, the primary ones that I'm aware of are Bridge and Ungermann–Bass. I'm not sure who you're referring to.

**Brock:** There was a third one that I think came out later than those two.

**Weber:** Let's see—not—Excelan.

**Carrico:** Excelan—I guess it did have some people who had been there, yes. Excelan, from my perspective though, was never really materially in the same business we were in. I didn't really track or follow them very much. I think I know who the guy is that you're talking about. But there were so many companies. When we started Bridge, we actually rented a building from Zilog, who'd since moved, or one of the buildings that had been Zilog's, and right next door was a company called Sytek who also was a LAN company!

  

**Brock:** Really?

**Carrico:** Mm hm. They built a little box with two ports in it for a broadband network, a proprietary broadband network. So, there were lots of LAN companies at the time who were around.

As a pragmatic issue though, we made a bet. The bet that we made at Bridge is that Ethernet would win. A lot of these other companies made different bets than that. Sytek bet that they could somehow go somewhere with their own broadband, and that never really worked out. I mean they did some business and so on, but no broadband standard evolved until much, much later. There were other proprietary networks out there. Eventually, there was Token Ring promulgated by IBM and TI. Then there was MAP [Manufacturing Automation Protocol], which was GM's Token bussed network. There were all these networks.

In fact, beyond that, you multiplied that by the number of protocol stacks. Many people had their own proprietary protocol stack. We at Bridge, in fact, started out with the XNS [Xerox Network Systems] protocol stack, which PARC was making freely available to specifications. We thought, "Well, Xerox will probably have a good chance of having it become a standard. So, let's use it." And that didn't really work out for us.

Within a year, we realized that it was going to be TCP/IP. And so, we had to go hurry up and write a TCP/IP stack and offer both of them, which we did. Within another year after that, we never sold an XNS. It was all TCP/IP. TCP/IP coming through the university systems, the fact that the university had already kind of picked it up and so on, just absolutely swept the day. Our early customers were often universities, so TCP/IP is what you needed.

**Weber:** To step back just a little bit, at the beginning of Bridge, you had—initially, you had gone—you had wanted to go to Ungermann–Bass when Judy went there.

**Carrico:** No, I hadn't wanted to go there. No, Judy had gone because she just wanted to go out, leave Zilog I think. I didn't know what I wanted to do. But after I met this guy, I started thinking about 'Maybe I could do a company too.' That's really what it was. I never even thought about going to Ungermann–Bass.

**Weber:** Okay. No, I thought you had gone and not—there wasn't a good feeling there, that you didn't feel there would be a future there for you.

**Carrico:** That's what Judy felt. But it wasn't me, I never went.

**Weber:** No, I know you never did. It was about putting out feelers to them, but—

**Carrico:** No, I never did for Ungermann–Bass. I didn't. She did go and worked there for a while. She knew all those people far better than I did because she had been there at the beginning when some of them had been there. And she knew Ralph, I never met Ralph.

  

**Weber:** Then when you did finally start Bridge, just tell us about the creation. I understand Judy was then doing work at Xerox PARC on the XNS, documenting the XNS protocols?

**Carrico:** She was doing that all along. Between XNS and Ethernet, she spent a lot of time doing standards in those early year or two. She and I recruited Eric Benhamou, who you must know, right? And a guy named Jean–Pierre Boespflug, and they were the four founders of Bridge. Eric had been at Zilog working for Judy, and Jean–Pierre had not been at Zilog, but Eric knew him from somewhere. He became our hardware guy, our hardware development guy. I wrote a business plan on Scripsit on a TRS–80. They had a little word processor that you loaded on a little cartridge tape called Scripsit. I wrote the business plan on that with a little tiny pin printer and started going out and shopping it. It took us a full year to finally raise the money.

**Brock:** Did you have connections into that world?

**Carrico:** Not really because I'd never done this before, so not really. I had some pointers from friends and stuff, but I didn't have any real hard connections. There were several problems. One of the problems is that they didn't see me as ever having run a company like this before, which I hadn't. I did have general management experience but not running a startup. One of the problems is that they did not like—I shouldn't say they didn't like—they were skeptical of a couple actually doing a startup. But I would say the biggest problem was that the ambiguity of the standards issue just scared them. What is going to be standard? All we could offer was our perspective.

They really, by the way, didn't bring up the XNS issue. That happened all later. That was too much for them. When you started talking about ISO protocol stacks, they just glazed. But they could understand the Ethernet thing. One of the biggest pushbacks we'd get is, "Well, Token Ring's going to win. It's IBM. Aren't you going to do some of that?" "No, we're not going to do any of that." "And what about broadband? Well, broadband, you can go miles with broadband." I said, "But there's no standards at all." So, he said, "Well, what if you need to go miles?" I said, "We have other ways to deal with it."

We went around and around and around on this. Finally, Weiss, Peck & Greer, who was a notable firm at the time, I finally talked them into it. This is about November of 1980, and we're about to close our first financing. They brought in Merrill Pickard, which was another big firm at the time. Then we brought in one third guy, I forgot who else they brought in. But we had enough money.

We're almost set to go and do the close and so on, and Strategic Incorporated comes out with a market research report that says Token Ring's going to win. So, I had to do it all over again. I managed to convince them that no, in fact, Ethernet is going to win, that here's the issues with Token Ring, here's where they are with the product. This is just FUD in the classical IBM way: fear, uncertainty, doubt.

<laughter>

**Carrico:** And there is no product, there's no product that even exists! They finally went along with it, and we started.

