Oral History of Robert (Bob) R. Maxfield

Interviewed by:
Gardner Hendrie

Edited by:
Dag Spicer

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START SESSION ONE (TAPES 1–4)

Gardner Hendrie: I'd like to start out by getting a little bit of your family background, where did you grow up?

Robert (Bob) Maxfield: I grew up in Wichita Falls, Texas, which is a small town, about an hour and a half northwest of Dallas, about a hundred thousand people. My Dad was a orthopedic surgeon, moved there after the war, he had been there in the war, during the war, he was in the Army Medical Corps, and so that's where I grew up, I was born in Detroit, Michigan about three months before Pearl Harbor and my Dad was doing his residency I guess it was, there and then immediately went into the army and moved all over the country during the war, and we wound up settling in Wichita Falls. I grew up there, went to the public high school, and graduated in 1959, and then went to Rice University, undergraduate school.

Hendrie: Do you have any siblings, any brothers or sisters?

Maxfield: Yes, I have a sister who's a year and a half younger, and a brother who's about six years younger.

Hendrie: So you were the oldest?

Maxfield: I was the oldest.

Hendrie: Okay, with all that that implies.

Maxfield: Exactly, yeah.

Hendrie: What did your sister and brother end up doing?

Maxfield: Well my sister graduated from the University of Texas and worked for a few years in Washington D.C. as a, I forget the title, legislative assistant or something, to Senator John Tower, who at that time was the first Republican Governor from Texas ever, and my mother was an avid Republican who-- and he actually was from Wichita Falls. So he had been a family friend for many years and when he went off to go in the Senate it was about the time my sister was graduating, so she worked for him and that's where she met her husband and they got married and she became a mother <laughs>.

Hendrie: Fulltime mother.

Maxfield: Fulltime mother, yeah.

Hendrie: And your brother?

Maxfield: My brother is a lawyer, went to law school and is assistant district attorney in a little town called Waxahachie, which is just south of Dallas. And he has three kids and my sister has had three kids.

Hendrie: Your brother stayed in Texas?

Maxfield: Yeah he stayed, and my sister moved to California, she lives in Pacific Palisades, has lived out there for about 25 years, yeah.

Hendrie: What are your first recollections as to what you thought you might want to do when you grew up?

Maxfield: Well, I remember when I was really young I wanted to be a pilot, as probably most six year olds do. As it turned out in the last 15 or 18 years I finally became a pilot, so and now actually am a recreational pilot. It took a while to get down to that--

Hendrie: The ambition was fulfilled.

Maxfield: Right. Other than that I don't recall having any by the time I was say in high school, I don't recall having any specific ideas about what particular job I wanted to do, other than I was pretty sure I didn't want to be a doctor, because in those days the practice of medicine was a lot harder than it is these days, Three or four nights a week, my Dad would was on call for the emergency room and would be up in the middle of the night many times, he didn't get a whole lot of sleep, worked his tail off and--

Hendrie: Didn't get to spend as much family time as he would've liked.

Maxfield: Right. So I was pretty sure that wasn't something I wanted to do, and I was always interested in science and math and things like that so. And in fact the interesting thing is that I was interested in computers in high school but this would've been now in the mid-50s, and in this little town where I grew up there weren't any-- there weren't any computers anywhere. There weren't even any books in the library about computers, but I was interested in how they worked. And I wound up doing a science project and somewhere or another I got a book that had some introduction to logic circuits, or something, and my uncle who had been a pilot actually at one point had given me a box of old aviation relays, these were just little, I guess, relays, that I had a box of 20 or 30 of them that he had given me, and I wound up doing a science project where I decided I would try to build a digital computer using these relays. And I managed to kludge up a thing, I mean it wasn't much of a computer, I think it added-- it was maybe a two-bit adder, so you had these switches you could toggle on the front and say okay, here's your binary input number one, binary input number two, and then the lights will tell you what the binary result is, but-- all done with these relays. And so that was sort of fun, and other than that that's about all I remember and I did quite well in math and science and stuff like that in high school. So I knew when I went to Rice that I was going to be a Science Engineering major and--

Hendrie: Did you always know you were going to Rice or did you apply at a bunch of other schools?

Maxfield: Well, you know, it's all sort of vague now. I was thinking of applying at MIT and Cal Tech and Rice, and the big attraction of Rice was first of all it had a good reputation as a science and engineering school, but it also had no tuition, and it was in Houston which was only a five or six hour drive from where we lived. And I had spent a lot of time in Houston in the summers, because I was a competitive swimmer also, and every summer there would be what they call the Junior Olympics, sort of the big meet of the summer was in Houston. And my best friend who was also a swimmer, he had aunts and uncles in

Houston, so he and I would go down to Houston for two or three weeks every summer and I would stay with-- <phone rings>.

<Crew Talk>

Maxfield: He had aunts and uncles down there, I thought Houston was a nice town, I enjoyed it, and--

<Crew Talk>

Maxfield: So, and it turned out that my friend was thinking about going to Rice as well. So anyway I applied, and my Dad was clearly interested in Rice, although he didn't push me one way or the other, but clearly from an economic point of view it was a big plus <laughs>.

Hendrie: A really good school and it's free.

Maxfield: And the only other thing I remember is being a swimmer I also had an offer from the University of Texas, a swimming scholarship to go there, and I do remember making a clear decision that well, you know, if I went to Texas I could pursue swimming and see how far I could go there, and probably get an okay education. But if I went to Rice they had a swim team too but it wasn't-- it was just sort of a pickup team that I'd get a lot better education. So fortunately I decided on Rice.

Hendrie: You had the good sense at that age even.

Maxfield: To this day I can't remember applying to MIT or Cal Tech, I thought about it but I'm not sure I ever did, I know I wasn't rejected and I don't remember being accepted. So I suspect that when it finally came down to it I decided what the heck, I'll apply at Rice, if I accepted I'll go and if I don't I'll do something else. So that's how I wound up at Rice.

Hendrie: So you went to Rice.

Maxfield: So I went to Rice and my roommate-- my friend went as well and we were roommates all the way through. And so went to Rice, majored in-- well, so started out in the Science Engineering Program, and then your sophomore year you make a decision as to which, you know, what your major's actually going to be.

Hendrie: Whether it's science or engineering.

Maxfield: Yeah, and by that point I remember that my decision process went something like this, well chemical engineering was interesting but I had by that time taken two chemistry labs, I had two chemistry courses with the labs, and I considered the chemistry lab part to be primarily washing dishes, and really didn't enjoy that at all, plus I was no good at it. The quantitative part where you were supposed to figure out exactly how much of the-- what was in this tiny little sample they gave you, I was terrible at, I didn't get any of them right. So then it was between mechanical engineering and electrical engineering, and I thought well, you know, mechanical engineering, if I did that then I could probably work on my car pretty well, and electrical engineering, if I did that I might be able to design my own stereo or sort of, you know,

know more about stereo. Ah, so, you know, I flipped-- really sort of flipped a coin, but I think I was-- my interest in computers sort of pushed me toward the electrical engineering side I think probably and so it wasn't much of a decision but I remember, you know, these sort of. So the thing is there was no great strategy, lifetime strategy that I had at that point in my life, I don't think, you know, I never did. So wound up majoring in EE, and that was-- engineering at Rice at that time was a five year program, at the end of four years you got a BA which was essentially a Liberal Arts degree because you were required to take a much more Liberal Art-- much more component Liberal Arts than most engineering schools, which I think was one of the strongest parts about the Rice education. And then you took a fifth year to finish up the rest of the engineering requirements, and I think that was a real strong point to a Rice education. So majored in EE, and when it came time to graduate, started interviewing, interviewed various places.

Hendrie: Let me just roll back a little bit, were they teaching any computer courses at Rice at this time?

Maxfield: There was no computer courses, we had one device sort of a course where we learned about transistors, and there was one part of that where we talked a little bit about how you could use transistors in flip-flops and things like that.

Hendrie: How you could make digital circuits.

Maxfield: How you could make digital circuits with them. But it was sort of maybe a couple of class periods. However, there was one of the professors there who was a key influence on many of us over a long period of time, Marty Graham, who was a young professor at that time, who had in fact just built the Rice R1 Computer, which I don't know whether the Computer History Museum has ever heard of.

Hendrie: I've never heard of it, but somebody may have.

Maxfield: But I do know a guy who has a piece of it by the way, that you might be able to get. But anyway, what this was was a computer that he had a grant to design, it filled the whole room in at Rice, it was made with vacuum tubes, various-- well he went through a series of memories, I think at one point he had the CRT memories, I didn't know too much about it 'cause it was sort of finished when I got there and I never sort of worked on it or did anything with it.

Hendrie: What year did you get there, do you remember?

Maxfield: I got there in the fall of '59. The only-- let's see, they had an [IBM] 1620 computer, is that right, yeah 1620.

Hendrie: Yeah 1620, IBM 16-20.

Maxfield: 1620, that was the one computer, the one real computer they had at Rice, and you could, on your own time, take a Fortran course and you could learn how-- you could use that computer, but it was just on a sort of an unofficial basis, and that was the extent of what the computer education at Rice [was] at that time. And I did not, in fact I didn't really have the time, as Rice is, you know, very intense education and you-- it's all you can do to do your class work and your labs and have a chance at any social life. So I didn't do a lot of sort of extra stuff and this was extra, but I was intrigued by it and I knew guys that had played with it. But that was it, I mean that was it.

Hendrie: That's amazing, and it turned out to be a major computer science school, later.

Maxfield: Oh yeah, yeah. These days yeah, it's--

Hendrie: Exactly. There weren't very many inklings of what was going to happen at that point.

Maxfield: Well, yeah, I mean, for example my class was the last, no one of the last, maybe the last or next to last class, for example we spent a whole year studying power engineering. So we learned how to build gigantic DC motors, and things like that, where if we'd have spent that whole year doing something a little more modern... And we spent one whole half a year in the lab doing mechanical drawing, was a requirement our freshman year, so I learned how to sharpen pencils using the-- and I learned how to use the T-square and draw all these isometric views as though I was going to be an architect or, you know, mechanical engineer or something. So there were a lot of things about the education that were sort of archaic at the time, but nevertheless it was a great education.

Hendrie: So you got to--

Maxfield: So interviewed a number of companies, and one of them was Sylvania Electronic Defense Labs, which ties into the story shortly, because the-- and, okay, let me back up. Let me tell a little story which will come in later, there was back in the mid 50s, '50-- I'm not sure which year, '56, '57 thereabouts, a guy named Bert McMurtrie [ph?] graduated from Rice, and was hired by Sylvania Electronic Defense Labs in Mountain View, California, which was doing military electronics work, but in particular they were doing the early work in lasers. And Bert had gone there to work and had become sort of a star there, and every year he would come back to Rice and recruit one or two or three or four of the top guys in the class to come out to work in at Sylvania, either in his group or in other groups, and over the years he had recruited, I don't know, in the order of a dozen people, and the year before me he had recruited Ken Oshman who was the number one guy in the class the year before me, and Ken had gone out to work with Bert in Bert's group at Sylvania. So the next year Bert assigned Ken the job of recruiting me from Rice to Sylvania, which he proceeded to try to do, and I took a visit out here and Ken and his wife Barbara showed me around and we had a great time, and-- but I wound up not working for Sylvania <laughs>.

Hendrie: You weren't married at the time though.

Maxfield: Yes, well, I was about to get married, I got married a week after I graduated, took a two-week honeymoon and then came out here.

Hendrie: Did you meet your wife while you were in school?

Maxfield: I met her during the summers while I was in college, yeah, we were-- I was-- during the two or three summers I was a counselor at a summer camp, and I taught swimming and sailing and fun stuff like that, you know. And that's where I met her and then the last summer too I worked in the summers, as I was about to get out of school, worked in engineering.

Hendrie: He recruited you, where was your standing?

Maxfield: In the class?

Hendrie: In the class, yeah.

Maxfield: I think I had, yeah I had the highest grade point average by a little bit, I mean there were two of three of us obviously so, but yeah I was basically right at the top. So, but the thing was that by then I had developed a real interest in computers and I knew that what I did want to do when I got out, whatever I did, I wanted to play with computers. And so the--

Hendrie: So who else did you interview with?

Maxfield: So the other companies, well, actually I wound up, really there were only two, well actually, let's see, I guess I interviewed with several companies, but I only took two trips. I took-- the way-- I went to work for IBM, but the way it worked in those days was that IBM had of course plants all over the country, and the way they did their college recruiting was they divided up the country, and so a particular IBM plant would recruit in certain schools. And the plant that recruited at Rice was IBM Lexington, which at that time, made-- did not make computers, they made-- actually they did make some sort of quasi early computer stuff, the 620 or something like that, that was sort of an accounting machine, but basically they weren't doing the main IBM computer stuff. And Lexington, Kentucky did not particularly turn me on because the other thing I knew for sure is that I wanted to do-- get a graduate degree. So really what it boiled down to was I wanted to do computers somehow or another, it had to either be Boston or the Bay Area. Either MIT or Stanford.

Hendrie: 'Cause those were the schools you wanted to go.

Maxfield: Right, it was going to be one of those, and other than that, you know, it was open. So I interviewed IBM, and then I got to thinking, you know, somewhere along the way I found out that IBM had a place in San Jose and they did computers there, and I didn't know exactly what, but I knew that at least that was close to Stanford, and also of course at that time, Stanford and also MIT had Honors-- what they called here anyway, Honors Co-op programs, where you could take a fulltime job at say IBM, and if you wanted to get a graduate degree at Stanford you would apply and if you got accepted then the company would give you time off to take a couple of courses a quarter, so you-- without, you know, and just give you time off from work to go do that. And that was very attractive because I wanted to work, and get some job experience, but I also wanted the graduate work, and so that was a big attraction for-- to both Stanford and I think MIT had a similar program. So the-- I decided well gee I wonder why couldn't I work at IBM in San Jose, so I thought well, to heck with it, and I just wrote a letter to IBM, San Jose, and said-- told them who I was and told them gee, you know, I've interviewed IBM Lexington but I really would rather come to the Bay Area, any chance that I could interview with them. Well, I immediately got a letter back saying "Absolutely, we'd love to have you come out," you know, "let's schedule a trip." So it turned out that the way it worked was one plant couldn't go poach on another plant's territory, but if a student happened to have the gumption to make the contact then you could do anything you wanted to do, and this was just-- I just stumbled into that.

Hendrie: And you had no idea this is how it worked.

Maxfield: No, nobody ever told me that, I just took the flyer. So it turned out on the same trip out here I went to Sylvania and I went to IBM, down in San Jose. And so that's-- I wound up working for IBM down in San Jose instead of Sylvania just because they promised me that I could work with computers.

Hendrie: Is that right, and Sylvania would've been doing lasers or something.

Maxfield: Well, you know, they did some work with computers but they had a lot of stuff and it was mainly systems work, not design, you know, I was hoping to design computers, course everybody wants to design computers, but it turned out that that wasn't going to happen for a new graduate. So that's how I wound up out here at IBM, and that's how I sort of got to know Ken Oshman because I had known him sort of at school at Rice, but he was a year ahead of me and didn't know him very well. But so after I moved out here I got to know Ken and then I got to know some other guys that also had gone to Rice and worked at Sylvania, because they tended to sort of hang out together socially more or less.

Hendrie: Did you apply to any other, were those the two trips that you took?

Maxfield: I took those two trips and I got an offer from IBM in Lexington and IBM in San Jose and I might've had one or two other offers, oh I think GE wanted-- I interviewed GE, they wanted me to come to _____ to do an interview and that's probably where I would've had to go and I just said "No I don't think so." So as far as I can recall the only two offers that I sort of listened to were those, yeah, and in Sylvania.

Hendrie: What were you going to go do, what did you end up doing when you got to San Jose?

Maxfield: Well, when I got to IBM it turns out-- so I'd interviewed two or three groups at IBM, and then-- and at the end of the day they said "Well, you know, which of these groups did you like best? "Oh well, you know," and there was one group that was doing-- the closest to sort of real computer work was a group doing actually custom, actually there-- no I can't-- I haven't talked about this in years, there was one group that was sort of doing sort of customization of computers, doing special interfaces or stuff like that that that sounded sort of interesting and I think I told them that was my favorite. But as it turned-- so anyway, I got the job offer and then when-- the day I showed up for work they said "Oh, by the way you're over in this group," which was doing instrument-- IBM had the 1800 series control computers, the basic processor was the IBM 1130 processor, which was an early 16-bit machine, the 1130 was primarily I believe used in business applications. But they had taken the same basic processor and put it in a different packaging scheme and had developed a bunch of stuff to go around it to make it into a control system, industrial control, you know, process control.

Hendrie: I'm very familiar with that, I was working at Foxborough.

Maxfield: Yeah, they were the big competitor, yeah. DDC, you know, the big thing, it was new at the time, Direct Digital Control. So, IBM had this little group whose job it was to do nothing but design input-output gizmos.

Hendrie: Yeah A-to-D converters.

Maxfield: A-to-D converters, D-to-A, right. And the particular thing I was first working on was what they call a thermocouple amplifier, it was a thermocouple D-to-A--

Hendrie: Yeah to get the signal up so it could go in to the box.

Maxfield: Yeah, to amplify the signal to get it into the A-to-D converter.

Hendrie: Yeah sure.

Maxfield: So I worked on that and then I worked on-- then they had a pulse motor thing, that I believe was a stepping motor, and I believe it was only used for a display, it just ran a set-point display up and down and it had a little stepping motor, and so the output from the computer, I guess maybe it output the number of pulses that you wanted to go up or down and this little box was to translate-- was to, you know, run the stepping motor up and down. So, there wasn't a lot of digital stuff to it, it was mostly the analog and the packaging stuff. But that's what I got saddled with and it was fun, I learned a lot, but I didn't actually get to-- in that particular job I never even touched the computer.

Hendrie: But you got to design something.

Maxfield: Oh yeah, oh yeah, oh absolutely.

Hendrie: Which you probably really hadn't had a chance to do that at Rice.

Maxfield: I did circuit design, not a lot of logic design, but more circuit design. And the other thing, but because I was interested in computers I remember one of the ways I sort of made my mark in the group was, I discovered that IBM had one of the early circuit analysis programs running on a mainframe where you could do circuit analysis. And so I had, in one of the things I was working on I had used it 'cause I thought it came in handy, but none of the other guys in the group, even the old time engineers [who] were using computers or knew much about it. And so there was this one guy who was designing some kind of an amplifier and I was talking to him one day and he was trying to figure out how to figure out the frequency response, and doing all this stuff, and I said "Well, you know, there's a computer program that'd help you simulate that and, you know, might help out," and he said "Oh really?" and I said "Yeah," and he said "Well you know how to use it?" and I said "Yeah I could figure it out." So I went-- so I started doing that and about a week later I came in and gave him this nice frequency plot of response of his amplifier <laughs>, that was-- so that was fun, so I got familiar with using a lot of the early computer tools. This program was called Snap, I forget what that stood for, but it was essentially a circuit analysis program.

Hendrie: Okay, that's cool.

Maxfield: Then what happened was one day-- oh, and then I got accepted into Stanford and I began taking a couple of courses a quarter working on a Master's. And at that point at Stanford I was mostly interested in more mathematical systems stuff, control systems but also I took digital logic courses and I took a couple of programming courses, did some programming in Algol which was the language of choice at Stanford at that time for all of the computer science and all of the programming stuff, and they were running on, I guess it was the Burroughs, was it Burroughs?

Hendrie: Maybe B5000.

Maxfield: Yeah I think it was, yeah that sounds right, yeah the B5500 or something like that.

Hendrie: Or 5500 yeah, it was designed to use Algol.

Maxfield: And it was this batch processing thing where you walked with your deck of cards over to the computing center and left them there and came back 24 hours later, opened it up and get the thing that says your job did not run because <laughs> you didn't get the card just right. So about three days later you finally get it to run and then you can start debugging it. And it was a couple of years after, no it was maybe two or three years later that suddenly the next big advance was suddenly there was a terminal in our building where you could remotely enter jobs <laughs>, so you can now get a job turned around in an hour or so and get--

Hendrie: If you had time on the computer yeah.

Maxfield: Oh yeah, yeah. Getting the time wasn't that much of a problem, but just the turnaround. Let's see, oh so--

Hendrie: So what courses, so you were taking a bunch of different courses?

Maxfield: Yeah I wound up, well what I wound up doing was so two years I just sort of took the standard MS stuff with focus on sort of systems stuff, what little computer stuff they had, they didn't have much, they had like a Digital Logic Design course and that was about it as far as digital computer stuff. And let's see.

Hendrie: Did they have a programming course at the time?

Maxfield: Yeah in the computer science-- they actually had I believe something they called the computer science department at that time and I took one course or maybe two in programming over there, I didn't take any advanced stuff.

Hendrie: But you were in the engineering, engineering and computer science were like this.

Maxfield: Yeah, they were into compilers and even artificial intelligence, I think, was getting started, I mean they were sort of off in that area. So back to IBM, there was a point I wanted to make, let's see if I can remember it. Oh, so at the end of about the first year that I had been there, all of a sudden one day there's an all-hands meeting of our small group, and the manager comes in and says "Well, we've decided-- the company has decided to disband this group because the [IBM System/360] Program, which of course at that time was just about to roll out, this now would've been 1964 and '65, and IBM had I believe announced, and maybe they were delivering the first 360s but they were in big trouble inside, I don't, you know, I don't know what all the details were but it was one of these things where everybody that can work on the 360 is going to work on the 360 so let's go through and let's just figure out what things we can quit doing, and our group was expendable, for the most part. So they came in and they said "Well, this group is going to be disbanded, the products are going to transfer over to this other group

that will stay in existence," which was what they called an RPQ Group, Special Projects, so the custom-- special engineering to go with the 1800 control systems. So they said "Okay, we'll take these products you guys have been doing and those guys will worry about maintaining the products," doing customer support and all that, "and so some of you will go over to there and keep doing what you were doing, and the others, we're going to put you over working on the System/360." Well, so I wound up getting-- not working on the 360, but going over with the old products and things I'd already been doing, still didn't get a chance. Although at that point I started being able to get in and do some programming on the 1800 computer because I got involved, so over there I did a pretty nice project, that I pretty much did from start to finish, which was an A-to-D, let's see, no D-to-A box with-- but it had analog storage, and the idea was you wanted to have an analog output and if the computer went down you didn't want to lose the analog output. So the idea at that time, the MOSFET [metal-oxide-semiconductor field-effect transistor], some very, very high impedance MOSFET transistors had just come out, they were junction FET's and you could get gate-- FET's with gate currents that were extremely small, so that if you-- all you had to do was charge a capacitor and if the power went off, or if the signal went away, I mean you had a sample and hold relay, so if you opened the relay the thing would hold for a long, long time, I mean I forget what the spec was in terms of the decay rate, maybe one percent per hour or something like that, or one percent per day.

Hendrie: Certainly the process plant that you had was not going to go and get some huge spike in its control.

Maxfield: Yeah, as long as the power supply to the analog thing was there if you weren't replenishing the capacitor it was just going to maintain the last value, and that was very important, and I forget who it was, I think maybe it was Dow Chemical had ordered this particular thing, and said we want, you know, 100 points of this or something, for our process control systems, and so they had taken-- given IBM a contract to develop this. So that was a little thing I did, and I did the whole project, you know, the circuit design, the interface, the board layouts, the production, wrote the manual for how to use it and, you know, did some little diagnostic programs to check it and make sure it was working right. So that was fun, and just about the time I finished up with that I was also finishing up with my Master's, I got my Master's done in about I think seven quarters from the time I started at IBM, seven or eight quarters, and then I decided--

Hendrie: Did you have to do a thesis for your Master's?

Maxfield: No, just course work. So then I decided that I'd like to go back and get a Ph.D., so I applied for the Ph.D. program, and--

Hendrie: So why were you interested in getting a Ph.D., do you remember what was motivating you?

Maxfield: Part of it was just to see if I could do it, you know, it's sort of like getting another merit badge, I was an Eagle Scout, you know, I'm one of these guys, you know, you give me a set of things that represent progress for some admirable goal and I will just sit and just knock them off, you know, it may take me a while and I'll do it. So, you know, I became an Eagle Scout, you know, and the same thing like I told you earlier, in recent years I became a pilot, well, you know, in piloting there's various stages, all the way up to airline transport pilot and the instructor rating. So, you know, I've gone through, I've done all of those. But anyway, so, you know, the Ph.D. was sort of the ultimate in the education thing, and so it's just one of these things, a challenge that I just felt like doing, and, you know, it wasn't like I was, I mean I enjoy what I was doing but again I wasn't doing what I really wanted to do which was to play more with

computers, and I didn't quite know-- so, I mean, the point was-- and also I had discovered at that point that IBM, although it's a great company in many ways, it had a very, very well defined career path for engineers, I mean, you know, and everybody understood that there were these various grades of engineers and that you would, if you were good you would move up these levels but there's no way you could, you know, get if there was--

Hendrie: You couldn't skip one.

Maxfield: You couldn't skip one and you couldn't get it in less than so many years and it was just-- it was going to be this very orderly path and it just didn't appeal to me that much.

Hendrie: It wasn't too exciting for you.

Maxfield: It wasn't like I-- that I saw a great-- I wasn't doing the kind of work that I have enjoyed doing, or at least I didn't know what I wanted to do, but I didn't much like what I was doing, and it looked like it was just a big company. So I went back to school, and got accepted in the Ph.D. program at Stanford and took a leave of absence from IBM. Actually, when I decided to do that they said "Oh, well why don't you apply" -- they also had a program for the Ph.D., for the same kind of thing, and they said, you know, "Well why don't you apply for this program?" and which they would've supported me through the Ph.D.. So I applied, but I didn't get it, so I got a fellowship through Stanford that supported me, and for the first year, and they said "Well take a leave of absence, you know, and then you can come back," and I said "Well fine." So the second year they said "Oh guess what, you got the program this year," so the second year of my Ph.D. was supported by IBM, and it took me, let's see, I started in the fall of '68, yeah, and I completed-- is that right, no, no, started in the fall of '66, and then was done with my Ph.D. at the end of '68. So the first year or so I was on a NSF Fellowship, and the second year IBM supported me.

Hendrie: Did you have any kids yet?

Maxfield: Oh yes, well I had gotten married right out of Rice and by this point we had our first child in April of '68, which was sort of while I was working on my Ph.D. and about six months before I finished up my Ph.D.. So that brings us to the fall of '68, oh and-- so my Ph.D. was in optimal control theory.

Hendrie: Okay.

Maxfield: But the tie-in with computers--

Hendrie: Well here's this mathematics bent that you said in your Master's degree.

Maxfield: Yeah math is really my thing <laughs>. Well, not pure math but, you know, applied math. But the tie-in with computers was that I was trying to do something practical with optimal control theory, I mean, or at least find practical applications for optimal control theory. So what my thesis was was a new way of doing algorithms for computing an optimal control for a particular kind of a system, and then I actually did models and programmed them on a computer to show the performance of the algorithms, so I did a lot of programming to support the thesis.

Hendrie: Who was your thesis advisor?

Maxfield: David Luenberger [ph?], and my assistant-- my second reader was Gene Franklin, who was the head of the EE department for a while. Dave Luenberger was at that time a young professor who then just retired recently from Stanford, but was head of the engineering economics systems department for a number of years. So just about the time I was wrapping up the thesis, now we're at the fall of '68, or maybe the late summer of '68 and I'm within a few months of finishing my thesis and I'm starting to think about what to do, whether to go back to IBM and I was interviewing in places in IBM to see, you know, what group I might go back into. I also interviewed with Bell Labs in Holmdel, New Jersey, and I remember one of the groups I interviewed there was a guy that was working on cellular telephones, and, you know, which of course didn't exist, and he was saying this is the next big thing, you know, this is going to be wonderful, and explaining [how] all the cells worked and how the system and how we're going to do the hand-offs and all this stuff, and it sounded really interesting and it's interesting how long it took before it <laughs>--

Hendrie: This is in--

Maxfield: This is in 1967 or '68, so it was yeah, '68. But they had the system all worked out, I mean the simulation and also on, you know--

Hendrie: They had it worked out on paper yeah.

Maxfield: Yeah.

<Crew Talk>

Hendrie: We were at the end of your Ph.D.

Hendrie: Maxfield: Yes I was interviewing for jobs, so I'm beginning-- so I'm interviewing, as I said, IBM and Bell Labs and I had a couple of other interviews that I didn't-- I don't believe I took trips to do. And so now, of course, I'm still interested in computers but-- and one thing that I learned by doing the Ph.D. was that I didn't want to do research, which is of course what a Ph.D is supposed to train you to do <laughs>.

Hendrie: I was sort of asking why you went into the Ph.D., because you didn't strike me as the pure research kind of guy.

Maxfield: That's right. So by the time I got done with my thesis I knew that I didn't want to be a pure research guy. Well the problem is, here I am a Ph.D. candidate and I go to interview in IBM and so who do they send me to, of course IBM research groups various places. And they were doing interesting things, actually the IBM guys had a couple of things that were sort of interesting, and at Bell Labs I remember one of the things you did being interviewed there was you gave a seminar on your thesis topic, so when you showed up that morning or the first day for your interviews you would start out by having a two hour session where there'd be a room full of people and you would give a presentation or seminar on your Ph.D. thesis.

Hendrie: That's a really great interview technique.

Maxfield: Yeah, and so then after that then they would-- they'd have a few things set up and I think probably what happened is after that they went off on a hurdle and say "Who wants to talk to this guy?" you know, "anybody have anything to say to him?" or whatever. Anyway, I don't remember too much, but I remember then somebody asked me, they said, in this thing, they said "Well what kind of stuff are you interested in doing here?" you know, and I said "Well, you know, I have a pretty broad interest, but I'm really interested," I said "I'm a lot more interested in application of computers to solving problems," in other words I know the mathematics and I'd like to somehow combine systems theory with actual real-world applications, you know, doing something, making it work in a computer system. I didn't know how to quite articulate that but if I had to, you know, it'd be something like well, you know, implement fancy embedded control systems or something like that, would've been a better way to describe it. And when I said that half the people in the room, you could tell, their eyes just glazed over, they said "Oh another one of these non-scientific guys," you know, he wants to do real world stuff, he doesn't want to do pure research.

Hendrie: Wants to get his hands dirty.

Maxfield: So the pure research guys just immediately glazed over but of course there was a lot of application-oriented guys as well, and so I wound up talking to those guys. So anyway, this is the status and we're now in maybe September, October, some time around in there.

Hendrie: Now where is this job, in Naperville?

Maxfield: It would've been in Holmdel, it would've been in Holmdel.

Hendrie: So this is a New Jersey job?

Maxfield: Yeah. And I'm interviewing IBM Advanced Systems Lab in Los Gatos here in San Jose, and also-- well they also had some research, a research group or two--

<Crew Talk>

Maxfield: So I was interviewing IBM in San Jose. And then one day I get a call from Ken Oshman, who I, you know, had now knew as a friend, saw him socially a lot, this is the guy that if you recall worked at Sylvania. Oh and all of the time that I was at Stanford, Ken Oshman was doing the same thing at Sylvania that I was doing, that is getting a Ph.D. at Stanford, and so he was on the Sylvania Co-Op Program, got his Master's and Ph.D. doing that, and so he was about a year ahead of me so he-- but we overlapped and so he had in the meantime gotten a Ph.D. in EE focused on lasers, which is what he was doing with Bert McMurtrie's group. And there were a couple of other guys that had gone to Rice who I had gotten to know socially, in fact we had a-- there was a poker game that happened about once, I believe it was once a month, that we all at various times played in, along with a number of other people, and the other two guys, their names were Gene Richeson, who was a year ahead of me, he was in the same class that Ken was at Rice, majored in Electrical Engineering, had gone out-- gone to work at Sylvania, the same year Ken did, and had worked in more of the sort of the systems area there. And the other fellow was Walter Loewenstern, who was actually several years older. Walter graduated from Rice

with a EE Degree in the late 50s and I forget the year, maybe '58, I'm going to guess, plus or minus, and had gone to Sylvania, had gotten his Ph.D. on the Co-Op Program, as well as Ken, Gene got a Master's, not a Ph.D., at Stanford. And so I get a call one day, and it's Ken, and he says "It turns out that Gene Richeson and Walter Loewenstern and I are thinking about starting a company, would you have any interest in that?" and I said "Well, you know, frankly I'm not too excited about the stuff I've been seeing in terms of my job interviews, so what do you have in mind?" and I said--

Hendrie: Let's talk, it's free to talk.

Maxfield: So I got together with those guys and it turned out for some period of time I'm-- and, you know, of course it might be good to get their impressions of these as well at some point, because everybody has a slightly different-- remembers it a little differently, but the way I remember it is that, you know, they had spent some time-- that the genesis was Walter was working in a group at Sylvania that was trying to take the-- some of the military systems technology that they had developed over many years, and apply it to commercial applications. This was one of those phases that the military systems business goes through where you're in a down cycle and all of a sudden let's fly, you know, the contracts are drying up, let's find a way to take what we know and apply it in the commercial world, not in the military world. And so they had had a thrust to go do some of that, and of course it never worked out.

Hendrie: It never does work out, does it?

Maxfield: But, I guess, maybe they were at the tail end of that because they had decided they had been working on a vehicle locator system and the idea was it was a transponder that you would put into police cars with base stations or whatnot where you could tell not where it was-- yeah I guess maybe you could figure out the location of the police car.

Hendrie: It would triangulate on that somehow.

Maxfield: Yeah. And they had thought about marketing this to police departments are the country, and they had decided not to, and Walter thought it was a good idea, and so he had gone to his boss and said "Would Sylvania be willing to allow me to use the technology if I go-- I'd like to go off on my own and pursue this and see if I can make a business out of it?" and they said "Sure, go ahead." And so Walter then quit his job and started supporting himself by consulting while he was trying to put a business plan together, and then at some point he got Gene involved, who was interested in being involved, and then at some point he got involved and the way I recall the story is that, you know, when Walter talked to Ken, Ken's reaction was yeah I'd be interested, I've always planned-- just to back up a little, Ken Oshman was the guy who sort of always knew what he wanted to do, he always knew he wanted to start a-- run a company, and in fact when he was at Rice, I mean he would, I mean he just has a natural business ability, and I don't know where he got it, I mean he worked in the summers and all this, but, I mean Ken Oshman is just a natural business genius, and he knew that-- and when he went to-- when he left Rice his choice was either go to Harvard Business School or to go get a Ph.D., and he decided "Well I'll go get a Ph.D.," I don't recall, you know, what his reasons were, "but maybe I'll get an M.B.A. later," or something. But there was no question in his mind that ultimately he wanted to run a company. So when he was approached by Walter his reaction was "Yeah, I'd be interested, I'm about ready to go do something, you know, I've sort of done my thing at Sylvania, I've done a lot of good stuff in lasers, but I have [a] condition," and Walter said "What's that?" and Ken said "Well I want to be President," <laughs>, and Walter, this shows how smart Walter is, Walter said "Okay," <laughs>, because Walter knew Ken, I mean

Ken is the smartest guy any of us had ever known in just about any way you want to say it and we knew that he probably had a better business head than any of us. So Walter says “No problem,” so they then spent some time talking and they had actually worked on a business plan based on some of these ideas that Walter had, and they had gotten, you know, ways into it and at some point they had decided to invite me to come in. And Ken called and said, you know, so I talked to them and they said “Well what do you know how to do?” and I said-- “Well, you know, what are you interested in?” and I said “Well I'm really interested in computers and all this, and what are you guys doing?” and they talked about-- and what this was was sort of military system stuff, there weren’t any computers anywhere in here.

Hendrie: Yeah there are no computers in here, there's electronics.

Maxfield: Yeah, there's a lot of stuff, a lot that I could've helped with and all, but it was more of a systems thing which they-- which Gene had a lot of experience with sort of marketing systems-type things to the military but he felt he could sort of market this kind of stuff and Walter knew the technology, it was RF technology that he was-- that was his expertise. And so they-- finally they said to me “Well, we'd like to have you come in, but, you know, since it's not clear how you would fit in here why don’t we make you a half partner,” in other words we're all going to go in equal but you come in for a half a share because, you know, we like you but it's not clear how you're going to contribute and I said “Okay, that’s fine.” So that was sort of the basic idea. And so then we began looking for venture capital, okay, so this is fall of ’68, and so we put together this business plan, which is essentially a systems business, you're selling engineering time, you know, this is not a product business, it's pretty much a one-off systems business, so in other words you have some sort of basic technology you want to use but it's got to be sold as a system in a one-off 'cause every police department is going to want it different or whatever, and along the way we decided well maybe the police department thing wasn’t as great an idea but, you know, being bright guys we had a million ideas. So pretty soon we had handfuls of ideas of things we could do all along this military-- this systems stuff.

Hendrie: And using some of this basic RF technology and systems technology.

Maxfield: Yeah, and not, you know, not specifically computers or anything. So we began calling on the venture capitalists, and of course in those days it was a very different industry than it is now, much more sparsely populated, and there were a few venture capitalists in the Bay Area that we talked to, and one of them, for example, was Gene Kleiner, at that time it was Kleiner and Sheldon Roberts I believe, one of the other Fairchild Seven. Anyway, he had a little venture capital thing that became Kleiner Perkins later on, but this was before--

Hendrie: Perkins hadn't come from HP yet.

Maxfield: Yeah, this was before Kleiner Perkins. And <coughs> they turned us down and--

Hendrie: Who else did you talk to?