  

**Brock:** Was this a known thing to you, of IBM doing these kind of announcements of something like Token Ring that, as I understand it at the time, was "We're going to have this great, fantastic thing. It doesn't exist at the moment, but that's going to come," to just kind of—

**Carrico:** Yes, there's—

**Brock:** —plant a stake and scare people off.

**Carrico:** I'm forgetting a very important fact here, because it will make it clear. One of the pitches that was made by both IBM for Token Ring as well as General Motors and some other people for this Token bus approach, was that it was deterministic. You're going to know absolutely where that token is, and you're going to know that if you send a packet over here in one, two, three time slots, it's going to be there, and there's going to be absolute guarantee of that. Because it had to be. That was just how the Token Ring worked. It was just—it would—it was just like this. You knew you could get a deterministic delay time between this, and this, and this, and this, and this, and this, and this, and this. That was their pitch.

Now, IBM did this because that's how IBM thought about things. It's how SNA [Systems Network Architecture] worked. General Motors and, to a certain degree, Boeing thought the same thing. "We can't have an indeterminate network on our factory floor. We don't want the plate moving here while the drill bit's going up." That's the kind of thinking they had. That was part of how this was—the overall push on why Ethernet wouldn't work.

Now, as we all know today, you don't see any problems with Ethernet in determinism at all. And the reason you don't partly is because the speeds are too fast for any kind of problem, for the most part. The only time you really get jitter in the delivery of packets is when you're going across the Internet. But when you're in a car, when you're in a building, there's no deterministic issue, even in factories. It's just nothing. I'll get to that if we get to another story I have about this later on.

We had to overcome this pitch that they were making about determinism, and that was a real big part of why Strategic came out and said this. I managed to then re–convince them, and we started moving forward with the company.

**Brock:** You knew that you were making a bet on Ethernet. Where did your conviction come from to make that bet? Why did you think Ethernet was going to—

**Carrico:** Partly because we thought we could make it the cheapest. Now, this wasn't to be true initially. It was a wholly understandable problem, how to make Ethernet work. We'd already worked through, it if you will, a little bit, and even with ZNet. ZNet was only different in speeds and feeds, it wasn't different in how it worked.

By the way, at the time, none of us had really imagined Ethernet the way it is now with the switches and the homeruns back to the switch. I mean if you have Ethernet here, the cable goes back to a switch, or

  

even maybe it's just pure WiFi, which is just kind of a wireless switch. We were still talking about running that yellow cable around and tapping off of it wherever you needed a device. Even then, we thought we could be really quite cheap, as opposed to having to put even more knowledgeable stuff in this node that has to be attached to every device that's going to be on the network. That's what led us there.

Again, early on, it was tough. When we built our first Ethernet controller, it was two boards. The Ethernet standard was 10 megabits per second, and we couldn't afford to wait for a chip. Chips were coming. We already knew that chips would be coming, Ethernet chips, but we had to get out there. So we built our first Ethernet controller. One board was the datalink level controller. It was essentially all ECL, emitter coupled logic.

**Brock:** Wow.

**Carrico:** It was one Multibus board, and then a second Multibus board did the next layer up, the IP–ish stuff. Then everything else was done on a CPU, which just ran the rest of the protocol set. Now, within a couple of years, the two boards were gone. On the CPU, we could put an Ethernet chip. Often, we used the Seeq chip. I don't know if you ever heard of that one?

**Brock:** S–E–E–Q.

**Carrico:** S–E–E–Q, right. They were one of the first people who actually got a chip out, and it didn't work. We had to code around that problem.

**Weber:** I've read that at the time, you thought Ethernet was one of the closest to potentially becoming a standard. I mean obviously IBM, but then—

**Carrico:** Yes, again, IBM and the Token bus were—there was really no implementations. What Xerox had proved, if nothing else, was that it worked. There's an implementation, you can see it right there.

**Weber:** But I mean it's a little bit later that they did standardize it. And you were a part of that with 3Com, and the various companies. But that was already visible that there was a chance that it would become a—I mean wasn't Xerox—?

**Carrico:** No, everybody pretty much thought that—because DEC, Intel, and Xerox, the DIX group, had gone ahead and pushed for it. Everybody pretty much thought that there would be no problem, it being a standard. This would have been more of a problem if the IEEE had not been persuaded to have multiple standards. Then we would have had a catfight, of course. But it was, "All right, well, this one's pretty much done. Let's do this one." Well, that was all good for us. If they'd have tried to make them co–equal in time, I don't know what would have happened. It would have been awful. It would have delayed this a long time.

**Weber:** That's where they did the various 802s that could—

  

**Carrico:** 802.1, .2, .3, .4, yes.

**Weber:** Right, they basically gave each one a sandbox to play with there.

**Carrico:** Exactly.

**Weber:** And Judy was involved with that, right?

**Carrico:** Yes.

**Weber:** But that's a year or two later after found—

**Carrico:** Yes.

**Weber:** And XNS, they were publishing the—Xerox was making public some of the protocol. Maybe that's a little later, they held back some of the printing stuff.

**Carrico:** Right, but that never really was an issue because <laughs> what happened is that by the time that might have been an issue, we already had to go to TCP/IP. Xerox, again, they never took advantage of what they had. I mean, PostScript was magic, and was left to Adobe to show everybody how magical it was, to some extent Apple. None of that ever became a problem simply because we had to very quickly shift to TCP/IP. It became just absolutely obvious.

**Weber:** Right, and I understand at the beginning both you and Judy thought XNS was far, far superior to TCP/IP.

**Carrico:** Yes!

**Weber:** Or OSI [Open Systems Interconnection].

**Carrico:** None of us wanted to do OSI. None of us wanted to do that, but it really didn't matter. When faced with reality, you cave, I think.