Maxfield: We talked to several-- and we talked to Tommy Davis at Mayfield, they turned us down, we talked to Arthur Rock, and this was interesting because Arthur talked to Ken and was impressed by Ken, and he said “Well, I'd like to think,” he said “I'll tell you what, I'd like to have you guys fly down and talk to

one of my associates, my computer guy." No, no, let's see, no, no, this is later, sorry, this is a story for later in the game.

Hendrie: Okay good.

Maxfield: Okay, so anyhow we get turned down by all the classic venture capitalists, and then we finally figure out why we're getting turned down, you know, they basically told us, they said "Look, we're not interested in investing in the systems business."

Hendrie: Yeah, no leverage.

Maxfield: "We want products."

Hendrie: No leverage, you're selling your brain by the hour.

Maxfield: That's our main problem, and of course, another problem is you're four guys, you're all engineers, you all have essentially zero experience in running a company, I mean at this point I'm 27, Ken is 28, Gene's 28, Walter's maybe 32, Ken has maybe managed two or three engineers in a research environment, Gene I'm not sure had managed anybody, none of us had ever managed anybody. So--

Hendrie: Brains and enthusiasm get good marks but experience was really weak.

Maxfield: So anyway, but we sort of ignored that part of it and said-- so now it became what had been one guy with a few ideas and enlist some other people and then you try to go see if you can make it happen, now it became four guys who just decided we really wanted to start a company. But now the problem was we got to find something that we can raise money to do <laughs>.

Hendrie: Now you've got to find an idea that's fundable.

Maxfield: Right. So it became the case then of sitting around a couple of nights a week and on weekends, 'cause the other three guys all had fulltime-- well Walter was consulting, the other two guys had fulltime jobs, and I was just finishing up at Stanford, so I had plenty of time at that point. So now it was sort of brainstorming things to do. Well, so one Saturday afternoon, literally, we're talking about a two or three hour period, we were sitting around, talking, having a couple of beers, and Gene Richeson and I had been to the Fall Joint Computer Conference in San Francisco in November of '68, so we're now into maybe January of '69. And at that Fall Joint Computer show Data General had announced the first Nova Computer. They were the bombshell of the '68 Fall Joint Computer Conference. And of course this was the beginning of the minicomputer boom, the 16-bit machines, and at that point in time--

Hendrie: At very low, amazingly low price points.

Maxfield: Well, and Data General's shtick was this is the first 16-bit computer with 4,000 words of core memory, so that's 8 kilobytes of core memory, for under $10,000, price point under $10,000. And they hit with a big bomb-- those guys did a super job of PR and, you know, making a maximum splash for being a startup company, and there were approximately 20-some odd other companies in exactly their position all

having announced minicomputers, this was the beginning of the craze, just-- and sort of like the microprocessor boom in the mid 70s or late 70s.

Hendrie: DEC had been there with the PDP-8.

Maxfield: Yeah. So DEC was the first, you know, they had the PDP-8, they'd been around for a while.

Hendrie: And Honeywell had the 16-bit machine.

Maxfield: Honeywell had a 16-bit machine, they'd-- Hewlett Packard had acquired a 16-bit machine--

Hendrie: Oh yeah, 'cause they bought that company.

Maxfield: Yeah they bought a little company, I forget the name, [Dymec – Ed.] and I think those guys were already out there or yeah, pretty much, not by much, oh well, I mean, except for DEC, of course, who had sort of pioneered the whole thing with the PDP-8. But then there were companies like DataMate in San Angelo, Texas, there were any number of these things, and they all had 16-bit machines.

Hendrie: Gordon Bell has this list that he has compiled of, I don't remember, it's like 90 minicomputer companies at the peak.

Maxfield: Yeah, and this was just at this one show, there were like 20 just new, boom, you know.

Hendrie: Probably all 90 were in existence in another two years, and then they started to roll down the other side of the curb.

Maxfield: Right. So anyway, and Gene was interested in computers because he had-- Gene had actually used computers at Sylvania, because the group he was in was building, these were spook jobs, black, highly classified jobs, to build sort of data acquisition systems that would go out and fly on airplanes and they were gathering data and they were just beginning to use digital computers, they had used analog computers for many years, and the military was just in the process of making a transition to use digital computers. And so Gene's group was bidding on systems, of which you would then-- the system would consist of specifying a digital computer, a ruggedized digital computer, and then they would specify all the stuff that went around with it, and they'd put the system together and all that, and Gene was more in the marketing of it, he was technically oriented but he was in the marketing side of it. So this Saturday afternoon we're sitting around and somehow, I don't know exactly know how the subject comes up, but Gene says "You know what the world really needs, the world needs a militarized version of these minicomputers," he said "because I've been involved in proposing systems incorporating digital computers to the military, and there are digital militarized computers out there but the way that they're done is if you want one you go to either IBM or Sperry Univac--

Hendrie: Ramo-Wooldridge had one at the time.

Maxfield: Ramo might have, I think RCA, a lot of companies were in the business of doing it, but what you did is you went and you said-- well some of them had what they called products, 'cause they had built

one or two of them, and you could get more of those, or you could just tell them “here's a contract.” But if you went to them and said “I'd like one of your computers,” first of all it would cost you in the order of a quarter of a million dollars per copy, second of all, you'd wait about six or eight months for them to get around to building one specially for you, third of all, there was no software to go with it, you had to write your own software, there was no operating system or anything like that. And so it was a very expensive involved job to use military computers and Gene looked around at these new minicomputers, 16-bit minicomputers, and observed that, you know, from a computing point of view these things are no- I mean these things are just as good in terms of speed, amount of memory, and everything else as these $250,000 MIL-SPEC computers and wonder what it would cost to actually build a militarized version of one of these things that would meet the mil-- Now when I say MIL-SPEC what we’re talking about is very severe environmental requirements because the military had very definite specs that said any piece of equipment that goes in certain environments has to meet these tests, temperature minus 55 degrees C. to plus 95 degrees C, vibration, I forget exactly the levels but very severe vibration, high shock, high humidity, something like 95% humidity for 30 days or something like that, very severe, which, you know, could be done but it was not trivial. So Gene said that’s what the world needs and then being the only guy that knew anything about computers in the group, everybody turns to me and says well, what do you think it would cost to build a militarized version of one of these minicomputers and I said gee, I don’t know, maybe three times the cost and Gene said well, let’s think about this. Say the general has a computer that costs $10,000. If we could sell a computer for $30,000 that met the MIL-SPECs that’s about hmm, eight times cheaper than anything that you can get that the military—

Hendrie: From these military contractors, yeah.

Maxfield: Yeah, and so then it was and of course if you did that the way to do it is to be a product company, not a systems company like these-- These were prime contractors from IBM and they claimed to have products but they didn’t really and they were basically prime contractors. So the way to do it would be to just have it be on a production line and you can get one in 30 days instead of waiting six or eight months, that sounded good, and then well, if you were going to do it the way to do it is don’t invent one from scratch but make one that is software compatible and input, output compatible with one of these off-the-shelf commercial minicomputers because then the guys can do their prototyping with the cheap commercial machine, build all their goodies, check everything out in the lab and then when they’re ready to do a militarized version they could buy our machine and just plug it in, plug and go. Gee, that sounded pretty slick and not only that but think how much easier that would be to develop the product because now we have operating systems, we have languages, all the software is done.

Hendrie: We don’t have to do all the hard stuff.

Maxfield: Exactly. We don’t have to invent the instruction set for the computer, we don’t have to invent the I/O bus. So we said gee, you know, that’s a way to get going for not much money in a real hurry and then so the next step, and this is all in a three-hour period, the next step is well, if you were going to do something like that which commercial machine would you do, you know, who would you go and want to get a license from to do it, and so we went through the list of all the key players and, you know, DEC, HP, who was the third, oh, Honeywell. Well, okay, those are all big companies. First of all, you know, how long would it take for them to make a decision to do something like that, number one. Number two, if you gave them the idea, are they likely to go do it themselves rather than try to do a deal with us? But what about Data General? Well, this is interesting because… so there’s this whole crop of new kids on the block. Data General cropped up for several reasons. First of all, they had done such a great job of making a splash. I mean they were getting a lot of mileage. The machine they had designed made the

best use of the brand-new generation of technology which at that time was medium-scale integration of TTL. You had four-bit-- Well, no, you had yeah, four-bit-- No. We didn't have four-bit slices then but we had sort of four-bit registers. It was sort of four-bit stuff. Anyway, their processor used as I recall 95 integrated circuits as opposed to maybe 300 or 400 for the other machines that were out there which had been designed several years before. So they had absolutely the lowest parts count. Well now, if you're talking about militarizing something and you want high reliability and, you know, the lower the parts count the better. So that was extremely attractive from the point of view of doing a MIL-SPEC machine. Also they were a small company so presumably they'd be able to—

Hendrie: Be able to make a decision fast.

Maxfield: Yeah, and so I mean they had just announced their product two months before at the Fall Joint Computer Conference so actually, you know, at that point in time and I believe there were four founders of Data General also, Ed de Castro, Henry Burkhardt, Herb Richman and, you know, I can never remember the hardware guy's name, Dick Sogge and at that point those were four guys in a storefront in Boston somewhere trying to get their first production machine out the door. So we said well, why don't we approach Data General? Ken Oshman walked over, picked up the phone, got information for Ed de Castro's phone number in Boston, called him up on a Saturday afternoon and said you never heard of us but we're four guys that are thinking about starting a company and we'd like to come and talk to you about getting a license to build and develop a militarized version of your computer, would you be willing to talk to us, and Ed said sure and then Ken said well, how about if we take the red eye next Friday night and meet with you next Saturday morning in Boston and Ed said sure. So Gene and Ken-- So the next Friday night Gene and Ken get on a plane, fly to Boston and spend all day Saturday with the guys and by the end of the day they've got an agreement worked out as to how, you know, that yes, and it turned out the main concern that Data General had was we'd be happy to do it but the problem is we don't have any extra bandwidth here, we can't support you guy, I mean, you know, if you guys are going to need a lot of hand holding we can't do it, we're too busy, you know, we got big fish to fry. So Ken and Gene assured them no problem, you know, we can handle it, you won't, and—

Hendrie: We'll just buy a machine and send us the prints.

Maxfield: In fact, that's exactly-- We said we will buy a machine, you send us a set of prints and we'll do, you know, and we'll see where we go from there and the terms of the deal were that they would license us that machine, we were limited to the military, to the ruggedized applications so that we couldn't compete with them in the commercial marketplace, and for that they got 5% ownership of the company that we were going to go form and we would buy a machine and I believe that's what it was. There might have been a few other. Oh, and then I believe there was a royalty as well. Yeah. There was a royalty on sales of a few percent <coughs> and—

Hendrie: The royalty was not a big deal.

Maxfield: Well, I mean it was a few percent, yeah, but it was not a staggering- and so based on that we went off and wrote up a business plan for going into the military computer business and started shopping, you know, around to venture capitalists and so we go back to some of the same folks with the new plan and they say yeah, well, at least this is a product company but the track-record problem for young engineers, no track record, no, we'll pass, and—

Hendrie: Did you ever go to West Vend (ph?), the B of A [Bank of America], who was there, a guy, Hal Greer.

Maxfield: I don't recall. I don't remember. Yeah, and at this point one of the ones we went to was Arthur Rock and he said hmm, interesting, and he liked Ken and he was intrigued and he said well, what I'd like you to do is go talk to one of my associates who is a computer expert because I want to get his input on what he thinks about all this and his name is Max Palevsky and it was interesting because we—

Hendrie: Because he had already started.

Maxfield: Oh, yeah, SDS, and he was already retired from that I believe. He wasn't still running it. This was '69—

Hendrie: He may have sold it by then.

Bob Maxfield: Yeah, or had it already been sold to Xerox. Maybe it had already been sold but at any rate so he was living in southern California and this is one of my favorite stories because remember the book by this guy whose pseudonym was Adam Smith I think that wrote the book with stories of the early computer-- Gosh. I can't remember the name of it but it was a bestseller and it was stories about business successes or whatever but anyway one chapter in there was on Max Palevsky and in that chapter this guy says well, he says Max Palevsky -- He said when I went to interview Max Palevsky for this book, you know, he was a very successful guy-- You know, I'm not going to tell this story. I don't want to tell stories that might be taken the wrong way by people at some point so I don't think I'll tell the rest of the story. Yeah. So Arthur Rock suggested that we go down and talk with Max Palevsky which we did and spent a couple of hours with him one Saturday and then after that it turned out then that Arthur decided to pass and his reason was that Max had thought that the business plan-- Max just didn't really under-- He was concerned about the size of the military computer market and a few other things, I'm not real sure, but I think Arthur's main problem was again the four young guys, no track record, but he decided to pass and then finally we came across a guy named Jack Melchor who was sort of a maverick venture capitalist in that he didn't have his own firm. Well, he had a firm but he was sort of a one-man show and well, it turned out he had some money that actually I believe primarily came from Arabs which I can get into a little more later but so he actually was a sort of a one-man venture capitalist and I have forgotten how we got his name but Jack's background was he was an engineer, had his Ph.D., physicist I believe, and had worked at some of the early microwave companies in the Bay area and actually had run-- I believe he had run a couple of companies and at one point Hewlett-Packard set up a subsidiary doing some kind of microwave equipment and they had enticed Jack to come and run that for them and so he had run that and was a very successful manager and then had some kind of temporary medical problem which I don't remember the details of and decided that life was too short and he didn't want to, you know, work in operations anymore and started into venture capital and that had happened a few years before we met him. So he had gone into venture capital and somehow or another we met him and Jack was the guy who basically bet on people. I mean, you know, he figured, you know, the business plan-- If the business plan doesn't work out, good people will figure something else out to do and so—

Hendrie: Modify the business plan.

Maxfield: You're right, yeah, they'll find a way. So Jack was the guy that bet on people and he was the only guy that was willing to-- He met all of us, he grilled us a lot, spent a lot of time with us and finally

said I like you guys, I think you'll figure out a way to do something successful so I'll back you. So the way the deal was structured was that- and because we needed Jack worse than he needed us by a long shot because at this point there was nobody <laughs> else that we could see on the horizon, we proposed to him I believe rather than him proposing to us, we said look, how about we make you a founder, an equal founder. Oh, and by the way, along the way I had started out as a half partner. Do you recall? Well, once we came up with this computer business _____ _____ it wasn't long after that before the other guys came to me and said we think maybe you should be a full partner since you're the only guy on the floor that knows <laughs> anything about-- Yeah. You're the guy that's going to have to go build this thing, design it and build it. So anyway now we're four equal partners and we proposed to make Jack an equal partner and we had decided that we thought we needed $100,000. Well, we were each going to put in $20,000 ourselves which of course we all borrowed from our parents and grandparents or whatever because we didn't have any money.

Hendrie: I was going to say did any of you have any money?

Maxfield: Yeah. Well, somehow or another we all came up with it, all from family basically, and so that was 100,000 of capital from the five people including Jack and then Jack said that he would guarantee a line of credit at the bank for another $100,000 so that was- and that as soon as we had met our first milestones, which consisted of finishing the design, launching it and getting orders, that he would take the responsibility for raising a round of venture capital, that is at that point he would go out and put his reputation on the line and raise a round which would include himself or his fund and some other guys as well and so that was the deal.

Hendrie: So he didn't even use his fund in the first round.

Maxfield: Right. Yeah. The seed capital was just pure seed so and in my case I raised the money, my grandmother loaned me the money, and—

Hendrie: That's nice to have a grandmother that could do that.

Maxfield: Yeah. Yeah. Well, I was surprised because I mean I called my parents and I said well, you know, here's this thing, I got this opportunity to start this company which I'd sort of like to do but I need to raise $20,000, <laughs> I _____ _____ it and, you know, a couple days they called back and said yeah, your grandmother's willing to loan you the money so that's how I got mine. I don't know how the other guys got theirs. So this was-- By now we're into May or so of '69 so we actually started operations on June 1 of '69 and so we found- there was a little shopping- there was an industrial park called Vallco Industrial Park which is at the corner of 280 and Wolfe Road more or less < and there was the industrial park and then next to it was a shopping center all owned by the same people called Vallco, V-a-l-l-c-o, and they were building some multi-tenant buildings in the park but they didn't have them available at the time, it was going to be a while. So they had the shopping center and they said we can put you in the shopping center for the first several months until these buildings are done, we can give you a storefront, and we said fine and they said well, it'll take us a couple of weeks to get the storefront fixed up for you and we said well, we're ready to go, have you got someplace we could have to just put some desks and they said well, you know-- The industrial park had been built on an old prune orchard and they still had some prune trees there and they still had the prune-drying sheds where they would dry the prunes and they said well, over at the prune-drying sheds we have a little office in the back, go up some little stairs and there's sort of this one big, square-room office, if you guys want to throw

some desks in there have at it. So we actually started life in a prune shed, it sort of becomes just like the Hewlett garage, you know.

Hendrie: It's like lots of these stories, right.

Maxfield: Yeah, right. So we spent the first week or two of our existence, four guys and a secretary of all things because Ken decided to bring his secretary from work who he thought was very good. She actually wanted to come and work for us so it was four of us and a secretary in this one room with desks and I remember I started getting on the phone and calling vendors and, you know, trying to start lining up things and some of them came to visit us and this is <laughs>-- Yeah, right. So anyway that lasted for a couple of weeks and then we moved into this little storefront in the shopping center and eventually we moved into a little bit bigger space in the industrial park.

Hendrie: Talk about the partition of work at the very beginning among the partners.

Maxfield: Well, because the final business plan was very different than the way we had started out, the way it worked out was that Ken of course was the president and I was in charge of the product development and the manufacturing when we got to that stage, Gene was in charge of marketing, and Walter because his expertise was really in RF systems really, you know, from a technical point of view didn't have a natural fit except that, he said well, you know, I can design power supplies and things like that and I said yeah, great, so the idea- so Walter came and worked with me in the engineering and helped with some of the design. He did the analog stuff. Well, he did primarily the power supply because we wound up getting a subcontractor to develop the core memory which was the other big problem <cle and so that's how we divvied up the initial responsibilities and then things evolved over time. So we got going and the plan was to have a working prototype at the Fall Joint Computer Conference in 1969 which was in November so this was June 1, yeah, well, and what I've got is I think maybe I got the prints a little bit before we actually started but I had the schematics of the CPU and the memory and not the power supply because we knew we were going to have to build one from scratch and then a few weeks after we started up we got a Data General computer with a teletype input/output device and that was about it and so that was all we had and the idea was that from June 1 until November the whatever, 8th or thereabouts, by then we were going to have a working prototype of our computer and we were supposed to ship the first units approximately March of the next year or nine months later or whatever. You know, in those days I mean young guys, we didn't know what we couldn't do. <laughs> So we just went and we did it. So we did. We—

<crew talk>

Maxfield: So now we got to go build this thing. So now we're getting into some of the technical details about what—

Hendrie: Did you have a plan? Had you thought about how you were going to partition the machine and—

Maxfield: No, no. Well, we started on June 1 and so what we did was we hired a couple, several, key people right off which were crucial of course because I didn't know really what <laughs> I was doing. We hired a digital design engineer, a guy named Merle Weatherall, (ph?) who was a very experienced guy

who was from Bill Perry's company, ESL, which was a company like Sylvania that did military systems stuff for the security agencies.

Hendrie: This was a guy you had already—

Maxfield: Well, actually I had forgot that at some point along the way Gene Richeson had started out at Sylvania but then he had moved over to ESL and was working at ESL I believe at the time that we- either that or maybe not-- No. Maybe he knew Merle because Merle had been at Sylvania and had gone over the ESL. At any rate—

Hendrie: There was a connection there.

Maxfield: Yeah. So yes. Gene knew Merle and he said this is guy is a good senior-level digital designer.

Hendrie: When you say digital designer, do you mean logic designer or circuit designer?

Maxfield: Logic designer. Logic designer, yeah, and so we hired Merle, we hired a super technician named Ron Diehl (ph?) who was one of these do-it-all guys. He could lay out, tape up, he could debug stuff, he could do anything, and then we hired a really good mechanical designer type for the packaging and yeah, the packaging was a problem, yeah, a big deal. Al was-- This was—

Hendrie: Where'd you get him?

Maxfield: I believe he came from Sylvania also. His name was-- My gosh. I can't remember. I've seen-- Al-- Maybe I'll think of it in a minute. Yeah, and that was really the design team and Walter and so the key problems were we were hopeful that the processor itself, the central processor, that we could pretty much use as is although we knew there would be problems whether we could make it work over the temperature range that we wanted because to do that you would have to get special what are called "high-rel" [high reliability] integrated circuits that would operate over wide temperature ranges and the way the semiconductor industry worked in those days, they didn't necessarily offer all of the same circuits in a high-rel version as they did in the commercial so it wasn't clear that we could get high-rel versions of the medium-scale integrated circuits that were in the designs.

Hendrie: Especially [since] some of them were pretty new and I think they were using the latest and greatest from TMI.

Maxfield: Yeah. Yeah, right. Actually, no, I think they were actually- most of them were Fairchild if I remember correctly. Yeah. I think so.

Hendrie: That's true because Herb Richman worked at Fairchild.

Maxfield: Yeah. Yeah, and they had the inside track on what was going on. I think-- Yeah, and it turns out that- pretty much that turned out not to be a problem. I think there were a couple of cases where we had to design around some things but the other problem was that even if you could get the devices that

would work over the temperature range because the logic delays changed dramatically with temperature you couldn't necessarily make the thing work <laughs> without changing some of the-- Yeah, so we had actually had to go in and do quite a bit of piecemeal re-design inside the processor in order to get it work at the right clock speed over the temperature range—

Hendrie: Was your objective to match the clock speed?

Maxfield: Yeah. Yeah. The idea was to make it exactly the same as much as we could, yeah.

Hendrie: Because you obviously could have had—

Maxfield: Yeah. We could have slowed down the clock but—

Hendrie: -- and still had the program compatibility part of it.

Maxfield: Yeah. Right, and so—

Hendrie: Did you have to use flat packs or—

Maxfield: Well, no, we wound up using ceramic DIPs

Hendrie: But ceramic DIPs did it.

Maxfield: Yeah. Ceramic DIPs. Those were much cheaper than the flat packs and also it turned out we figured out a way to get the heat away from them which is another-- So the key problems were to get the CPU to work, get a memory that would work, a MIL-SPEC memory, big problem, big problem, and of course you remember—

Hendrie: The memories always had these incredibly narrow temperature margins.

Maxfield: Exactly. Exactly. Right, but there were people that built MIL-SPEC core memories but of course the other thing was [that] the Data General machine was packaged on large boards like this so you had- the CPU was on [one] board, the memory was on another board that went in a box and of course yeah, making the size of those boards work in vibration and shock and everything else was a nonstarter, number one. Number two, the form factor that people wanted military computers in was what was called an ATR box of very specific size which was like this—

Hendrie: More like a cube.

Maxfield: Yeah, and it plugged into these racks and equipment and it was a very standardized external mechanical interface. So the boards couldn't be any bigger than about this no matter what we wanted to do, the PCBs, and then of course we had to do something about the memory. Well, so and then there was designing the power supply to work over the temperature range and then the mechanical packaging of all this that would be rugged enough to stand it and also what are you going to do about getting the

heat away. You have all kinds of problems if you have things open to the air and so what we really- our objective became [that] we wanted it to conductively cool, that is we wanted the box to be airtight with the heat conducted to the outside of the box where you could blow air, you could put heat exchangers on the outside of the box if you wanted to and blow fans over it so those were sort of the design issues. We found some subcontractors in southern California who were experts at building core memories and so that we subcontracted to those guys because they had come out of a company called EMI, Electronic Memories, Incorporated, EMM maybe, and anyway they were in Southern California and they were really early manufacturers of core memory arrays and that company actually had a militarized core memory standard product, sort of quasi-standard product, using special cores, and so these guys claimed that they could take that stack and build a memory around it to any form factor that we wanted and so the scheme that we came up with was a box that held the processor and a few input/output cards, and then the memories actually were plugged onto the back, they were in their own box with a connector that plugged onto the back with a, you know, essentially a bus that went all the way through so you could stack two or three memories on the back of the box and they all plugged into each other and bolted onto each other, 4KB core memories, you know, 4KB, yeah, the original, and you could get as many as four of them on that box and then if you needed more than that because you could address up to 64KB, we had another box, an auxiliary box, that you could put more memory on or something and so Walter designed the power supply, those guys did the memory, Merle did the processor and I did part of the processor just because I wanted to <laughs> get involved and that was- so I did part of that and then I pretty much drove the packaging stuff and learned a lot about thermal transfer and ruggedness and, you know, all this kind of stuff, just as much as I could sort of- and we did have I believe a consultant, a mechanical consultant, for a while that helped us out but what we wound up with was for stiffening, to make it really rugged, was the cards were about this big to get the- and what we did was to get the heat away from the integrated circuits, you know, these things looked like this and they'd get soldered into the board. Well, we put a copper grid down, laminated it to the printed circuit board which just had copper strips going across that the ICs all straddled and then coppered down the edges and then the cards were clamped really tight at the edges which did two things. First of all-- Oh, and then over the-- So that was how the heat got out. It got conducted [heat] from the ICs through these copper arms over to the edge of the copper and then over the top of the card went an aluminum cover which was bolted down to the card at four places. This is for the vibration, rugged, it'd make it just stiffer than a board, and then at the edges we had this clamping scheme that just grabbed the things and you screwed them down from the outside. So the box-- Actually there was no inside box and outside box. Literally the edges of the box were where the cards were. There was clamps machined into the edges of the box and then we actually tightened them from the outside. Anyway there were a lot of interesting ways that we came up with but so we managed to solve all the problems basically. We got the packaging done, we got the- solved- got the thermal stuff done, and by the Fall Joint Computer Conference we had actually built a couple of prototypes and everything was working except the memory. The memory didn't quite work so here we're getting close to the fall—

Hendrie: Is there electronics? Did EMM or EMI or whoever—

Maxfield: No. The subcontractors we had was a guy named- just a small consulting shop that-- George Wells was the technical guy who had been the VP of engineering I believe at EMM but had decided to go off and do his own thing and so he and his guys were designing the memory and, you know, the last month or so I'd get on a plane about three times a week and go down and spend two or three days with them because they couldn't get this thing to work and it was—

Hendrie: Just to work at all or over—

Maxfield: Right. Just to work. Just to work. Right.

Hendrie: Much less get a temperature—

Maxfield: Right. Exactly. Yeah. So we're getting close and we've got this booth all ready for the Fall Joint [Computer Conference] and Gene Richeson's got all the collateral material ready and ads and all kinds of stuff and we can't get the memory to work so and in fact we never did get the memory to work in time for the Fall Joint Computer Conference. Now here's the thing- and which wouldn't have been too bad except we wanted a working demo and the way we were going to demonstrate that it was working was we were going to have the Spacewar! game, the same game that Data General had run on the Nova the year before in their booth-- Yeah.

Hendrie: You got all the software and it was all compatible.

Maxfield: Yeah. All I had to do-- Actually I mean it took me a little- because all I had was the object tape for Spacewar!. I had to do a reverse of the singular and figure out-- There were a few incompatibilities because their input/output, the A-to-D they were using, they didn't-, you know, I didn't know what the design was, I didn't know what the input/output commands were, I had an A-to-D that I had kluged up and I had to do-- That was-- Yeah. <laughs> So anyway but I got that program to run and of course we were checking our CPU in the lab, just plugging a Data General memory onto it. You know, we had the Data General box with just a memory in it and we'd just plug it in and we could run the computer. So the idea, the way we were going to set up the booth, was over on one side of it we were going to have this little Spacewar! game where you have this little CRT display and these two little game things [controllers] and two people play against each other and the computer was going to be sitting up on a shelf above the game, that was the working machine, and then there was going to be another prototype with a plastic see-through cover on it where you could see the inside mechanical details and it was going to be on sort of a little pedestal that people could gather around and look at and you could look into it and see the memory and see the power supply and see the PC boards and all that and so when it became clear that we weren't going to be able to get the memory to work what we wound up doing was the computer that was going to run the game was sitting on a platform. Well, as I told you, the memory bolted onto the back of it. So what we did is we cut a hole in the wall of the thing and put a bracket on the back and put the Data General box with its memory in it behind the booth and put this thing up against it and plugged the Data General memory in and ran it and it worked perfectly the whole time and although if you looked at it and then you looked at this machine over here and you realized that the memory bolts on the back and you looked up at that machine on the shelf and you noticed there's no memory bolted on the back of that. I mean we didn't actually-- If we'd have been clever we'd have put an empty memory box with the connector going all the way through but we didn't do that but not one person during the whole show ever observed or at least commented on how come that box that's running the game over there doesn't have the memory attached to it which is what you say is how it works. Now anyway so it was one of those things you just have to do when- and but- and the rumor was, which I never really got confirmed or not, but the rumor was that in fact the prior year when Data General announced their machine and they had this same Spacewar! game running there was a rumor that their machine didn't work either and that what they had was maybe a DEC or some other machine or maybe like something else hidden away that was actually running the game but that was a rumor that I've heard a few times and I never asked Ed whether that was true or not but- so if that's true then it's sort of ironic that we had the same <laughs> problem. So but anyway we got through the Fall Joint Computer Conference, we made a certain amount of splash, and the interesting thing during that time was when Data General went public they had their IPO that same week and I remember being impressed that all four of these guys who were wandering

around the show were each worth, and the number sticks in my mind, they were each worth $6 million as of that day when their company went public, you know, and I just thought oh, my God, can you believe that. So anyway—

Hendrie: They're about the same age you guys are.

Maxfield: Yeah, a year older, a year or two older. Ed might have been a little older. I'm not sure but, you know, I think they were all-- Yeah. Henry, he was younger, yeah. I mean he was—

Hendrie: I think he was 22 or 23 at the time.

Maxfield: Yeah. Yeah. I think so. So we got through the Fall Joint Computer Conference and everything worked okay and then we managed to get a couple of orders and—

Hendrie: You still have to solve the memory problem.

Maxfield: Oh. We got it working, you know, within a month. I mean--

Hendrie: It just went away.

Maxfield: No, no. This wasn't, you know, catastrophic. It was just that, you know, it sort of worked. It just, you know, it wasn't reliable. It would work five minutes and then something would go wrong so I mean it was just fine. You know, there were some noise problems, intermittent noise problems, and stuff like that. It was not a major design problem. Right. No. So we got that all worked out. So then we actually delivered our first production unit in April of the following year and in fact that quarter, the April, May, June quarter of that year, we actually were profitable as a company and were, you know, and <laughs> and we never lost money and we never had a losing quarter after that. I mean literally that was it. Now in the meantime of course we were running out of money so we met our things and so Jack Melchor then did what he was supposed to do which was lead a, get a round of venture capital. So in about March, about the time we delivered our first machine, we did our venture capital round where we raised $608,000 as I recall from three VC firms. Jack's was one, one was Continental Capital and the third one was Wells Fargo SBIC firm and that turned out to be the only venture capital round that the company needed until just before, about a year before we went public as we were getting in much later, several years later. Just for sort of working capital we raised a million dollars and then a year or two after that went public. So the product, we called it the 1601 computer, and we went out and started trying to sell it to the military and to the prime systems contractors and it was quite a slog because we were a company saying this machine meets all the MIL-SPECs, if you want one you can have it in 30 days, it costs you 30,000 bucks, and people didn't believe us. I mean, you know, they just looked at us and said it can't be, it just can't be, I mean, you know. So it took-- Yeah. So it took a while for a few real adventuresome guys to say well, what the hell, let's buy one and try it and so-- Yeah. So some guys did and they had good experiences and we busted our tail to support them and managed to get it going and of course just about the time we came out, this was now in '70, '70, '71 time frame, there was a semi-recession and everything was tight and, you know, so it was doubly hard. At one point we decided-- We actually laid off two people, two assemblers, <laughs> because we were building all our own stuff, and that's all, that's the only layoffs we ever had so- well, until maybe way, way-- No. I don't think we ever had any layoffs.

Hendrie: Who was your first customer?

Maxfield: First customer was Sylvania Electronic Defense Laboratories. Might as well leverage all the old ties and friendships there and so literally Gene Richeson sort of twisted the arm of one of his good friends over in Sylvania that had an application where they needed a computer and he talked the guy into-- The guy's name was Jim Peebles and, you know, we appreciated that immensely and they bought it and they used it and it worked great and then we got another order and another order and another order and so it- and over time we did quite well and then of course the scary part was then- one of the key things we had to do was to prove that it would meet the MIL-SPECs. We had to go through what was called a qualification testing program where you go over to an independent testing lab and you run all these tests and man, I tell you, I was sweating blood over that when we did that because, you know, who knows. We thought we had it designed but we didn't have time to really-- Well, we could test it most-- We tested it pretty well over temperature before we ever shipped a machine but, you know, vibration, shock, humidity, these things take a long time to do, and we just didn't have time to do them and but we did and we managed to get it without any major changes. It passed all the MIL-SPECs and so that was a big relief. Yeah. The design held up fine and that was-- Let's see. Oh. The other thing, you remember I mentioned that Data General's main concern was whether they were going to have to hold our hand a lot and all that and as I said we started out with the schematic and one of their machines and for the first two years or at least a year and a half I never even talked on the phone to anybody at Data General about anything technical, period. In fact, I'm not even sure I actually ever met Dick Sogge. I met Henry at the Fall Joint Computer Conference when we displayed because we had a problem and we needed to borrow a voltmeter and I went over and asked him if we could borrow a voltmeter and Henry got it for me and but because the thing was that it wasn't like we were copying all of their designs so I mean there wasn't much-- We either had to make it work or-- Yeah. Yeah, and so- but- yeah- but the only time that I talked to him was oh, maybe six months or nine months after we started shipping machines and maybe the second or third or fourth machine that we shipped. I got a call one day from the engineer who said, you know, I've had this machine on the bench and I've been playing around and checking things out and he said I've got a problem and it's repeatable and I can tell you exactly what's happening or, you know, what the symptoms are. You know, it just had direct memory access and he said I've got a DMA channel I'm using and when I do just the right things the whole machine locks up and I said oh, I said well, let me call you back. So I went out on the bench and sat down with the machine and got out my oscilliscope and started re-creating the thing and within a couple of hours I knew what it was. You know, it was a design error and it was one of these things where, you know, you don't find it unless you've got just the right things trying to do things together. So I called Data General and I forget who I talked to. Maybe I talked to Sogge at that point but I talked to somebody and I said I got this problem and they said oh, well, we'll get back to you, and I came back and said well, we fixed that last year with an ECO, you know, that was fixed a long time ago. Well, we hadn't been on their ECO distribution list. We had not-- Literally I had a set of prints that existed before they ever shipped their first machine, well, probably, no, probably within a few months. So they had had a problem that they had fixed but we didn't even have a channel of communication where they were feeding us fixes. <laughs> Well, you know, being as young and inexperienced as we were, you know, I hardly even knew what an ECO was and so I said well, could you send me a print that shows the fix and they did and so I went out and implemented the fix and that was that and that's the only- but that's interesting because that's the only-- I mean they had a clean design. I mean that's obviously the only problem they had had after they started shipping their machine and but that was the only contact we ever had. <laughs>

Hendrie: Do you remember how many engineers you ended up having in this first period before you got profitable—

Maxfield: Oh. Okay. Right. By that time we had one additional engineer, a guy named Bud Thiel, (ph?) who was an analog guy and he then took over the memory designs of future generations and also power supply designs because Walter decided he didn't like doing the engineering per se and he wound up moving into sales which worked out great but so we hired Bud Thiel (ph?) and I believe-- No. We hired an assembler or two and maybe one other technician and that's all we had by the time we started shipping hardware and then as we kept building up and were profitable and we could afford to hire more people then over time we hired more engineers. Yeah. Right. Yeah. Yeah, and we hired, you know, Gene hired a head of sales, a guy named Tony Gerber who was a young guy who had never really sold anything but had a Ph.D. in electrical <laughs> engineering. Yeah. Yeah. From London, one of the schools, one of the British schools, but and he turned out to be a great salesman. I mean-- Yeah. <laughs> Yeah. So anyway and we managed to grow so the first year, I think the first fiscal year say from June to June, July to July, after we shipped the first machine we did about a 1.3 million in revenues and then the second year about 2.4 [million] as I recall in revenues and the third year about 3.6 million. So we were growing not by, you know, so at the end of three or four years we were at 3 or 4 million dollars but our profits, our pretax profit margin, was about 28% and so we had a nice little business.

Hendrie: A good business, nice and profitable.

Maxfield: Yeah, and it turned out that- and then the question was well, what do we do for the next-generation machine, do we continue to track Data General because of course Data General-- Now I'm trying to think. They came out first with— The Super Nova was their second machine I believe which was higher performance and stuff and then the Eclipse or how many—

Hendrie: They did the Super Nova. Then they came out with the Nova 1200—

Maxfield: Right. That was sort of the _____ machine. Yeah. Yeah. Replaced with the Micro Nova. Yeah. Right. Yeah. Right.

Hendrie: And then they came out with a machine, the 800. The Super Nova did not do well.

Maxfield: Right.

Hendrie: It didn't work very well.

Maxfield: Yeah.

Hendrie: Then they came out with the 800. Then about the same time they came out with the third generation sort of at the bottom end which was the Nova II--

Maxfield: Uh huh.

Hendrie: I think the Nova II got out before the Eclipse—

Maxfield: Okay. Yeah.

Hendrie: --but then they followed on with their expanded instruction set machine, the Eclipse.

Maxfield: Yeah. Right. Yeah. Well-- Uh huh.