**Weber:** The initial investment was how much?

**Carrico:** $1.8 million for sixty percent of the company, I think. By the way, that was a lot of money at the time. That was enough to get us going through probably about a year and a half. Nowadays, that wouldn't be. But it was a lot of money. It got us there. Now, one of the interesting things that happens fairly early on—so, I'm president and CEO. Judy was—I think she was VP of Engineering is what her title was at the time. This changed with time, but I think that was her initial title. Then Eric was VP of Software, and John–Pierre was VP of Hardware. That's how the initial organization went.

  

But, the board had a little bit more cold feet than I expected about me. You know, what can you do? And they brought Ray Noorda in. Now, Ray Noorda ended up running Novell later. Ray Noorda was the guy that Novell brought in who made Novell what Novell was for its period in the sun; but Ray Noorda was running a power supply company when he was put on the board of Bridge. He was put on the board literally to back me up in case I turned out to be unable to do it. This is just the kind of fun you get as a startup guy, right?

**Brock:** So, they brought him onto the board.

**Carrico:** Yes, just as a board member. He was there to learn a little bit about it, and if I stumbled, they were going to put him in charge. They liked him because he had done a couple things before for them. He was a smart guy, but he had no knowledge of networking.

**Brock:** When he began.

**Carrico:** Exactly. So, he got the free education for Novell from Bridge, which is kind of interesting.

**Brock:** I know later, you had talked about, if I'm not mistaken, the possibility of combining Bridge.

**Carrico:** Yes, we had.

**Brock:** Now, was he on the other side when you were doing this?

**Carrico:** He was CEO. Yes, Ray and I talked too about maybe combining Novell and Bridge later on, and then he backed out. He had actually brought it up, but then he backed away, and I'm not really sure, to this day, why. Subsequently then, of course, that ended up pushing us—pushing us? I'm not sure that's the right description, but migrating us towards 3Com.

**Brock:** I hadn't understood that previous connection. And he left the board at some point when they were—

**Carrico:** Yes, he did when he got hired by Novell, he left the board to go work on Novell fulltime. Novell wasn't a competitor for Bridge at all. It was just that he got—he did get a free education by being on the board for several years.

**Brock:** Right. That's fascinating.

**Weber:** At the beginning of Bridge though, I guess there was a falling out with Ungermann–Bass. Could you talk about that?

**Carrico:** Oh, yes. There was no nefarious anything. Judy went to go work for Ungermann–Bass, I was trying to decide what I wanted to do and eventually came up with "I think we should go do one ourselves." We talked about it, and finally, she decided to do it too. And after only about—I can't remember exactly

  

how long, maybe six or nine months at Ungermann–Bass, she resigned. Then we went and started the company. Ralph got very upset about this, Ralph Ungermann, and thought we were somehow—she just went there to steal secrets and so on. There really weren't any secrets to steal. He met a couple times to talk about it. But really, we just talked. Ultimately, it didn't really come to anything. They were able to fully go do what they were going to do, and we went off and did what we were going to do. There was nothing—there was nothing to take.

**Weber:** Well, I mean they had both been part of the same—

**Brock:** The Zilog?

**Weber:** Zilog—I want to say ZNet, right ZNet.

**Carrico:** Yes, yes.

**Weber:** They both learned at the same source presumably, right, Ralph Ungermann and Judy?

**Carrico:** Exactly, right. Both of them came from the same background. If anything, it was Judy who'd done the bulk of the technical work on ZNet, not anybody who went to work for Ungermann–Bass. I don't know that there was anything—I don't think there was a there there. We did compete with them later on, for sure; but we had no leverage because of any of what transpired early on.

**Weber:** That didn't lead to any legal action though?

**Carrico:** Mm–mm.

**Weber:** They were trying to do an Ethernet type thing, but completely their own. I mean it was like their own standard.

**Carrico:** Initially.

**Weber:** Right.

**Carrico:** But eventually, they didn't have any other choice, and they did Ethernet, and they did TCP/IP too. Yes, we all went through that, sort of. We built it kind of differently. We built a very modular product that you could change a lot very easily. We built a higher–powered product in the sense that we put a 68000 CPU in, and they were using a Z80, which allowed them to have a lower–priced part. But that didn't turn out to be the real issue here. We did compete with them and won some and lost some, but in the end, it worked out real well for us.

**Weber:** Initially, the digital PBX folks were also competitors, right?

  

**Carrico:** Oh, yes. In fact, they were the toughest competitors because—but—you know what a digital PBX is, right?

**Brock:** I believe so. This is this private branch stuff for telephony inside of a building or something.

**Carrico:** Right but all it really—they weren't really that. What it was is a box that did some kind of internal switching between ports. Some of it was done by TDMA [time–division multiple access], and there were various ways they actually did this. People would use it the way they were going to use our stuff. So, everybody homeruns to the box. Say that's the VAX. The cables would come into the PBX here, and then the cables would fan out all over to the monitors and CRTs somewhere over here. So, you could switch among things in much the same way, but it didn't have any of the flexibility of distribution. It was a single point of failure. There were all kinds of issues relating to it that could be addressed with our kind of approach. One of them being, for example, changing the actual datalink mechanism.

One of the first—well not first— one of the early customers we got was Southwestern Bell. They were putting a new building up in St. Louis, literally. They wanted to put Ethernet inside, but they wanted fiber optic Ethernet. Now this was very early for fiber optic anything. There was this other company. We brought them in, and they knew how to build fiber optic Ethernet at the time. There's some technical details here. But they did know how to do it. So, they put that part in, and then they used our boxes to connect between—I think they had 10 different kinds of computers and hundreds of different kinds of CRTs—and hook them all up, and it all worked.