Hendrie: They kept going locked step with Novas and Eclipses—

Maxfield: Yeah. Yeah, and so we went through a decision process early on of well, are we going to continue to follow the Nova line and we decided not to in that it was just going to be too hard to track and also what we were finding was that what our marketplace needed were things that were different than what they were pointed at in their marketplace. For example, our market really was a bug on performance, high-speed floating points and things like that, and that wasn't as important for what Data General was doing. So we wound up doing essentially our own version of what Data General was doing, that is they were compatible, upward compatible, that is we had expanded instruction sets as we went along but you could still run the original software so we did a 1602 and then a 1664 and the difference was that for example the 1602 we designed from scratch and it was actually microprogram-controlled which was one of the early microprogram-controlled processors. I forget how wide the instruction word was in the ROM but and we had, you know, an expanded instruction set and hardware floating point and some other stuff. Well, you know, the hardware floating point I guess was the next generation, the 1664, so basically we continued to, you know, to track the Data General architecture but we basically had no- we didn't attempt to stay in lockstep with Data General at all and we, you know, did our own memories and, you know, 8KB, 16KB, higher speeds, higher clock speeds.

Hendrie: So you just deviated from the—

Maxfield: Yeah.

Hendrie: --from their logic design and even their system architecture.

Maxfield: Right, except that the I/O was still compatible and the basic operating system, yeah, was still compatible. You could-- Yeah, and then we developed- then another problem that our market needed was a real-time operating system, you know, and the way Data General had gone, the original operating system was sort of a non disk-based… which- and then they immediately went to the disk-based operating system. Well, see most of our machines didn't have disk drives even after-- Yeah. Right. Yeah. <laughs> Yeah. Right. Yeah. We tried that a couple of times but so one of the things we developed from scratch was a real-time operating system that we provided with our machines and we continued to, you know, develop input/output hardware that was appropriate, and we did a few special systems things for some customers and over time eventually the product line got into the big time of military procurement. For example, I believe- I wouldn't be surprised if the surface-launched cruise missiles, the cruise missiles that were used in 1990 and again now that are launched off of ships, probably the guidance computer, that's the computer that sits on the ship that programs them before they go, may still a ROLM computer because we were on that program very early on and I wouldn't be surprised if we're still there the way <laughs> the military, you know, stays with things that work and we also wound up being a fire-control computer on the F-16 air force aircraft. It's a system that identifies threats via the radar and tells the pilot whether he's got missile sites that have illuminated him or whatever and several thousand of those were put on F-16s. I have no idea if they're still flying or not. Yeah. So there were a number of big applications in the military that these machines eventually got used on.

Hendrie: You obviously didn't sell them directly to the military. You sold them to prime contractors.

Maxfield: Yeah. Typically to prime contractors and-- Well, for example the F-16 was Dalmo Victor which was a local company. They eventually got bought out by Loral and the cruise missile I don't remember who the prime contractor on that one was or it might have been General Dynamics and then of course it varied. Well, and then we learned that dealing with the military is a different world in its own <laughs> as opposed to most commercial things and after a few years the business was going good but [what] we were really concerned about [was that] we didn't know how big the ultimate market was.

Hendrie: To Arthur Rock's question.

Maxfield: Yeah. Exactly, and it's not like we were growing. I mean we were growing nicely but it's not like we were taking off and we had big issues because see, one of the things the military was used to getting as part of-- If they brought something they got what's called rights in data which means you give us all of your design information and we own it and if we want to have somebody else build that box we have all the rights to go do that and everything that the military typically procured they owned because they had paid for the design. Okay, but here's one of the rare cases where they hadn't paid for the design. This was the standard product and so all of a sudden when they started talking about procurement things they said okay, well, and of course we need rights and data and all of us said no, we're not going to give you rights and data because you didn't pay us to design this thing, this is the standard product. Well, the bureaucracy just couldn't deal with that so and then eventually we made it happen but it was agony, you know, and took a long time and a lot of problems and a lot of programs. Another thing that started happening was the politics came in because the big guys, IBM, who had built military computers, and Sperry Univac who built military computers, they didn't like the idea that here was another competitor coming in and so they-- Well, so their approach was the military should not proliferate computers. What the military needs to do is standardize on one computer and that way you get all the benefits of-- You get higher volumes, lower price, less training, blah blah blah blah blah, and of course it should be our computer and of course those guys had been around for a long time, they were prime contractors, they had- infinitely well plugged into everything going on, and all of a sudden you got these standardization efforts going under way in the military and lo and behold there was a Sperry machine that [Navy had bought called the-- I can't think of it now, something 20, UL-- Antioch 20, Antioch 20, a 16-bit machine. It was about this big and it had about half the performance that our machines did and it was about eight times as big and it cost about three times as much and lo and behold the Navy initiated, decided, well, we think we're going to standardize, you know, Sperry's promised to cost reduce it and make it in a smaller box and all that so we're going to go with that and the Air Force said well, we got a better idea, rather than just sort of taking [about] what's out there, we're going to design our own computer from the bottom up, we're going to define the instruction set and then we're going to go out for bids on who wants- , you know, it's going to be sort of a standard machine and anybody can build it and anybody can- and so they started down that path and the Army, God bless them, said well, we like the ROLM and we're not going to bother with standardizing, we're just going to keep buying ROLM machines for a while but nevertheless you could see that we didn't- and we fought all of these things and of course what- and our approach was standardization is good but it shouldn't be a single machine, you need to have maybe two or three so you get some competition and two or three's not too many to support but if you've got competition going then you're going to get the best price, you're going to get the best machines, you know, you can use them in different applications based on what their strengths and weaknesses are, but we couldn't sell that. I mean that didn't work. So anyway here we are in about 1970, late 1973, and we're doing 3 or 4 million dollars a year but we're starting to get really nervous about, you know, how big the market is and in fact that maybe the market would go away. I mean if

everybody standardized on one machine and it wasn't ours we were going to be in big trouble. So we began a conscious effort to say well, we want to continue to grow and we don't want to just be locked in so we began a conscious effort to try to decide well, how could we diversify, figure out some way to leverage what we've done and what our strengths are and go into some new marketplace and well, we can't go into the commercial marketplace because by our agreements with Data General that won't work. Well, maybe we could go into the ruggedized industrial marketplace, you know, maybe there's industrial stuff which we explored some and anyway we went through this process of consciously looking for something we could do. This is late '73, about late '73 for the most part, or early '74 maybe.

<crew talk>

Hendrie: You're trying to figure out whether this could really be a big company and if it can what are you going to do to make it one.

Maxfield: And so we went through this process of looking for—

Hendrie: Do you know whether any of these early-model ROLM computers exist anymore, whether anybody has any of them like a 1601 or a 1602 in their basement and whether any of the military versions really exist.

Maxfield: I don't know of any specific ones but I've been starting to nose around and try to find some because I was trying to find some that we could donate to the Museum. I'm sure it would not be a problem getting some of the CBX products and that but the computers-- In fact, we just had a ROLM reunion a few months ago where a lot of people were there and I asked a lot of people and in fact I passed out a flyer to everybody there saying if you know of any because since I've been interested in the Computer [History] Museum and in the last year or so the events that have been I thought, you know, maybe I'll just see if I can't go out and round up some stuff but so far I haven't found any of the MIL-SPEC computers. I'm pretty sure eventually I'll find some of the other stuff.

Hendrie: I wonder whether there are any in the F-16s at the graveyard in Tucson.

Maxfield: Well, yeah. Yeah, that version was actually just a bunch of cards, not a box I think.

Hendrie: Oh, I see.

Maxfield: Because it went into a box with -- see eventually --

Hendrie: Went into somebody else's box?

Maxfield: Yeah on that one what we did was we eventually licensed _____ to just build the cards and put them in their box because it was in one box with a bunch of other stuff.

Hendrie: Yeah, yeah, yeah.

Maxfield: But, yeah, I'm hopeful that I can dig that out.

Hendrie: I mean that's interesting but not quite as interesting as -- as the box.

Maxfield: Yeah. Well, there was a time when we sort of had a little collection of sort of museum stuff in our, you know, breadboards and boxes but it disappeared somewhere along the line and nobody knows where it went.

Hendrie: Oh, that's a shame.

Maxfield: Yeah.

Hendrie: Well, you know Data General did after EMC bought Data General.

Maxfield: Uh huh.

Hendrie: They were clearing out some storerooms and they found serial number one.

Maxfield: Oh, my goodness.

Hendrie: Of the Nova.

Maxfield: Is that the one that's in the [Computer History] Museum now?

Hendrie: And that's now the one in the Museum and, of course, it was -- you know they got it back because they had a -- their first customer I believe was Los Alamos and they went and, you know, bought it. They shipped it and it never got there. UPS lost it.

Maxfield: The very first machine.

Hendrie: And so they had to quickly put together another one to complete the order and get it out there.

Maxfield: And then eventually it came back.

Hendrie: And then eventually it turned up. It was in some -- I don't remember – Ed de Castro's tape has where it was. It was someplace off in, you know, like I don't know it was in another country but it had really gone astray. And so, that's still serial number one and they just kept it so we manage to have it.

Maxfield: Yeah.

Hendrie: We would love to --

Maxfield: Well, I can dig up pictures and stuff but it may take a while to dig up a machine.

Hendrie: Okay. Well, pictures, you know, are the next best thing.

Maxfield: Yeah. Right. Right.

Hendrie: All right, let's continue with the story.

Maxfield: Okay. So now we're to the point where we're trying to figure out something else to do and one of the things was that we had just -- we were continuing to grow and by this time we're up to maybe, I don't know, 150 people. We had moved into a new building, not one of our own but a new bigger piece of the building and we had just bought a new phone system, a bigger phone system, which was this electromechanical monstrosity that took up a whole closet and we were going through that process. And, as we were in our -- at some point and I forget exactly the details, I believe actually that what happened was Tom Fatjo [ph?] who was a friend of Ken Oshman's from his boyhood days and who had been a very successful businessman in Houston, had come on our board and he lived in Houston and he -- he somehow or another ran across a little company in Dallas that had taken a Data General computer and had put a bunch of stuff around it and made essentially a telephone PBX controlled by the Data General computer. And, I forget -- and I guess it's because it was a Data General computer and Tom knew we were looking at areas to diversify into [that] he suggested to Ken that maybe you guys might want to talk to these guys. Maybe there's something there. And we went and we talked to them and I forget what -- at any rate, what happened was the market they were after was a very highly specialized sort of very expensive PBX because the way they were building it, it was very expensive but that sort of intrigued us because we had just installed this electromechanical monstrosity in our building.

Hendrie: And were feeling pain.

Maxfield: Yeah. And one thing we knew for sure was that there is a lot of PBXs in the world out there and that the market was changing. First of all, there was a transition starting to go on from the old electromechanical relay systems control for the logic and all that to electronics and that the marketplace was opening up. There was now competition. See, you have to remember you could not buy a competitive -- a PBX or even a telephone from anybody other than the telephone company until 1968 when the [Carterphone] decision decreed that it was okay for people to sell what was then called terminal equipment, that people could buy their own terminal equipment.

Hendrie: And attach it to the telephone network.

Maxfield: And attach it to the network and, of course, the telephone companies led by AT&T said 'oh the end of the world.'

Hendrie: The telephone system would collapse.

Maxfield: If we let any old body -- oh, absolutely. It's going to bring the system to its knees. It could never work, blah, blah, blah. But nevertheless, the FCC said nope. We're going to allow competition. So what happened was an industry sort of came up and it became called the interconnect industry, which

were people that would sell you a fax machine or an answering system or a telephone or a PBX branch exchange.

Hendrie: Right.

Maxfield: And there was starting -- and by 1973 or so there was a smattering of an industry out there of various kinds but there were a few small PBXs that had some electronics in them but we sort of looked at that and said gee, you know, there's a lot of neat things you could do if you had a computer controlling the thing instead of hard-wired logic, which all these things had.

Hendrie: Right.

Maxfield: Number two, all of these guys that are building electronic machines, they're using analog switching technology, that is they're doing various -- they're not converting the signals to digital and then manipulating them. They're just moving the analog signals around.

Hendrie: Yeah, they're just using logic to figure out where to switch it.

Maxfield: Yes. But in the long distance network for many years that was mostly digital because they already were doing digital conversions for long distance transmissions so it's not like that was a big secret. And, anyway, the more we looked at it the more we thought, gee, we have a lot of skills. The computer skills we know how to do. A-to-D and D-to-A conversion, which is all you're really talking about, we thought, is not that hard. Maybe what we should do is a computer controlled digital PBX and maybe that's what we ought to go do. And the more we thought about it the more exciting it became because first it's a commercial market, not the military. Second, it's a gigantic market.

Hendrie: Yes.

Maxfield: So it's plenty of room to grow. Third, it would be a lot of fun to build your own telephone system and, fourth, how hard could telephony be anyway? I mean, you know.

Hendrie: Of course.

Maxfield: We're computer experts.

Hendrie: Right.

Maxfield: If we can understand computers, telephony has got to be a piece of cake.

Hendrie: Right.

Maxfield: You know it's tip and ring stuff.

Hendrie: Exactly what you don't know won't bite us.

Maxfield: Yes, exactly.

Hendrie: What we don't know won't bite us.

Maxfield: Yeah. So the more we thought about it the more intrigued we got and then we got to the point of saying well, you know, how can we really drive into this? And there was a guy who I'd known socially for many years who was a great engineer, a guy named Jim Casson [ph?] who worked at Hewlett-Packard and Jim had been working in Hewlett-Packard's I think it was called the DSD or DASD or something, data acquisition systems division or something like that. And basically what that division did was put together very sophisticated data acquisition and control systems, you know, digital input/output.

Hendrie: Right.

Maxfield: All kinds of stuff and I had actually tried to hire Jim for a couple of years before that because I knew he was a great engineer and I liked him a lot and had tried to get him to come to ROLM and he just said well, you know, it would be fun but I'm just not interested in, you know, the stuff you guys do, you know, with respect to computers.

Hendrie: Yeah, exactly.

Maxfield: So, one day I called him up and I said, 'hey Jim,' I said 'I'd like to talk to you about something.'

Hendrie: Yeah.

Maxfield: 'Could you come over and let me just -- we got an idea we're cooking around over here and we'd like to just run it by you and see your reaction.' And so he came over and so we spent what turned out to be several hours in me describing this idea that we had that maybe we'd go and, you know, as we got into it, you know, I could just see his eyes start to light up and he'd start to say, oh yeah, you could do this and you could do this and, gosh yeah, that's just like a sort of digital acquisition. He said yeah we'd have a backplane. We'd do this. We'd do that. And so the end of it was that basically I convinced him to leave HP and come to -- and join ROLM to go make this thing happen even though we hadn't actually committed to do it. I mean we had --

Hendrie: Yeah.

Maxfield: But he was willing to bet on it so he left HP, came to ROLM and then a couple -- and started working on the design of this thing and a few months later --

Hendrie: Now you're still running engineering?

Maxfield: Yeah, I'm still running engineering and by now initially I ran manufacturing but then we hired a manufacturing manager. Dennis Pubujian [ph?] had become one of the key players on the team and he was running manufacturing by then. So, I'm running engineering and so by that time a guy named Leo Chamberlain is running marketing. Gene Richeson left the company after a couple of years and Leo Chamberlain had come in and was running marketing. So, and of course it was Ken and Leo and I that

were sort of pushing this idea. And so, we decided, okay, Maxfield will go try to bring in a key engineering guy to evaluate the design. Leo will go hire a marketing guy. Because one thing we thought early on, which I think was -- I mean this is something that was in retrospect a great decision. If you're going to go diversify like this, this is a totally different product than a MIL-SPEC computer.

Hendrie: Yeah, right.

Maxfield: I mean yeah there's a computer in it but --

Hendrie: But that's about it.

Maxfield: Both from a technical point of view and from a marketing point of view even more so.

Hendrie: Yes.

Maxfield: So, then you had the decision, well, if we want to do this should we just take some of our existing people and carve them off and say you guys go do this? And we sort of did a little, you know, I took some of my engineers and sort of threw out the idea to them. But my engineering group, you know, really no reaction at all. I mean they just, you know, why would we want to go do that, you know. MIL-SPEC computers are great. I enjoy what I'm doing.

Hendrie: Yeah, I like what I'm doing now.

Maxfield: So, we decided that the right way to do it was if we're going to do this we're just going to -- at least at the key management level we're going to bring in people who are fired up with the idea and have their own skills.

Hendrie: And it's their only responsibility.

Maxfield: And have the skills that our in-house guys are missing in some of the areas that are going to be important.

Hendrie: Yeah, okay.

Maxfield: And so, Maxfield was to go hire an engineering guy and Leo was going to go hire a marketing guy and he hired a guy named Ignolli [ph?], who also was from HP who had started out life, he's a Brit, and had started out life as a software engineer and at HP he was involved in the software development operating -- I believe it was operating systems for the HP 3000.

Hendrie: Okay.

Maxfield: Which was the -- you know one of the later HP machines.

Hendrie: Sure.

Maxfield: And then he had, along the way he had decided he liked marketing and had gotten an MBA I believe and had gone into marketing at HP and was sort of chomping at the bit to do something new and so we hired Ignolli and so he came -- I think Jim -- I forget exactly when they came onboard but -- wait a minute. Let me think about this now. Wait, let me get the time straight here. I think, okay I think we're now at mid -- yeah we're at mid-'73 so like maybe the summer of '73, something like that.

Hendrie: Okay.

Maxfield: They're both onboard and, in fact, and I said to Jim, you know, you can hire a hardware engineer if you want and you can hire a software person if you want before we even make this decision. So, as soon as he came in he brought in a hardware guy that he had worked with at Hewlett Packard named Ken Lavezzo [ph?] who was a super analog designer.

Hendrie: Yeah.

Maxfield: D-to-As, A-to-Ds, all the kind of stuff we were going to need and -- oh and then it turned out that one of my best software guys really was hot for the idea.

Hendrie: Yeah.

Maxfield: And so, a guy named Steve Plan [ph?] so he said I want to go do the software for that thing so he -- so he went over and joined Jim and then Dick and so they went off and sort of started the design and paper design and actually some prototyping of the telephony stuff, proving to ourselves that we could -- that we could actually convert, you know that we understood telephony. So, I think maybe now we're up to maybe the fall of '73 and we have now got sort of a rough paper design of what this machine is going to look like. Dick Moley has begun work on how we might market this thing and we put together a business plan. We went to our board of directors and we said well we got this plan to diversify and we're going to go into the telephone business. And, in order to prove to you that we know what we're doing we want you to come out to the lab where we got a telephone at one end of the lab and a telephone at the other end of the lab and we're going to show you that we're converting the digital signal and we're transmitting it digitally and we're picking it up over here. And so, this is how we're going to do it.

Hendrie: Yep.

Maxfield: And so, and here's our business plan and the idea is well over the next year if we didn't do this we would do, I believe we were projecting maybe $6 million in revenue and maybe a million and a half dollars or something or $1 million of profit but what we're going to do is we're going to spend all of that profit developing this new product.

Hendrie: Now have you gone public yet?