It was a difficult time to get that order because that order was about 30 million dollars, which was very big for us. I had to fly out there because they were saying, "Well, you know, this all seems to work. And it sounds good, and we like your product. And look, see we got fiber optic Ethernet too. We like that." He says, "But I don't know. We have thousands of users in this building and hundreds of computers." And he says, "What if they all start typing at once? Are we going to get congested?" And I said, "No." I went up and drew a picture on the wall that showed the interleave that you actually get. I said, "This is 10 megabits per second. Okay so, now let's look at the actual interleaving that you'll get, right, as keystrokes come in and out." You can show that there's almost no case where you will actually get collision from just keyboard strokes just because of the interleave factor and the speed. When I drew that picture, he signed the P.O. It was good. It was a good day.

**Weber:** And so, who would you rank—rank your main competitors at the start.

**Carrico:** Well, as I say, there were a lot. Ungermann–Bass is probably number one, there was Sytek also, and then really it was collection of things. There were a lot of smaller companies who got in and out of the business over time, but we didn't really deal with them directly much. Early on in particular, as you mentioned, it was almost all the digital PBX companies were the competitors, and that just faded away. By the time it faded away, there were other small vendors, whose names I don't really recall, of various kinds of stuff. As time went on, even more people got into it.

  

We also created some of our own competitors. We OEMd [original equipment manufactured] the Bridge product to Honeywell. We painted it Honeywell colors and did Honeywell manuals and all that stuff. Honeywell went off and used it with—this was when Honeywell still was the Honeywell computer business, and used it with Honeywell computers and sold it to their kind of customers. Honeywell sold it, for example, and put the CS–1 boxes into submarines at one point. The kind of customers we probably never would have found.

It became very broad. We also had done a good job of creating international agencies, basically LLCs in England, France, Germany, Israel, Japan, Australia, so we could—we had a real presence of our own, which you needed to make people comfortable. It was a comfortableness factor.

**Weber:** I'm not saying it was a direct competitor. I'm sure you were aware of the BBN C30?

**Carrico:** Mm–mm. I mean it doesn't ring any bells, maybe it would have then.

**Weber:** It was a converted ARPANET IMP [Interface Message Processor] that they were selling as a router at that time.

**Carrico**: I'm aware of BBN [Bolt Beranek Newman], but I don't remember ever running across that product.

**Weber:** Okay. They were 500 grand and they were a minicomputer.

**Carrico**: But see, that's the problem. Who are you going to sell that to? I mean, people—it's got to be the right price, right?

**Weber:** Yes. I mean, Sandy Lerner described them as a $500,000 refrigerator. And Datapoint was not a direct competitor?

**Carrico**: No, no.

**Weber:** The PBX companies had the advantage. They were there for voice already, right?

**Carrico**: Well, a lot of these boxes were just data–only PBXs.

**Weber:** But, I mean, the company already had a relationship with the client through voice.

**Carrico**: Yes.

**Weber:** So it was easy to just add it as an add–on.

**Carrico**: Sometimes, yes. But I never really had much of a problem with this, it just never hardly came up. We also started out selling primarily to the natural early customer, a technical sell. We sold to universities.

  

We sold to government labs, and this worked great for us. Places like LLL [Lawrence Livermore National Laboratory]. Los Alamos. Oak Ridge National Labs. Those kind of people always would buy stuff like this. Big universities. Hospitals; did very well in hospitals. There are groups of people who are always looking for something state–of–the–art and we found very good success with them.

**Brock:** I was wondering about the—originally the idea was to create these bridges, these internetworking, if you will, of connecting together heterogeneous things. Then it seemed like there was a realization, well, not too many people wanted to combine heterogeneous networks together initially. So I take it there was a shift to just—was there a shift in the kind of…?

**Carrico**: Absolutely.

**Brock:** Okay.

**Carrico**: Yes.

**Brock:** But was the capability to do that heterogeneous internetworking still part of the technology and the product when you made the shift of focus?

**Carrico**: Yes. From the beginning, absolutely. First of all, the fact that we used the multibus cards allowed us to have hardware flexibility for whatever we wanted.

**Brock:** Got it.

**Carrico**: Second of all, very early on we started doing things like, not just ASCII terminals, but Bisync terminals. There were still a lot of Bisync terminals out there. We executed Bisync and so we would sell it to people. Well, that's one of the ways we got Honeywell was because Honeywell had Bisync terminals. We did that. We went and built a box that was essentially a 3274 box, so it would allow you to talk to IBM terminals. We were doing the protocols at the very lowest level but we were still doing them, and so it wasn't just limited to an ASCII terminal talking to a DEC [Digital Equipment Corporation] VAX. We did all of that.

Then as time went on, the reason we dropped back was simply the market wasn't ready for it. The market had to mature into it and then as that happened more and more things happened. For example, early on we did do X.25, because X.25 would allow us to connect, say, this building's LANs with the building next door's LANs, before there was really a viable Internet as we think of it today. We did a lot of that, and then time marched on, we added new things.

We added, later on, a gateway to a broadband network. We actually bought a little broadband company and offered its products so we could have a gateway between Ethernet and their offering of broadband and we sold that to customers. As time moved forward, we started connecting more and more things. We started to do Token Ring. We actually pretty much did it and then just decided it just didn't seem to have

  

enough market presence to spend any more time and we shut it down. There was a time when it seemed like it might, but then we just decided, “Nah, we’re not going to do that.”

Then we started doing things like what were now, we would now call, full–on routers. By the time we sold ourselves to 3Com, we were shipping like a couple of hundred regular routers a month. It was really Bridge that shipped the early routers that everybody gives Cisco the credit for. We were shipping those long before Cisco existed.

**Weber:** You said you did the first commercial router.

**Carrico**: Mm–hm.

**Weber:** What year was that?

**Carrico**: Oh, I don’t know the year.

**Weber:** I mean roughly.

**Carrico**: Must’ve been like ’87, ’88.

**Weber:** If you could go back on the actual product, I mean, the terminal server was the first product, right? What was the price point roughly on that?

**Carrico**: Well, we had a product line. Initially the first product was $10,000. We basically kept that price more or less constant and then added more and more serial ports in it, but kept the price constant, to get the price per port done. That turned out to be a big thing. Then we built two smaller boxes, which were smaller form factors, more pancakey boxes. Those were in the neighborhood of three or four thousand dollars, and so they would offer the lowest price per port. People did want a low price per port. Then pretty much all of the larger gateways and routers, those kind of products, were all in that $10,000 area.

**Weber:** First, there was the single box terminal server.

**Carrico:** Mm–hm.

**Weber:** Then the two boxes. Then when was your first actual bridge that you made?

**Carrico**: Now, tell me what you mean by bridge. Because this is—the terms get used a little bit—

**Brock:** <laughs>

**Weber:** Bridge, as I understand it, is where it connects the networks but doesn’t actually switch packets like a router. Is that right?

  

**Carrico**: Right. Yes.

**Weber:** And then the real router switches packets and a gateway's between two networks.

**Carrico**: Yes. No. It switches IP packets but the—

**Weber:** Right. Right.

**Carrico**: The bridge is—I don't remember when we did it.

**Weber:** But, I mean, as another type of product.

**Carrico**: Yes. All these were probably in the '85, '86 area.

**Weber:** And then the router followed a couple years later.

**Carrico**: Yes. Then the other thing we did is we built a card that plugged into a DEC. We called it IVEX, and that card was a unibus card that would plug into a DEC and be the DEC's network interface but would—it's essentially, was a CS/1 on a card. So that you didn't have to put the box and the cables in front of the DEC, it would just take care of all that for you over the Ethernet to remote boxes that talked to the terminals, and that did well for us. That was another product area that we did. Another thing we did is we started building network management tools. We built a product called the NCS/1 out of—built it out of a Sun workstation. It would gather data on the network, gather data about usage and collisions and problems and so on.

**Weber:** So your entire product line used 68000 processors.

**Carrico**: Yes, correct.

**Weber:** Which were pretty powerful for the lower–end machine. Talk about the logic behind that.

**Carrico**: Well, the logic was simply that we wanted—first of all, we wanted to only use one processor.

<laughter>

**Carrico**: Because no one wants to support more than one. Second of all though, is that the processor worked pretty well. All objective measurements, it was really quite fine, did the job for us. But we needed to get the performance in certain cases. For example, we actually had the CS/1 in a 64–port version, and that's a lot of traffic, serial interrupts, that you have to take if everybody's typing away at high speed. It's the serial interrupts that are the problem because you have to get them and process them, turn them around and send them back. You needed a reasonable amount of performance, and then when you get to things like gateways or routers, performance becomes really important again, and so having a serious

  

CPU made the difference and so we could start with the one and keep going with it the whole way. It was really quite effective.

**Weber:** Let's talk about the—so '85 was your IPO.

**Carrico**: Mm–hm.

**Weber:** And want to talk a little bit about that. Any sort of important developments right before the IPO? Take us to that point.

**Carrico**: The IPO—well, first one we, or previously, I can't remember if it was '83 or '84, we had done a mezzanine round. The mezzanine round had been done with Morgan Stanley. I had run into Frank Quattrone and we did a mezzanine round, and had had an initial experience interacting with the potential investors for that kind of money. That went well, and then eventually, about a year later or so, we decided to take the company public. In those days to go public you had to be a real company with real revenues and this other thing that's very mysterious, called profits.

**Brock:** <laughs>

**Carrico**: Okay.

**Weber:** What are those?

**Carrico**: We had profits. We were doing about $30 million a year and we were making money at it and so decided it was a good time. It wasn't really so much any product thing as the profitability at the time, plus, getting the cash in, allowing us to have more flexibility to grow from there. It really was.

The other thing, and I don't know if it's so important now or not, but then it was felt that being a public company gave you more credibility in terms of, a lot of companies, a lot of customers' perspective about you. You're serious if you're a public company. You're not just six guys in a garage. Which by the way, you do get asked these kind of questions. Some people won't do business with you, some people are actually quite interested in doing business with you. But once you're a public company, you're serious. Particularly, and again, in those days, when you had to demonstrate already that you were making money.

**Weber:** Right. It was a stamp that you were—

**Brock:** Who did you work with for that offering?

**Carrico**: That was Morgan Stanley also.

**Brock:** Morgan Stanley.

  

**Weber:** And the mezzanine round was 1.8?

**Brock:** No, no, that was the initial—

**Carrico**: No. I don't remember off the top of my head how big the mezzanine round was.

**Weber:** Okay. But February '82 was the mezzanine round. No.

**Carrico**: No. That was the initial—

**Weber:** Sorry, that's the different—

**Carrico**: —public offering. I mean, that was the initial investment.

**Weber:** Right. You're saying just a year before. Got it.

**Carrico**: Mm–hm.

**Weber:** Okay. So then talk about the process of going public then.

**Carrico**: I imagine it's not much different than it is for everybody else. It is a process, particularly if you've never done it before. You make the decision and then you basically sit down with a gaggle of lawyers and a gaggle of investment bankers and you write the S1. That's the first real step.

Basically it fell to me and Judy to write the bulk of the S1 and then everybody else would go over it and critique it and modify it and change it and add and subtract and, you know, was an iterative process. When everybody felt good about it, that created the red herring itself, which is what's going to go initially to the investors. You print that, and you're also giving all the data to the SEC. Then you start on the process of going and running around like little chickens with your heads cut off to sell the road show—on a road show to sell the people essentially what's in the document.