Maxfield: No.

Hendrie: Ah, okay, still private company.

Maxfield: We're still private. So, in other words, for a year and a half we're going to apply all of our profits.

Hendrie: Oh, you have the luxury to do this.

Maxfield: We're going to apply all of our profits into developing this new product.

Hendrie: Yeah, try doing that with your public [company]…

Maxfield: And we think that if we do this, and I've got the plan somewhere that, you know, after that we'd say, oh, and I think maybe we were talking maybe two years into it we might say, oh, $5 million or $6 million worth of PBXs if all went well which would be a good return on the development.

Hendrie: The investment and a big boost to revenue.

Maxfield: Yeah. Well, and so the way -- so at that time our board of directors consisted of Ken, Jack Melchor our venture capital guy and our lawyer John Wilson from Wilson and Sonsini.

Hendrie: Oh, okay.

Maxfield: And that was the board.

Hendrie: No outside board members.

Maxfield: Well, so the other two venture capitalists, which were Continental Capital and Wells Fargo, they were invited to sit in on board meetings but they were not on the board.

Hendrie: Yes.

Maxfield: So they were here at this meeting.

Hendrie: Okay.

Maxfield: Actually, no. We had one other board member by then. We had Les Hogan on the board.

Hendrie: Oh, okay.

Maxfield: Who had been a friend of Jack Melchor's and Les was a great board member. So, anyway, we do this and it turns out that the two other venture capitalists just went ballistic. They said, oh my God, you can't be serious that you're going to do this. You've got this great little business going, great margins. What in the world do you think you're doing? You're going to compete with AT&T. My God, you know, who in their right mind, blah, blah, blah, blah, blah. But, they didn't have a board seat so at the

end of the day the board voted unanimously to go ahead with this thing. And as I recall one of those VCs within a few months sold his interest in the company to somebody else.

Hendrie: Yeah.

Maxfield: And I think the other one, the other one hung in there. And so we said, okay, let's go and we started the development and so this was now about maybe November and the plan was to staff up to maybe eight engineers. I believe it was four hardware guys and four software guys and maybe a couple of guys in the marketing area. And by January we were staffed up and by -- so now we're into '74. So in about June or July of '74, we had sort of a working red board prototype and by late in '74 I believe we cut our own system. We threw out our old telephone system and cut over to the alpha version of our new one.

Hendrie: Oh, wow, okay.

Maxfield: You know we said if we're going to do this we're going to inflict it on ourselves.

Hendrie: Right.

Maxfield: And then in April of '75 --

Hendrie: Great QA experiment.

Maxfield: Yes. In April of '75, we shipped the first production units. So, 15 months after we pushed the start button we shipped the first production unit. So now, some of the details, well a couple of stories along the way. As we were doing the technical design there were a lot of issues in terms of bit rates and D-to-A and telephony and so we brought in a couple of really heavy duty telephony guys that knew all this stuff and the interesting thing was that -- because we had some sort of novel idea. For example, it was a conventional wisdom that if you were going to digitize voice it was an eight-bit companded algorithm which meant it wasn't just eights linear. It was sort of like floating-point. There were eight bits for a sample but it was a non-linear scale.

Hendrie: Ah, okay.

Maxfield: And that's the way because in the long distance every bit counted because capacity was a limit and so the AT&T, the telephone company said of all of the standard companded pulse code modulation system for digitizing. Well, our guys looked at that and said, you know, well that's good for long distance where you can afford a lot of equipment to code it and decode it.

Hendrie: Yes, because there -- the line is incredibly expensive.

Maxfield: Right.

Hendrie: And you get a little bit more through it.

Maxfield: But do we really want to do that for every telephone conversation?

Hendrie: Yes, for 100 feet, 300 feet, et cetera.

Maxfield: Yeah, right.

Maxfield: So what we had decided to do was a 12-bit linear.

Hendrie: Okay.

Maxfield: Which was our analog guy Ken Lavezzo believed could be built quite inexpensively. I mean this is way before the days of integrated A-to-Ds and D-to-As.

Hendrie: I understand.

Maxfield: So, I mean these were discrete things. And, in fact, I mean in the original versions of the product we didn't do the digitizing at the phone. You went back to the switch and went into an interface card, which had A-to-Ds on the interface card and so, for example, 16 telephone lines would feed one A-to-D.

Hendrie: Ah.

Maxfield: And so you would sample.

Hendrie: A multiplex.

Maxfield: A multiplex.

Hendrie: Sixteen telephone lines, okay.

Maxfield: Yeah, because to be cost effective that was the only way you could do it then.

Hendrie: Right.

Maxfield: So that was one, like one design issue.

Hendrie: And you weren't going to insist people have their own, your own telephone.

Maxfield: No, in fact that was key because some of the very early products that were out there had, you had to buy their custom telephones, which were very expensive and we decided -- we thought about that and said well, no. We're going to be able to use a plain brown phone, which was the standard term.

Hendrie: Yeah.

Maxfield: Or, I mean we'll offer a featured electronic phone but you don't have to have 100 percent of them.

Hendrie: Exactly.

Maxfield: So, that was a couple of the key decisions we made and so there was this one consultant who was a guru and he said, well, you know, maybe the 12-bit thing will work and all this but what in the world are you guys competing with AT&T for? You guys are absolutely crazy and this guy was sort of a guru in the industry. This is crazy. AT&T is going to bury you. Nobody in their right mind would do that. Okay. So, we did it anyway but the other thing we did was -- oh, and the processor that we used, we basically just took what by then was our about third generation machine. Actually we did -- the processors we did got more and more complicated but then at some point we went back and did sort of like the Micronova. We said well let's go back and do a 1601-compatible that's a lot faster but is really cheap, you know, minimum number of components but the basic instructions.

Hendrie: And, of course, there's a lot more MSI now.

Maxfield: Yeah, using the new MSI because now instead of putting it on five boards we can put it on one and it will be twice, three times as fast, blah, blah, blah, and we had just done that for the military.

Hendrie: Okay, so the 1601 was on five boards? The CPU ended up being on five boards.

Maxfield: Yeah. Yeah, it was on five -- the original one was on five boards.

Hendrie: Okay.

Maxfield: So we had done a small one and so we just simply picked up that processor and ported it over to the -- to use in this system so it was a very low cost 16-bit machine.

Hendrie: Now had you ever done any fault-tolerant, you know, tearing a board in the military?

Maxfield: No.

Hendrie: The military machines were never -- never --

Maxfield: No, they just --

Hendrie: They were just there and when they broke that was it.

Maxfield: It was there and when they broke that was it.

Hendrie: Okay.

Maxfield: So, the other thing was the memory. What kind of memory are we going to use? Well, are we going to use core memory? Well, this was in the early days of semiconductor dynamic RAM. In fact, Intel had just come out with the 4KB, four kilobit dynamic RAM, their second -- you know the first generation was the 1KB.

Hendrie: Yep, yep, yep.

Maxfield: Well, they had just come out with the 4K dynamic RAM.

Hendrie: Okay.

Maxfield: And after agonizing we decided we're going to go with semiconductor.

Hendrie: We're going to gut it and do it.

Maxfield: We're going to gut it out. And then the decision was well, okay, now what are we going to do, what are we going to do about parity? Are we going to have parity? And I remember Jim Casson one day he said, well, you know, the problem with parity is that, you know, what do you do when you get a parity error? You know this is a telephone system. You'd like not to just have the damn thing just stop so it's not clear how we would deal with parity if we did it. And besides, this is semiconductor stuff. This stuff is either on or off. It's not like core memories where it's a little -- and so, you know, there shouldn't be a problem so we won't do parity. So, we did a 4K chip-based RAM and it all worked great. Everything was fine and --

Hendrie: Now this was on -- it was still a Nova-compatible 16-bit machine?

Maxfield: Yeah.

Hendrie: Okay.

Maxfield: Yeah, still a Nova-compatible 16-bit machine.

Hendrie: Compatible actually, okay.

Maxfield: Actually it had a slight -- it was actually a microprocessor-controlled version that had a slightly increased instruction set. For example, it could address 64KB instead of 32KB and a couple other things, not much more but basically just a Nova machine.

Hendrie: Okay.

Maxfield: And let's see what other technical things? Basically, the way it worked was it was just a high speed digital backplane and the cards that plugged into it were line cards, line being a telephone, and the

line cards would interface to either -- it was either eight or 16 telephones. I forget what the initial version was and then there were what were called trunk cards, the central office trunks.

Hendrie: Yes, going.

Maxfield: So, a different interface there.

Hendrie: Right.

Maxfield: And we hired a telephony guy, one of our -- you know so Jim hired an expert on telephony that designed all the interface cards and he was the expert on how does the signaling work over the trunks and all this kind of stuff.

Hendrie: Yes.

Maxfield: And it turned out that there was a lot we didn't know and, in fact, there was a lot that he didn't know that we found out but we struggled through and had some problems but got all the telephony stuff to work. Then there were really sort of architectural things that the guys did a great job of thinking through because they said, okay look, you know, how is this thing going to be maintained in the field? What kind of reliability are we going to have to have because, of course, the sort of conventional wisdom for the telephone system in an AT&T PBX was 40 years in MTBF. I mean it wasn't bad. I mean literally that's what people thought about when they thought about telephone systems. I mean these things don't fail.

Hendrie: Exactly.

Maxfield: And, you know, electronic computers fail.

Hendrie: Right.

Maxfield: And especially mainframe computers are notorious for failing, you know. You're down hours a day, you know, hours a week.

Hendrie: Yep.

Maxfield: And so clearly there was a big, big uncertainty about well now wait a minute, you know. What does it really mean to put digital logic in computers into a telephone? I mean can you even come close to getting the reliability that people expect?

Hendrie: Yes.

Maxfield: So, we thought long and hard and so we did a number of things, redundancy, we had hot stand-by as an option. You could have two processors, a watchdog timer that would -- where one processor, they would both be loaded with the program. They would periodically update themselves with the changeable parameters so that they were hot but only one was running. There was a watchdog timer

that would say are you okay? Are you okay? And if it decided this guy wasn't he'd just turn it over to this guy. And so we did that. It worked good. We also put in the ability to do remote polling, that is we put a modem in the system where you could call up the system from a remote terminal.

Hendrie: Ah, okay.

Maxfield: And run a diagnostic program -- well, you couldn't run diagnostics but what the system did was had a lot of self-test diagnostics and whenever it came up against a problem that wasn't catastrophic it would save it away in an error table somewhere and you could dial in and get the error table any time you wanted. So, if a line card went down or something it could flag it. There were diagnostics on all the cards.

Hendrie: Yep.

Maxfield: And so the idea was that all of our distributors out there, they would poll the systems every night and download the error tables and if there was a problem -- and the idea was the diagnostics would be good enough to say, you know, line card number three in slot 12 failed.

Hendrie: Yes.

Maxfield: So that the idea was that by the start of business the next day at eight o'clock your service guy would be waiting on the doorstep as the people open their building and say I need to swap out a card. You had one fail last night. And, in fact, that worked. I mean that was -- and, of course, that was --

Hendrie: That was something --

Maxfield: Something this is --

Hendrie: Nobody else did.

Maxfield: You know this is 1975 we're talking about here.

Hendrie: This is amazing, yes.

Maxfield: So, that was one thing we did. Also, the other thing we had a cassette with the program on it in the system so that if you had a catastrophic failure for some reason the system could reset itself. It would attempt to reboot, load the program off of the tape cassette and bring itself back up if it could.

Hendrie: Okay.

Maxfield: Which a lot of times --

Hendrie: It could, yeah.

Maxfield: And, in fact, there were a lot -- in fact the one story I'm going to tell next made that a godsend. So, we thought through a lot of things and put a lot of features in the system that for a computer system were pretty far ahead of the game because this was a real-time computer system and it's a turnkey system.

Hendrie: Yeah, and this is a real-time computer that people are truly dependent upon.

Maxfield: Yeah, and people don't program it. You know, you don't -- the people that are maintaining it are not computer experts.

Hendrie: Exactly.

Maxfield: All they know how to do is, you know, troubleshoot, swap things out, whatever. So, we did our best to make the thing as absolutely bulletproof as we could. Now, so what happened was we started shipping systems and they were working good? There were, you know, the usual number of problems and we fixed them as best we could but about, I don't know, a few months into it we had maybe 20 systems in the field or something like that. Suddenly -- oh, I remember what it was. We came out with a release two of the software, that is there were a bunch of features that didn't make it into release one obviously and so, you know, maybe three or four months later we came out with release two. And as soon as -- and the idea was we could go out and just send a guy a cassette with release two on it and he could just go load it into a machine already in the field.

Hendrie: Right.

Maxfield: Load the new thing and just reboot.

Hendrie: So, they started doing that and they found out that when they did that on some of the machines it was -- it wouldn't run.

Hendrie: Yeah, okay.

Maxfield: It wouldn't run and finally after, you know -- we finally figured out that it was something to do with the memory.

Hendrie: Oh.

Maxfield: Nobody was quite sure anyway. So, all of a sudden we had these machines failing in the field.

Hendrie: Yes.

Maxfield: And so and, in fact, they would run for a while and then they would collapse. And so what you get is these catastrophic failures so they were resetting themselves every five minutes and reloading and then running for ten minutes and then dying again.

Hendrie: Oh.

Maxfield: Or running for an hour or running for a day.

Hendrie: Oh, and the customers just had big smiles on their face with this.

Maxfield: Yeah.

Hendrie: Oh, yeah.

Maxfield: It was nasty.

Hendrie: It was brutal.

Maxfield: It was brutal. Well, anyway what we finally realized was we had discovered and we might have been the first guys in the world, or at least among the first to discover the phenomenon of soft memory errors in dynamic RAM where a bit would just, whether it was being accessed or not would just occasionally change.

Hendrie: Just die.

Maxfield: And nobody quite knew [why]. I mean eventually we contacted, we figured out what was going on. We contacted Intel. For a while they sort of stiff-armed us and then they finally fessed up that, yeah, we know about it and we're working our tails off trying to figure out how to fix it.

Hendrie: To try to figure this out. Yeah, exactly.

Maxfield: And so that was just -- that was one of the quirks of the early dynamic RAM.

Hendrie: Yeah, well, yeah, I mean they had no -- it was when they got down to few enough electrons. I mean the one case probably did it but nowhere near as often because it was the alpha particles making a pad, a leakage pad.

Maxfield: Yeah, eventually I think it was alpha particles or something that were out of the atmosphere.

Hendrie: Yeah, from the package.

Maxfield: Oh, from the package that's right.

Hendrie: They were in the package, yeah.

Maxfield: Right. So anyway -- oh and the other way we -- one of the ways we discovered this was suddenly we realized this seems to only happen on release two systems, not release one or when we upgrade a system to release two.

Hendrie: Yeah.

Maxfield: And so finally, I forget who it was, maybe it was me, maybe it was somebody else, went out and talked to our super tech, our super system tech on the production line and said, Larry, you know, are you having any problems with memories on the systems when they're in systems test? He said no, not really. He said, you know, occasionally I have to change something out and we said well how are you -- explain how you're taking -- he said well, you know, I load the software and then if it doesn't work then I start swapping out memory chips until it works and then I ship it. So, we had even seen the problem in production but the system tech was, you know, his job was to get the systems out, make them work, get them out.

Hendrie: Right and he saw -- he didn't need engineering to solve this problem. He knew how to solve this.

Maxfield: Yeah, right. So, oh my God. So, then we began a -- so we began a multi-dimensional effort.

Hendrie: Yeah but this still doesn't say why rev two, release two --

Maxfield: Well, the problem was that a lot of this software was pattern dependent. In other words, they would fail only if the array of ones and zeros in the memory in the rest of the memory happened to be a certain way.

Hendrie: A weak bit as opposed to --

Maxfield: Or something.

Hendrie: Yeah. Exactly.

Maxfield: And so if you had one program in there it was okay but when you load a different program -- and most of the memory was program not data.

Hendrie: Yeah, right.

Maxfield: Because the data was all just being shuffled elsewhere. So, there was very little read/write data. In fact, that part, that was nice because if you got bit failures there it really didn't matter. You might lose a call or something but the system would usually recover.

Hendrie: Yeah, right.

Bob Maxfield: But when you lost a program error you were in big trouble.

Hendrie: Okay.

Maxfield: So anyway that led us to -- well finally we figured out what was going on. So, we began intense effort with Intel to track what they were doing. We put some intensive system test procedures to try to weed the things out and then we started a crash effort to develop an error correcting memory. And so we -- I mean parity obviously wouldn't have helped much.

Hendrie: I was going to say parity wouldn't have helped.

Maxfield: So what we did is we developed, you know, we had a 16-bit memory. We developed a 21-bit memory with single bit error correction.

Hendrie: Very good.

Maxfield: And initiated a crash effort. It took us about six months by the time we started until we were out in the field retrofitting memories and the idea, you know, error correction for people that might be watching this that aren't familiar is that there are sophisticated coding systems where if you have 16 bits of data and you can create an additional five bits that are based on what the other bits are such that if any one of the 21 bits fails, any one fails, you can actually detect it and figure out which bit has failed and fix it with special logic in the memory. So, when you access a word you can determine whether it's correct and if it's not it actually fixes it on the fly and the system, the processor never sees it. So we implemented that and by the time we got it out in the field and up and running pretty much Intel had solved the problems and, in fact, you know, I don't think, I don't even know if people still do error correcting memories or not in the bigger computer systems.

Hendrie: I don't know either.

Maxfield: But it's not an issue anymore, you know.

Hendrie: Yeah, exactly.

Maxfield: Well, actually they do because I know when I bought PCs recently sometimes you have an option. You can get error correcting memory as an optional memory in PCs, at least you used to be able to.

Hendrie: Okay.

Maxfield: So, that problem plus there were an accumulation of a whole lot of other problems and eventually we had -- the field was on fire. In other words, we had about 50 systems out there.

Hendrie: Yes.

Maxfield: And at any given time a lot of them were in trouble and our techs were out there babysitting them and we had customers that were irate. And, I mean the thing was about to blow up, plus the warranty that we had set up we told people was 90 days to our distributors.

Hendrie: Yep.

Maxfield: And, of course, a lot of these things were out of warranty and you had all these problems with error and so we said no problem. We're going to extend the warranty. We're going to fix these problems. And finally we got to a point where, okay, we got our arms around everything. We know how to fix all these systems. Now, what are we going to do? And we said, okay, we're going to put together a tiger team of guys and we're going to spend whatever it takes for the next several months. We're going to sweep through every system in the field.

Hendrie: Yep.

Maxfield: And we're going to upgrade every single system to the latest levels.

Hendrie: Yep.

Maxfield: And, of course, it has to be done at nights and weekends because the systems have to be up during the day.

Hendrie: Exactly.

Maxfield: So, anyway, and we did that on our own hook and extended the warranty and when we got through doing that and by that time we had probably a couple hundred systems in the field and we got them all done and then we managed to get the fires out and from then on it was great.