Time is of the essence, because you want to make sure that nothing happens <laughs> that's going to hurt you along the way because you're investing a lot of money in the process. The lead investment bank picks a syndicate of people who will invest, the bankers who will buy the offering and then resell it. In our case we went to, I don't know, I think four or five places in the United States, four or five places in Europe, just as fast as we could. Gave presentations essentially morning, noon and day and all—every time you could imagine—and then ended up in New York and they come in and tell you whether or not the interest—the book is filled, is the interest there. The joke was if the guy walks in smoking a cigar it's all good, and so of course he did. Then you run off and get the final S1 printed, and you're pretty much on your way. It's a quite intense few weeks.

**Brock:** So the presentations are actually to the other brokers and investment bankers who may become—

  

**Carrico**: No.

**Brock:** —part of this syndicate or...

**Carrico**: No. So the syndicate is basically offered this. In the case of Bridge, there might've been—I didn't bring an S1 with me, but there was a—Morgan Stanley was a lead. I can't remember exactly, but, it might've been Goldman Sachs and—who else at the time? Or say, Salomon Brothers and maybe Lehman Brothers. I can't remember who it was, so there'd be four or five people who'd be on the front cover, but those are pretty much sold in amongst themselves. They will attend one of the presentations usually, some guys from those firms, but they don't really need to be sold. What you're really selling to are the—

**Weber:** Oh, the institutes.

**Carrico**: The institutional investors such as Aetna.

**Weber:** Right. Right.

**Carrico**: Such as the Prudential. It's those kind of people who put the money in, by the way, such as pension funds. Like one of the times I stopped, every time, at the teachers' pension fund for Wisconsin, in Madison, Wisconsin. Some guys who have little tiny funds but still want to participate; tiny relative to the Prudential or something. It was all over the map. In Europe you're going to sell to maybe Barclays bank, the Royal Bank of Scotland, those kinds of people.

**Weber:** And this was you and Judy and—

**Carrico**: It was me, Judy and Jack Bradley, who was the CFO.

**Brock:** Is Morgan Stanley setting up that schedule for you?

**Carrico**: Yes, yes, yes.

**Brock:** Okay. All right.

**Carrico**: Yes. Whoever is your primary banker takes care of that. You still pay for it in the end, of course, but they take care of it, because they know what the drill is.

**Brock:** Right.

**Carrico**: And it's an adventure.

**Brock:** What was the reaction of the market?

  

**Carrico**: It was favorable. We got it out at the price we hoped to get it out at. We didn't have any real issues, didn't have any issues with the SEC. I don't know, a week later we got the cash; it went very well.

I'm trying to think, was this Bridge that I did this? I'm pretty sure it was. The day the company was going to become effective, we were having a customer meeting at a hotel in San Francisco, and I was going to give the keynote speech in the morning and I walked up the aisle and saw customers and I said, "I'd like to let you all know that the company became effective on the New York Stock Exchange at," you know, whatever it was, "$12 a share at eight o'clock this morning." That was pretty exciting. It is!

**Brock:** What did that mean for you personally? In terms of your personal financial independence, did you become financially independent on that day? That must've been—

**Carrico**: Not so much.

**Brock:** Close? <laughs>

**Carrico**: No. Because partly of naivety on my part and partly just because of the dynamics of the business, Judy and I together just didn't own enough of the company to ever, with that particular situation, make us financially independent. We got some money. I mean, it was nice. We could've bought a house and stuff like that, but it wasn't enough to—it was nowhere near the kind of money people talk about now.

**Weber:** What percentage did you guys have?

**Carrico**: Let's see if I remember. I think we ended up making three or four million dollars at that time.

**Weber:** But as a percentage of the company, you were—

**Carrico**: Yes. Because of multiple rounds of financing and so on, we had been pushed down to too low of an ownership. In the end, I think I had not been as aggressive as I should've been in insisting on it, but it was really hard to do that when you're doing your first one. You hear all kinds of stories now, but in those days that was tough to really make a big strike on a first deal.

**Weber:** What was it like for you and Judy as a couple to be both life and business partners?

**Carrico**: Early on it worked pretty well. It really did. The down side of it is you never get away. On the other hand, you can always talk together about, "Well, what about this? What about that?" and so on. You short–circuit some of the time that you might not if you're trying to get ahold of somebody to ask them a question. I think in the long run it was difficult because of you ended up having maybe too much of a business relationship and not enough of a personal relationship, and I think that fed into the ultimate result.

**Weber:** But in the Bridge years it was—

  

**Carrico**: It worked then, and it worked—remember, we did Bridge. Then we merged with 3Com, then NCD, then Precept, and then Packet Design before we finally decided that, "Well, maybe we shouldn't do this anymore."

**Weber:** The encrypted LAN for government markets, was that an important project?

**Carrico**: So this was a company we bought.

**Weber:** Okay.

**Carrico**: We bought a company that was being run by a guy named Joe Kennedy, and it was called Phoenix [Technology, Inc.]. The idea was that there might be some business there. The government was very interested in encrypted things and that's what prompted it. I have a great NSA story if you want to hear it.

**Brock:** I would love to hear it.

**Carrico**: This is not directly related to that but it made me think of the story. We built a product called the CS100. It's one I just showed you. It's one of the smaller flat ones. We had, by accident, had called the board that was the actual PC board that the parts were on, we had called it Tempest inside. We had shown this board at a show in Washington, D.C. Well, we'd shown the product with the top off and a plastic cover on, and a bunch of the NSA guys walked around and saw that it said Tempest on it.

The first thing they said, "Is this Tempest qualified?" I said, "No. It's not Tempest qualified. Just happens to be a code name." Said, "Well, we'd like to try some anyway." I said, "Great." I always was very accommodative on that as much as I could be, because it can get carried away. We sent them a couple units and we had a guy explain to them how to hook them up and so on and they hooked it up and they were all pretty happy with it, and they said, I said, "But we need those units back because we need to send them to—" and of course somebody said, "You have to talk to these guys," right.

They sent me to go talk to them and the guy says, "I'm sorry. We can't give them back to you," and I said, "Why?" He says, "Well, only if you can guarantee that the data that's in the random access, dynamic RAM goes away and can't be reproduced when the power's off." And I said, "Well, there's no real way to guarantee that. The odds are really high, but I can't guarantee it." He said, "Well, then I'm afraid we're going to have to keep them."

**Brock:** I think it's still the same way today. We had an issue trying to collect something and it was, "If something sensitive has passed through the device, we're going to have to grind it up."

**Weber**: Wasn't that the big, the one where they were offering the case?

**Brock:** Yes, yes.

  

**Carrico**: Yes. So they're very, very—

**Brock:** <laughs>

**Weber**: But they didn't pay you for it or...

**Carrico**: Ultimately, they bought other stuff and we just let it go.

**Weber:** <laughs>

**Brock:** I was interested around encrypted LAN. As you're getting into this business with Bridge or maybe even back at Zilog, when do issues of security, and these sort of the issues of information security, arise?

**Carrico**: The issue of this, outside of people like the NSA, didn't really come up very often. Most people were going to put this inside their facility, and the facility was the security. At least in the early days. Now, as time went on, and particularly as people started doing Internet stuff, punching holes out to somewhere else—virtual holes—then it started to be more of a concern. But early on, not much.

These people weren't all that secure with the computers they had, so an extra line going to the terminal didn't seem to make too much sense to them. But that was the idea though, to try to leverage off that with the Phoenix acquisition, to use what Phoenix had done to go and make an offer to people who were interested.

**Brock:** Were there people in this landscape of networking companies and LAN companies and this, were there people who were concentrating on government, be it military or intelligence community, like, just focused on their needs, or did they have captive suppliers? How'd that work?

**Carrico**: I'm not sure exactly what your question was.

**Brock:** I guess I'm trying to ask were there companies who were building networking equipment, software and the like, specifically for the government?

**Carrico**: Oh, sure. There always are. There's a whole raft of them around Washington, D.C., and we did work with some of those customers on, I mentioned earlier the submarine–based CS/1s.

**Brock:** Right.

**Carrico**: But, to best of my knowledge, there too, nobody was concerned, because they weren't going to put any holes in the submarine. Everything was going to be internal and they weren't too concerned about that.

Really, 'the building is the security' happened a lot. One of the things we did, we sold a lot of equipment to a company called Rafael in Israel. Rafael is a government–owned entity that makes military stuff for the

  

Israeli Army and Navy and so on. They had this facility they were building out in the middle of nowhere Israel and we went there to look at it and they had built all these tunnels under the buildings to put cables and stuff. There too we were putting all kinds of networking in, but they weren't concerned. It was all going to be—you weren't going to be able to get into that facility, so who cares.

**Weber:** Because the physical security, that was the computer security or network security for you all.

**Carrico**: Right. Now, again, that's changed a lot now because of the Internet.

**Weber**: Banks, financial institutions, were not major customers then or they were?

**Carrico:** No. They actually were, but it never really came up very much. If they were really concerned about it, they'd encrypt it before they put it on our line. They weren't expecting us to encrypt it ourselves, and they might not even have been happy with it because all we were doing was sending packets back and forth. There was no obvious place to decide how you might do that.

**Weber**: Right. You were somewhere in the middle of their overall system. They don't want it using some strange encryption scheme that they don't control. That makes sense.

**Carrico:** No. We actually did well with banks. Citibank, which is now J.P. Morgan, was one of our very earliest and big customers in New York City.

**Weber:** Should we get to the—are we logically at the start of the courtship with 3Com?

**Carrico**: Whenever you want.

**Brock:** <laughs>

**Weber**: Bob Metcalfe had said they had been trying to merge with Bridge for years. He said that later. Is there any basis to that?

**Carrico**: Mmm, well sort of. I had had conversations with Bob Metcalfe a couple of times about it. We thought that there would've been a good synergy, and I still think there would've been a good synergy if we'd stuck to our plan between the two. Because at the time what was 3Com doing? 3Com was selling a lot of Ethernet controller cards, and a little bit of some network system stuff that allowed you to share disks over the network, much like Novell. Those were their two products. Those were good products. They were needed. That was fine.

We came at it from more everything else that you might want to do on a network, and we hoped that we could be more of a womb–to–tomb supplier. That was kind of the thinking that was involved. It came to pass, though, that while we thought we had agreed that that's what we would be doing, once we actually had merged the two companies together, both Metcalfe and Bill Krause didn't seem to want to give the

  

Bridge product its due, if you will. They seemed to want to kind of just have it as an also–ran, as opposed to turn it into what would've become Cisco.

I mean, we could've been Cisco with that combined entity, and in fact we had seen our ramp for routers go up and up and up and up and up. But when we got there, he didn't want to do it. I mean, even though we had—Judy and I thought we'd all agreed to it. Now, why that exactly is, I cannot tell you, but we couldn't find a way to resolve it. Ultimately, I just decided, "I'm better off doing another startup." I don't want to argue all day every day, nor do I really want to have a board fight. You know, decided to move on.

**Weber:** And by the time you were even starting to talk seriously with 3Com, Cisco was emerging as a serious competitor for routers.