Hendrie: It was fine but the first 50 systems really --

Maxfield: It was.

Hendrie: You had a bath.

Maxfield: Yep and --

Hendrie: Oh, wow.

Maxfield: So anyway, so the net of it was that about after we got going on that the first year we actually sold $10 million worth of CBXs.

Hendrie: Oh, my goodness.

Maxfield: We called it the CVX.

Hendrie: Plus some more to the military.

Maxfield: Plus the MIL-SPEC.

Hendrie: Yeah.

Maxfield: The second year -- the first full year of production there was a six-month period where we sold maybe, I forget, $3 million or $4 million, the first full year $10 million. Then the next year $20 million, the third year $50 million, the fourth year $100 million and the next year $200 million worth of CBXs.

Hendrie: Was this a good idea or was this a good idea?

Maxfield: So, this became the tail wagging the dog, you know.

Hendrie: Right.

Maxfield: But the interesting thing is we got into this business because we were worried that the MIL-SPEC business would not pan out.

Hendrie: Yeah.

Maxfield: Well, it turns out that within by 1984, so eight years after we -- well we shipped the first product in ’75, the first CBX in ’75.

Hendrie: Yeah.

Maxfield: By 1983, the MIL-SPEC business was doing $100 million in revenues so it grew just fine for the next --

Hendrie: It also grew.

Maxfield: It grew fine over the next eight years.

Hendrie: It just took a long time to see it.

Maxfield: So, we made a great decision for the wrong reasons but everything worked out.

Hendrie: There was nothing wrong with that.

Maxfield: Yeah.

Hendrie: I think we have run out of this tape.

Maxfield: Good. Okay, well that's sort of a good --

END SESSION ONE (TAPES 1–4)

START SESSION TWO (TAPES 5–8)

Hendrie: We have Bob Maxfield with us again to finish his oral history for the Computer History Museum's Oral History Program. Thank you for taking the time.

Maxfield: Looking forward to it.

Hendrie: Let's see. I think we were discussing the early shipment days of your telephone switch product at ROLM, and you were, when we stopped last, you were talking about some of the terrible- that's the only way you can describe the memory problems, that arose in the systems and what you had to do to deal with that.

Maxfield: Yeah. And I'm not quite sure where we were, so some of this may be repeating a little. I believe we got into the memory problems. As I mentioned, we were one of the first users of the four thousand bit dynamic RAM chips in our memories, and we had neglected to put in parity or other things, not that parity would have done any good as far as making the system recover from any errors.

Hendrie: Were these Intel chips?

Maxfield: The first chips we used I believe were Intel, and TI also had chips at that point.

Hendrie: Yes. Okay.

Maxfield: And we used both over time, and as I recall both manufacturers had problems in different degrees. So as I mentioned, suddenly the systems in the field started dying. We had, as I recall, something on the order of forty or fifty systems in the field, at least. And I think I went through the description of how we discovered the problem, that the problem cropped up because we had sent a new release of software to the field, so that the program, a new program was getting lowered into memories, and it turned out that some of these memory chips, depending on the pattern of the bits that were in the memory, you could get the soft failures where a bit would just change. And if a bit in the program changed, then the thing was dead forever. So it turned out that our final test technicians had been testing

things in such a way that they would run the program. If it didn't work, then they would start replacing memory chips until it did, and then they would ship the system to the field. And so the system worked fine until you loaded a different version of the program, and then it would die. So we had a crash effort, worked with Intel and TI, who had just discovered the problem, and came up with more rigorous testing methods, but in the meantime [we] did a crash effort to develop an error correcting memory, which added five bits to the sixteen-bit word, but allowed us to detect single-bit errors and correct, detect and correct single-bit errors. So that took, by the time we figured out the problem, invented the correct memory, and were ready to shipping to the field, about five or six months went by, so we had a lot of work to do. And there were a number of other early, early problems, as there always are with new products, various problems we had discovered that, you know, we had fixed. But we finally got to the point where we said, "Well, we've got to sweep through the whole install base and clean everything up, because the systems just were not up to our standards of excellence at that point."

Hendrie: Now, when a customer with a system, you know, had one of these errors, and it was in the part of the memory that was storing the program, what would you do?

Maxfield: Well, the system would crash a lot of the time.

Hendrie: Yes. I understand what the system would do, but what was your answer?

Maxfield: And what would happen is that in the system, of course, we had it to where if the system crashed it automatically rebooted itself, and it had a tape that it would reload its program from. And in a lot of cases, the program would then run okay for a while, but then after a day, or a week, or whatever, it would crash again. Well, so fortunately there weren't that many systems that it actually happened to. It was potential for all of 'em, but there were a handful of systems that really were catastrophic. And what we did was whatever we had to do. We'd send a tiger team out with a whole new set of boards, or processors, memories, whatever, because that was, you know, a telephone system.

Hendrie: It's a real telephone system.

Maxfield: It's a lot like a computer system, you know. In those days the computer system was a mainframe, and people were used to that being out of service a lot, a lot of the time, for routine maintenance, if nothing else. But a telephone system, people expect it to work twenty-four hours a day, seven days a week. So we were getting quite a black eye, although it was interesting, because a lot of the customers that had the biggest problems, they still loved the system because of all the functions and features. They just hated it that it was down a lot. But we managed to recover and sent a tiger team to the field. We actually took a whole bunch of people and said, "You do nothing for the next several months but go out and go to every single system in the field, and upgrade every system to the latest level,

and get 'em all solid." And we did that, of course, at our expense. The warranty had long since run out on a lot of the systems, but we said, "Hey, we're extending the warranty until we get it right."

Hendrie: Yeah. This is company survival here.

Maxfield: Right. So end of it was we got through that, and by doing that actually we built a lot of goodwill with our distributors, who, you know, then had confidence that when things were wrong, that we would make 'em right, as opposed to what had been the case in the PBX business. This particular business with the sort of monopolistic manufacturers that were in it before, the idea- and they were big companies, and they were hard to deal with in that respect. So, you know, we were viewed as much more responsive to problems.

Hendrie: Yeah. This was a distributor business?

Maxfield: Yeah. Now, yeah, I think we ought to back up and talk about the channels of distribution for this, because that was another key decision going into this business that was crucial. And, in fact, there was an interesting case written a number of years ago, business school case, by a Stanford professor, on this decision, this particular decision, which was interesting. So the question is, here we are, a small company. We're basically a product hardware company. We need a channel of distribution. And I think I mentioned the first time we looked at doing this product, we decided we weren't a big enough company. We didn't have enough money to do it, but then we decided we thought we had a strategy. The possibilities were we could have sold the product to AT&T, who was the major telephone company. But, of course, they had their manufacturing arm, Western Electric, which made PBXs. And so the chances of them using our product instead of their own were pretty small. And then the way the market was, AT&T in any given city, there would be a telephone company, and AT&T was the largest. This was before AT&T was broken up. So ninety percent of the market in the U.S. was AT&T. The other ten percent or so, fifteen percent maybe, was the independent telephone companies, of which there were a couple of large ones, General Telephone, United Telecommunications, and then a whole bunch, thirteen hundred or something.

Hendrie: Little guys.

Maxfield: Mom and pop telephone companies. And, of course, that was a channel of distribution, because most- well, the bigger ones of those companies had their own manufacturing arms, as well, but they had more of a history buying other products, as well, but that was only a small fraction of the market. So the other possibility was what were called regional interconnect companies, or interconnect companies, that had sprung up with deregulation after the Carterphone decision. And they were selling PBXs in competition with the telephone companies. They were getting products from Europe or Japan, who were building products, electromechanical and maybe a few electronic PBXs that were almost

identical in terms of functionality to what AT&T had. But these guys were able to survive because with the deregulation that happened in '68, these guys could sell their product to the customer, rather than the customer having to rent the product from AT&T, and have no control over the rentals, 'cause the rental price just went up every year.

Hendrie: Yes. And so they had a real economic...

Maxfield: So it was primarily an economic argument, and not much in the way of features or functionality. But they had managed to carve out maybe ten, twelve percent of the market by about 1974, 1975. Most of the companies were small. They were underfinanced. They were regional, local. But we decided that- Dick Moley decided, who was the guy that was responsible for the marketing strategy for the CBX, decided that the strategy would be we would go out and we would pick, to start with, just a handful of these guys in the major market areas, that we thought had the best potential, seemed to be the smartest, seemed to be the best businessmen, and get them convinced that they would use our product. And what we would do, something that nobody had ever heard of in this market, was we would give them exclusivity in their market area. They would be the only guys in New York City, let's say, that could sell our product. So that way they didn't have the price competition of many guys trying to sell the same product, and they could charge a premium for it because it was worth it.

Hendrie: Yeah, 'cause of all the features. Yeah.

Maxfield: And they would also be able to make enough margins to support it properly and so forth. And we insisted that they go through a lot of training. In other words, we insisted on a lot of investment on their part in spare parts and in training, 'cause we wanted a quality operation. And Dick was able to convince about seven guys, seven guys around the country, that were the initial set of distributors. So the strategy was build up, and as we build up our sales volume, and our ability to produce, and our orders, add more and more distributors in different parts of AT&T's empire. And at the same time, go after the independent telephone companies in their areas, or at least some of them, and try to sell through telephone companies in some of the smaller market areas. Anyway, that, and, oh, and then the other thing that overlaid on top of that was that we recognized that a major market, especially with the kind of functionality that we could deliver, was in what we call national accounts, major corporations that had multiple facilities all over the country, like an IBM, or a General Motors, or General Electric, or big companies, insurance companies, so forth, that might have dozens of PBXs scattered around the country. And a lot of times the decisions were fairly centralized in terms of what kind of telephone system, because people were starting to build telephone networks with private lines, and so forth. And so we had sort of an in-house sales group, whose job was just to establish relationships with the big companies and convince them that they wanted to use our product everywhere, because if they did, then the products could interconnect, and they were easier to manage and maintain.

Hendrie: Okay. So it's a direct, a national, direct sales coordinate national accounts.

Maxfield: Yes. Called national account. Not that we sold directly, but it was relationship building, and then when they were ready to put a PBX in in Chicago, we would put them in contact with our local guy.

Hendrie: With your exclusive agent.

Maxfield: Yeah, with our guy, and we would make sure that, for example, the pricing around the country was rational. You know, some places the labor costs were higher and lower, and so forth. But that way we could sort of help control, make sure that the pricing was consistent, so that they didn't get upset that they felt one guy was trying to charge too much in one town, or whatever.

Hendrie: What were some of the features of your product that were particularly attractive to the nationals? I mean, that wasn't in AT&T's standard offering.

Maxfield: Well, the two biggest money savers were what was called "Least Cost Routing," and that meant that, remember back in those days, you had different kinds of telephone trunks that you could bring out, and there were what were called "foreign exchange lines." You could have a trunk coming into your building that actually went to, like I'm in San Jose. Palo Alto might be a long distance call, or narrowly, but I could get what was called a foreign exchange line for a fixed price per month, which went directly to Palo Alto, which made calling Palo Alto free.

Hendrie: Yes. I understand.

Maxfield: So if I had an office there, or somewhere else in the country, and then also there were other kinds of lines called "WATS" lines.

Hendrie: I remember WATS lines. Yes.

Maxfield: WATS lines, the idea was you didn't pay on a per-minute basis. You paid a flat rate each month for the line, maybe a thousand dollars a month, and you could put as many calls over that trunk anywhere in the country as you wanted, as long as up to some maximum number of minutes. So the problem was, you could buy all of these different kinds of telephone lines coming into your facility. But then getting people to use them was almost impossible.

Hendrie: Or getting them to use them correctly.

Maxfield: Because with the old PBXs, you know, you would say, well, you have to get on, and you have to dial this particular code. And if it's busy, then you just got to wait, and then try it again a few minutes

later, because there might be somebody else using that trunk. Well, obviously, you know, there was no way to build in to force people to do that, and so the result was it was almost impossible to take advantage of these kinds of capabilities. But because we had a computer in the PBX, we could program it to do various things. So for example, you could say if a call, let's say we have a plant in Dallas, Texas, well, in a particular area code. We say okay. And so we buy a foreign exchange line or two going there.

Hendrie: Or, yeah, well, the company would. Yeah. You would tell them, this is what.

Maxfield: Yeah. The company would. Yeah.

Hendrie: Yeah, yeah, the company would.

Maxfield: So we'd do that.

Hendrie: We'd tell them about doing that, yeah.

Maxfield: You know, yeah, sorry. For our customers, we would configure this network for 'em. We'd tell 'em, okay, you need…

Hendrie: Ah. So you would do something.

Maxfield: Oh, yeah. We would do analysis of their traffic. I mean, one of the things we could do with the PBX was capture all kinds of statistics.

Hendrie: Ah.

Maxfield: On calling patterns. And then we could come in and say, "Okay, we can now- now we've analyzed your calling patterns."

Hendrie: Of course.

Maxfield: "And what you need to do is buy three WATS lines, and a foreign exchange line here, and this, that."

Hendrie: "And we think it'll save you X."

Maxfield: "We think it'll save you X thousand dollars a month," and we will configure the system so that people, so that it's transparent to the users. In other words, the user picks up, dials the plant in Dallas. And what happens is the system selects that trunk and the cheapest possible way. So if the foreign exchange line is free, which is the cheapest, it would place the call over there. If all the foreign exchange lines were busy, it would use a WATS line. If all the WATS lines were busy, then maybe it would use a regular old line, much more expensive, if the guy's class of service was at a certain level. So you could give individuals different privileges. The president could have--

Hendrie: The president never got a busy signal.

Maxfield: No. He never got a busy signal. And as you went down in the organization, if you chose to do it that way then, you know, you would. So what would happen is if your class of service didn't allow you to get to a certain place for a reasonable price, it would give you a particular busy tone, a special busy tone, that would say-- and then if you wanted to then automatically cue for that, in other words, you didn't want to have to try calling back ever five minutes, you'd just simply hit a code on your phone, and you were now cued, and the cue could be several people. And so then as soon as the person that was on that line hung up, then it would automatically call back the next person on the cue. Your phone would ring with a special ring, and you'd pick it up and get a special tone, and it would then dial your number for you.

Hendrie: It would automatically dial.

Maxfield: Yeah.

Hendrie: You didn't have to redial it.

Maxfield: Yeah. So as a result, you could configure it. So for people that had a large, long distance telephone bill, which a lot of companies did, especially the larger companies, it was a huge savings. I mean, you could pay for the system in a few months.

Hendrie: Wow.

Maxfield: With the kind of savings that you could get.

Hendrie: Now, did you have proprietary phones? Did you have to have any phones?

Maxfield: You didn't have to have. That was another issue. Another design issue was some of the old.

Hendrie: How are we going to do this?

Maxfield: Yeah. Well, some of the early electronic systems they did their own custom telephones, which had extra buttons and all. But the trouble is that was very expensive, because, you know, buying a plain, brown phone.

Hendrie: AT&T, that's right. Western Electric knew how to build phones.

Maxfield: Yeah, exactly, yeah.

Hendrie: For really cheaply.

Maxfield: And so what we did was say, "Well, the system will absolutely work just fine with a plain, brown phone, or if you want, we also have what we'll call feature phones." We had a whole range of those over time that cost more, but they had displays, and they had buttons, and all this. But we figured out ways that you could do the features on a plain, brown phone. And you had to just- you'd do a switch a flash, and then you'd get a special tone, and then you would dial in pound, star, seven, three, or whatever. You know, it was a little bit of a nuisance, and people didn't like it, but they could get the functions done with it, if they really wanted to.

Hendrie: Okay. Yeah.

Maxfield: And then over time, as the technology kept getting cheaper and cheaper, then eventually we had a fully digital telephone that cost, that we would sell to the user, for the same price it would cost to get a plain, brown phone. It had a fully digital link and display and everything else. They were called ROLM phones. That was later, but there was good technology there. We really were the first ones to come out with a full digital telephone, that is where the signal was converted from analog at the phone, sent digitally over a link to the switch, as opposed to analog from the phone to the switch, and then having a digital-to-analog, I mean, analog-to- digital conversion at the switch, or vice versa. And, in fact, we had, over a single twisted pair, we could connect using a technology we developed with custom integrated circuits at each end. It was called "ROLM linking." And what we had on a single twisted pair was bi-directional, two hundred and fifty-six kilobit per second data streams, both ways, plus power to the telephone. And in those data streams, we could get up to three sixty-four kilobit channels, so you could have two voice channels and a data channel.

Hendrie: Oh, my goodness.

Maxfield: Or two data channels and a voice channel, and then one channel for control. And this was, you know, this was a long time ago. I mean, these days that's really not…

Hendrie: Well, this was when digital PBXs were going to be the way data was switched before Ethernet.

Maxfield: Yeah.

Hendrie: Before local area networks became the way data was...

Maxfield: Yeah, exactly. And that, in fact, you know, a little later in the story, we get to FX.

Hendrie: Yeah. We don't need to get there. So that was one of- I understand. That was one of the features.

Maxfield: Yeah.

Hendrie: You said there were sort of a couple. What were they?

Maxfield: Well, and then the other feature I sort of alluded to, which was the ability to capture information about all the calls. And, in fact, we had a service where we would capture all the information that the customer wanted on who called who, so we could keep track of every single employee, every call made. And then we actually had a service bureau type operation where we could take that data and run reports for 'em, and actually price out the calls, every call, and then sort it by department, by phone, by however you wanted it sorted. And you could use that then to understand what was going on, calling patterns. You could find employees that were abusing the system and calling relatives.

Hendrie: And this was revenue source, too, for you.

Maxfield: Sure.

Hendrie: And you charged for it obviously.

Maxfield: And it was a revenue source for that, yeah. So that was some of the examples of the early capabilities. And then, of course, as we got into things, that was sort of in our first release of software, were those kinds of things. And then as the customer started using the system, we started getting all kinds of other ideas about what the next versions of software should be. You know, for example,

automatic call distribution. Well, back in those days, there were what were called ACD centers, you know, where you call in, and you get routed to an operator, you know, lots of operators and load sharing, and all that. But they were typically multi-thousand user systems. Well, companies, you know, had many applications where they could use a small call center to do something like for customer service, or whatever. So maybe you'd have ten agents, or twenty agents, or something. Well, it was not that big a deal to just build that into the software so that we could then offer in your PBX that you buy from us, you can configure a number of your telephone stations to be an automatic call distribution segment.

Hendrie: Oh, wow.

Maxfield: And do the load sharing, and keep data on it, and tell 'em, you know, all the efficiency that they were getting, and so forth. And another application that came up was some retail stores, for example, would have multiple stores in one metropolitan area, you know. Think of a Sears, or a Penny's, or somebody.

Hendrie: Of course.