**Carrico**: Not initially. We saw them, but just barely. They were like three guys. There's a quote, in fact, one of the magazines quote Sandy Lerner talking to Judy and saying that, "We wouldn't have existed if you hadn't merged with 3Com."

**Weber:** Yes. No, she said that.

**Carrico**: Because we really had everything going for us. Many more customers, many more salespeople, and it was—the eye was taken off the ball because—and honest, to this day, I'm not really sure why. I'm not really sure why 3Com did what they did.

**Weber:** You merged in '87, right?

**Carrico**: Mm–hm.

**Weber:** And you left '89? No.

**Carrico**: '88.

**Weber:** '88.

**Carrico**: I was there a short amount of time.

**Weber:** Yes. That was the beginning of Cisco's big—yes. I guess they were still pretty small potatoes. From your perspective they were small potatoes.

**Carrico**: Oh, yes. And in fact, [John] Morgridge tried to invite, independently, both me and/or Judy onto the Cisco board in, like, '89 or something.

**Brock:** <laughs>

**Carrico**: Probably should've done it.

  

**Weber:** You did end up doing things with Cisco, but that's… So the 3Com time was obviously not a pleasant one, but could you talk about the steps within it a little bit?

**Carrico**: What do you mean?

**Weber:** So first you did the merger, and—

**Carrico**: I did the merger and I was going to be president. Krause was going to remain CEO, and then Metcalfe was going to be—I forget what we called him. Metcalfe was unhappy because he thought he should be president, but Metcalfe had had no operational experience. I didn't care if I was president or CEO as long as we did what I thought was the right thing. But Krause just didn't want to do, I mean, he wanted to focus over here and kind of left this hanging and I didn't even understand it in the slightest.

He, by the way, admits it now too. It became an ongoing issue primarily between me and Krause, and, we talked about it endlessly, but I could just see his mind was made up. He nominally was in charge of the company, and short of having a confrontation at the board level, there wasn't much I could really do. We did, at the request of the board, we did go and have a kind of a counselor come and talk to the two of us together, and that didn't really help.

<laughter>

**Carrico**: I finally said, you know, "I think this is enough." One of the things that came out of this, though, is that not really dependent on any of this, is Eric Benhamou, who had been running software engineering at Bridge, came to me while I was still at 3Com and said he wanted to run this new division that was being created to be a software division, but as the actual general manager. I said, "Sounds like a good idea. I think it's time for it," and we put him in that spot, and it is from that spot that over time he eventually ended up becoming CEO of the company down the road. We got that going anyway.

**Brock:** Was the central tension there between being a networking company versus being a computer company?

**Carrico**: Exactly.

**Brock:** That was my reading of the materials.

**Carrico**: Exactly.

**Brock:** Was the computer company idea, was this again in keeping with the Xerox PARC, the distributed personal computing idea? What was the essence of the computer idea? What kind of computer?

**Carrico**: As far as I saw it, the main product they had, besides the cards, was they had this three–server product which would allow you to share files over the network amongst PCs that had some software on them that could take advantage of that. It was essentially a shared fileserver or multiple shared fileservers

  

which also could do things like print and so on on the network. They were building these products as little specialty–ized boxes, these three–server boxes, and was nothing wrong with that. It was just that you were trying to be a computer company when you already had Novell to compete with, and Microsoft was coming out with a similar product. Plus, arguably, everybody else in the computer business. You know, it didn't seem to make any sense to me to do that.

**Brock:** What was Microsoft's similar product?

**Carrico**: I don't remember what they called it now. But Microsoft had a product that ended up trying to compete with exactly what Novell had.

**Weber:** But Novell also offered all the different LAN, I mean, e–mail and file–sharing obviously. But Microsoft also tried to do the whole packet. You say that Cisco rose, Bridge was suppressed, essentially, within the merger. What form did that take that they were giving you less budget to develop new products or less sales resources or marketing resources? What was the—

**Carrico**: Yes, it was a little bit of all of those things. It wasn't an active 'kill things' kind of a situation. It was really more of, "You know what? These routers are really looking good. Let's put some energy and effort and sales effort and marketing effort into it," and, "No. Let's not do that." It was more that. It was more a passive, "Just let it lie," in a period where a viable competitor started poking his nose above the water. It was more like that. Nobody tried to really kill anything, and in fact, the core of 3Com's business ultimately turned into—came out of what Bridge did. Because the three–server thing went away and the Ethernet cards went away. What 3Com was, until it got bought by HP, was essentially a box of Bridge.

**Weber:** Once you merged, you no longer had control over a sales force or any of those things.

**Carrico**: Correct. Correct.

**Weber:** Right. You couldn't say—

**Carrico**: There would be an argument about everything like that.

**Weber:** If you and Krause were to summarize your position very briefly at the time, you would've said, I think, what you just said, that to continue building the kind of hardware you were, and that the market was exploding particularly through routers, and his vision of the future would've been?

**Carrico**: No. I think it was just really, "Are we going to be a computer network company or are we going to be a computer disk drive company?" I mean, a computer server company. It was that, and they really were pretty far apart. Somehow I never understood that that's what he thought before the merger. It sounded like when we did the merger, and we had a bunch of meetings during that time, that we were all on the same page, that this was really going to be the way to go.

**Weber:** But he wanted to become almost a Novell but bigger, something like that.

  

**Carrico**: Yes. Also, bear in mind where Bill came from. He was coming from the minicomputer business at HP. He wasn't coming from some networking background. In his mind I think the natural progression was, "We're going to do what minis could never do. We're going to have fileservers everywhere and all these computers are going to talk to each other," and that. More or less, as you said, the Star vision.

END OF THE INTERVIEW

  