Maxfield: Well, they might have many stores. Some of the stores might be in the parts of town where people didn't like to live, or, you know, they didn't want to be there after dark, or something, but the stores would be open. So they had a hard time getting employees that would go in some of these areas. But that was one rationale, but the other rationale was they wanted to have a common experience when you called. So they wanted, if you called Penny's, they wanted you to not get to any particular store. They say, "What store do you want?" And they say, you say, "I want the so and so store." And then they would plug you through to that store. So it was what was called- or they would plug you through to the appropriate phone in that store. So it was what was called centralized attendant service, so all the attendants were actually in one place.

Hendrie: Ah.

Maxfield: And then the stores were all connected. Each store had a PBX in the store, but all the attendants sat in one place.

Hendrie: Sat in one place. Ah.

Maxfield: And, of course, these days that's done all the time, you know, these call centers and all that. But this was back when doing things like that was new and really provided a lot of benefit for specialized applications. So one thing we found as we got into over the two, three, four years, was that we didn't really have to invent a lot of new features. Our customers told us what they wanted, and if we were smart

enough to listen to 'em, and then go and look around and say, "Well, how many other people have this same problem?" and discovered there's a lot of 'em.

Hendrie: Yeah. Do the ones that appear to have a common thread.

Maxfield: Yeah. And in fact, that was something that, you know, that was really… it was the marketing guys. It was Dick Moley and his product managers that were out there talking to the customers that would come back with this. When we had our original product plan, you know, when we came out with the CBX, we new that we had a completely digital machine. And so the idea, we had this idea of integrating voice and data way back then, that the idea was, well, since it's all digital in the PBX, once we get it going, we can add data. So now we can connect data terminals to computers through the PBX.

Hendrie: Okay.

Maxfield: And that was sort of in our plan, but we knew that the world wasn't ready for that yet, because, first of all, in corporations, the telephone guys weren't the computer guys.

Hendrie: They were completely different.

Maxfield: And they were totally different.

Hendrie: Power centers, you might call them.

Maxfield: Right. But nevertheless, we knew that would be a compelling case at some point. And we sort of assumed that the second year after we went into production, that we would be doing data communications. Well, we had so many other good ideas that came along that we said, "Look, you know, let's just put if off, 'cause we don't know how well people are gonna accept it, and we know people will take ACDs."

Hendrie: Yeah. Let's do the things the customer...

Maxfield: Yeah.

Hendrie: …we know the customers will like.

Maxfield: So it turned out it was about three or four years before we actually got to the point of announcing data communications.

Hendrie: Oh, my goodness.

Maxfield: And that was just at the cusp of when local area networks were starting to crop up, but not, you know, not- but still, you know, you were still hooking a lot of computers to many- a lot of terminals to many computers via various kinds of mechanism switches, or whatever, data switches, or modems, or whatever.

Hendrie: Local area networks had not been put on twisted pair yet.

Maxfield: No. No, they had not.

Hendrie: But when that happened then-

Maxfield: No, they had not.

Hendrie: Then the digital PBX story was over.

Maxfield: Yeah, well, yeah. And in fact we played around with doing exactly that. Typically people would run three pairs of wire, just ‘cause that was the cable you would buy, instead of just one, although all you needed was.

Hendrie: No, of course, because- yeah.

Maxfield: But we realized that you could put our ROLM link on one pair, and then you had two other pairs, and you could use that and do a- the idea that later took off of the centralized local area network, that is the hub.

Hendrie: Yes, exactly.

Maxfield: Yeah. Well, you know, all the telephones are star wired into a hub, and so the idea was, well, we could build something that would go there, and do a local area network. But, you know, from a technical point of view, we talked about it, but by that time we were well into- we had launched the data communications- the basic data communications product allowed us to communicate using ROLM link, at

up to fifty-six kilobits from a terminal to anywhere you wanted to go, to a computer, or anything else. And that was a big part of the market at that point. It was just, you know, 'cause this was right at the edge of the transition from minicomputers, plus terminals, to personal computers that wanted to do peer-to-peer networking. And we were finding that we were having a very hard time getting into the IT, information technology guys, because as we said the telephone guys never talked to 'em. And so we were finding that although we had introduced data communications, and a few people picked it up and used it, and the ones that did got a big benefit from it, it was a very tough sell for our distribution channel, because they weren't calling on the right people, and they didn't know how to talk to 'em in their own way.

Hendrie: Yeah. You almost- yeah.

Maxfield: And so we had this idea. Well, we, you know, the next phase is local area networks, and we could do that, too, using the same infrastructure that we have, and we finally- there were other things that we just decided were higher priority, and then it was maybe five years later when, I forget, what was the first company that did the hub based twisted pair that works?

Hendrie: Oh.

Maxfield: Ops- Op- Ops.

Hendrie: Yeah, yeah, yeah, yeah. Yeah. I can't remember.

Maxfield: Yeah.

Hendrie: But they were out in the Bay area.

Maxfield: At any rate, you know, in the early days when Ethernet finally sort of won the land battles, it was still on coax. You had to run rings of coax through your building if you wanted to use Ethernet.

Hendrie: And that was very expensive.

Maxfield: Oh, very expensive.

Hendrie: Because you had to do custom wiring.

Maxfield: Absolutely. And so, you know, that transitioned from going from sort of a ring or bus organized coax everywhere to twisted pair wiring into.

Hendrie: Star wiring into a hub.

Maxfield: Into hubs.

Hendrie: Yes.

Maxfield: That was the transition that really put Ethernet, made, you know, that was the ultimate answer.

Hendrie: Yeah.

Maxfield: But we weren't in a position to- we weren't positioned in the marketplace in a way that we could have been the ones to do it.

Hendrie: Yeah, yeah. If nothing else, just 'cause of your distribution.

Maxfield: Yeah.

Hendrie: Your distribution channel. Tell me a little bit [about] the process that you, you know, you came up with a lot of very popular features in this first product. You'd never been in the telephone business. Talk to me about how you figured out what the spec was for the software that was gonna run in this. Were there particular people that just…?

Maxfield: Well, you know, we had a process that we put in place, you know, for each new release of software, because, you know, there were lots of things we wanted to do.

Hendrie: But I'm thinking about when you got started, just, you know, how did you figure out what the original spec should be? I understand as you get out into the field, you get product managers.

Maxfield: Sure, oh, okay. Well, the original spec was pretty easy, because, first of all, you know, we knew we couldn't do everything at day one, but we figured you got to get- you know, the question is how much do you have to get done in the original product? Well, the first thing we did was say, well, it's got to do everything any other PBX on the market has ever done, which, you know, there was a reasonable set

of features like forwarding. You know, you could forward a call to another extension. Conferencing, call back, transfer a call from, with or without voice announce, you know.

Hendrie: Yeah, yeah, yeah, okay, full of features.

Maxfield: All- full features.

Hendrie: A whole bunch of that stuff. Yes.

Maxfield: And then we tried to think through, well, what are all the other things that we can think of, because we've got a computer in here, and therefore it's a lot easier to do all these things that everybody else was doing with hard wired logic. And, you know, things like- and the least cost routing thing was something that we, you know, actually people had already started doing things. But, you know, there was a thing called a WATS Box that came out just about the same time our PBX did, where they had a whole separate system. It would sit between the trunks coming in and the PBX, and actually do least-cost routing. So the ideas, a lot of these ideas, were floating around, some in stand-alone products and other things.

Hendrie: Yeah. So you didn't necessarily have to think of them from whole.

Maxfield: Yeah.

Hendrie: Come up with them from whole cloth.

Maxfield: Now, the other thing though, of course, that the marketing guys did, that Dick Moley in particular did, was spend a lot of time going out and talking to customers, even before we finalized the design. And he would run a lot of these ideas through 'em, and then find out which ones seemed to resonate the best. So basically, you know, it was a matter of picking what we thought were the best ideas, and we thought we had sort of all the really great ideas, you know. I mean, there were a number of 'em that we said, "Well, okay, well, there's this set that's gonna be in Release One. And Release Two is the rest of 'em. And that'll come six months later." And we thought that would be it, you know. We thought, well, you know, "We'll get it all done." And it's fortunate that it's one of these things, you know, that innovation you just never know where it's going, you know. The ideas come out, and you just keep finding more and more things. And that turned out to be a real blessing, because the reason we were able to stay really competitive and grow our market share as rapidly as we did, is because, first of all, we came at it from the point of view of a computer company with multiple releases, you know, new product introductions every six months or a year, mostly software, but a lot of hardware, too.

Hendrie: And because it's software, you could do that.

Maxfield: Yeah. And this was something that although when we hit the market, AT&T hit the market with a computer controlled PBX called the "Dimension," and Northern Telecom hit the market within, these were all within months of our announcement.

Hendrie: I was going to ask what the competition, competitive.

Maxfield: There were two big competition, two big competitors, that hit just about the same time. Northern Telecom actually had, not only a computer control, but a digitally switched PBX. And those were the two. There were really no other technological competitors for couple of years. But there were a couple of major things. One was Northern's switch was targeted at the high end of the market. So it was, you know, it was not cost effective below about a thousand lines, a thousand telephones. Whereas ours was cost effective from about a hundred to eight hundred telephones, our initial product. And so for awhile we didn't really compete head on with Northern Telecom in the early days. AT&T, theirs was more in the hundred to four hundred line market, which was a big chunk of our market. They had, however, chosen analog technology. They had a digital computer in there, but it was analog switching, which in the early days didn't matter at all.

Hendrie: I was gonna say, did it matter?

Maxfield: Nobody knew. The customer didn't know the difference. But we were able to make a big deal out of it from a marketing point of view.

Hendrie: Ah, okay.

Maxfield: And so the way we were able to position ourselves against AT&T was, well, you know, they've got last generation technology. So Mister Customer, you know, here's all the future benefits that are coming with digital technology, and we talk about data, data communications, or whatever, you know, all the things that we could do. And that helped us. I mean, because obviously competing against AT&T, being a little guy, it was a huge competitor. But we were able to- but the other thing was AT&T, of course, was a company whose idea of doing a new product was, well, every five years you think about it, you know. I mean, 'cause they came out. The old line telephone companies, you didn't do new products all the time, you know. The technology didn't change much. So I think AT&T's product development process was just not geared to just keep turning things out. And we were, and so what happened was, we kept coming out with new things, you know, the ACD feature, the CAS feature, doing this, doing that.

Hendrie: Right. And so your product looked better and better and better.

Maxfield: And we kept looking better and better, and they were having a hard time catching up with us, and so we were able to, because of finding these new things to do, we were able to really increase our market share dramatically because our competitors really weren't used to doing this. And eventually they did, of course. You know, they figured it out.

Hendrie: They figured out we have to learn how to do it.

Maxfield: After a few years, but in the meantime, we were able to go from essentially zero to the number two market share, to AT&T and the whole PBX business.

Hendrie: Wow. Now, were you able to have a price advantage with AT&T, and did AT&T- two questions. And did AT&T sell their Dimension system?

Maxfield: No. No, they didn't sell their Dimension system.

Hendrie: Okay.

Maxfield: I think maybe in the later years, after a few years, I think maybe they started- my memory's a little hazy.

Hendrie: Yeah, okay.

Maxfield: But basically it was a rental system, so that was another differentiator that we had.

Hendrie: Okay.

Maxfield: So the net of it is that from the time period from about 19-- we first introduced the product in '76. Up 'til about 1980, we went through this huge spurt of growth at the company. You know, this product went from being, you know, nothing to the majority, you know, ninety percent, eighty percent of the company's revenues. The MIL-SPEC computers continued to grow quite well, too, but this just- this just.

Hendrie: They were just- they were overwhelmed.

Maxfield: This was the tail wagging the dog.

Hendrie: By the success of it. Yeah.

Maxfield: So that presented a lot of interesting challenges of its own, because as I talked earlier, I mean, our sales went from like, you know, over a period of years ten, twenty, fifty, a hundred, two hundred million. And therefore all of just the issues of the number of people it takes to manufacture the products, the facilities. You know, in one year, the division-- oh, at this point in time, in early '77, just as the product- the product really took off in about 1977 in terms of suddenly the orders just went through the roof, 'cause what happened was if you-- we got enough of 'em out there that the word of mouth started to spread, especially among national accounts. And all of a sudden a lot of the big companies were, you know, wanting to buy ten and twenty of these things at a time, and suddenly our orders were outstripping our ability to produce. So we went through the kind of problem you like to have in business, which is we got more orders than we can handle, so the manufacturing challenges were interesting. And Wayne Mell, who was the head of manufacturing of our division-- at this time, by the way, by '77, the company had divisionalized, and so we had the MIL-SPEC Computer Division, and the Telecommunications Division. Before that we had been functionally organized, so that you had VP marketing, you know, and then VP engineering, and each had subgroups. And obviously in two completely different businesses that doesn't make sense. So we divisionalized, and I became the General Manager of the Telecommunications Division, and <cough> excuse me, Leo Chamberlin, who had been the Marketing vice president, became the general manager of the Computer Division. So this Division went, and one year I remember we had five hundred people in the Division at the beginning of the year. At the end of the year we had fifteen hundred people in the Division. And we had, at the beginning of the year, we were spread over, I think, three different buildings, but all on the same site, because by then we had bought a piece of land, or had developed a piece of land that we could build a number of buildings on, sort of a campus-type environment. And we had built the first couple of buildings, three buildings. But then things grew so fast that we couldn't build new buildings fast enough. At the first of the year, we were spread over three buildings, and by the end of the year we were spread over nine buildings all over town, you know.

Hendrie: Yeah. You just had to find any space you could, because.

Maxfield: So those were fun times, you know, hiring mainly in the manufacturing area, because in those days, remember, we didn't outsource stuff, you know. I mean, we built, we stuffed our own PC boards.

Hendrie: You wave soldered them.

Maxfield: Yeah. We wave soldered 'em.

Hendrie: Wow.

Maxfield: And built the cabinets, and, you know, did all that stuff. So that was a real challenge, and Wayne Mell absolutely did a fantastic job. In fact, one of the interesting techniques he did, which was very unusual, is rather than just keep building a bigger and bigger manufacturing line, you know, bigger this, bigger that, he created a module, production modules that sort of operated in parallel. So there might be four different lines all building the CBX products, all the same identical products, a different guy running each line. And that allowed people to experiment with better ways of building it, testing it, getting it out faster, solving problems. And so there was a lot of innovation on the manufacturing side, as well, and a lot of advanced automated testing technology that they developed to test the products instead of having, you know, a technician out there, having to train a bunch of technicians.

Hendrie: Yeah, okay. Can we just take a pause?

Maxfield: Yeah.

Hendrie: I'd like to talk a little bit more about that, but we need to change the.

Hendrie: Alright. We're back on. Let's see. You were just talking about some of the manufacturing issues, and sort of how you- some of the concepts.

Maxfield: Yeah. So Wayne, you know, came up with this modular technique, which worked out well, because when things got to the point- we got to the point where expanding in the Bay Area was a real problem, because the cost of living here is very high relative to other areas. And so we decided that we needed to start moving some of our production outside the Bay Area. And we looked around and wound up deciding to build a plant in Colorado Springs. And because we had this modular concept of manufacturing, it turned out to be very easy to do, you know. We just set up a- took one of our- one of the guys that was, or a small team of guys that had been running part of one of the lines that wanted to move to Colorado Springs, and a couple of guys is all we needed. And they hired a bunch more there, and then we started building PBXs in Colorado Springs.

Hendrie: Wow.

Maxfield: So, you know, Wayne did a lot of things that got us through a very, very rapid ramp up without losing quality, and we were able to keep up with our orders so we didn't lose market share.

Hendrie: Didn't lose customers. Yeah.

Maxfield: So, yeah, during this period, we talked a little bit about the features and the software evolution that we did. But the other thing that we did was, I mentioned that the initial product was targeted at the one hundred [to] eight hundred telephone market.

Hendrie: Yes.

Maxfield: And obviously there's a lot of market on both ends of that, as well. And so we began expanding the product down in size by just trying to insert new technology, get the cost down, and package it for a smaller market, and then also move it up to larger line sizes. And ultimately we wanted to sort of cover the whole market, which goes up to multiple thousands of lines. But the problem there was that to go to larger systems, we were running out of computer capability, because remember the computer that was built, put into this thing, was a sixteen-bit Data General machine.

Hendrie: Yes, an expanded version of the Nova.

Maxfield: No. I mean, it was our version of, or actually about a third generation version based on the Data General instruction set, you know. It wasn't a Data General computer, because we were developing our own by then, the very first product. I mean, it had the same instruction set, same put out, and all that.

Hendrie: And you moved to the Eclipse level of instruction set?

Maxfield: No.

Hendrie: Or some of the expanded ones. You just stayed plain development?

Maxfield: No. No. Because that didn't buy us enough. I mean, what we decided was that, and this, now we're into about 1978, where we were doing well. We're growing fast, and we want to move up to larger line sizes, but the problem is we needed a thirty-two bit machine. I mean, we needed a lot more addressability. I mean, we needed a lot more everything. And so in about '78, or '77, maybe, I forget when, we decided to undertake what turned out to be the most ambitious technical project we ever did.

Hendrie: Oh.

Maxfield: Almost, almost sank us, but we managed to pull it off. But we decide, okay, we're gonna invent, we're gonna do a big PBX. So the things that we did, all in parallel, was we designed it from scratch, a thirty-two bit processor, computer. Now, remember this is before microprocessors. We

couldn't go out and just pick up an [Intel] 80386 or whatever. So we did a thirty-two [bit] machine based on the four-bit slices. You remember the old four-bit ALUs?

Hendrie: Oh, yeah. Is this a TI product, or the more integrated one? AMD had some.

Maxfield: AMD, I think.

Hendrie: AMD had a four-bit.

Maxfield: Yeah. And you'd take, if you want a thirty-two bit machine, you'd take eight of these things and you put 'em beside each other, and then you put a bunch of stuff around it, and they can do adds and subtracts, and all kinds of functionality. So we invented the instruction set to go with that just from scratch, just for the kind of stuff that we needed to do in the PBX, because, of course, when you think about it, running a telephone system is very different than most computers, than the stuff most computers do.

Hendrie: Yeah, right.

Maxfield: And so to really have a processor optimized for doing the things that a telephone system does. It's not- you know, in a lot ways you would not want it to do things that a counting computer would do. But so, you know we, with a clean sheet of paper, we could sort of do some interesting things. And then we said, "Well, what we need to do is develop a programming language to go with this," and it can't be just any old programming language, because most programming languages are not oriented toward real-time systems, you know. They're oriented toward other things.

Hendrie: No, they're not- yeah, exactly.

Maxfield: And so we needed what we called a systems programming language, and there were such things around at the time, but we decided we'd invent our own.

Hendrie: Do you remember what the options were?

Maxfield: No. I don't remember all the fine details, but things like data typing, and things like bit manipulation, and all kinds of issues down at that level were very important, and I don't remember all of that.

Hendrie: Now, were you going to write your own operating system for this also? I mean, you obviously did a lot of application code.

Maxfield: Oh, yeah. Oh, yeah. I mean that was a given. Yeah. The operating system, the programming language.

Hendrie: And so you were all gonna do it in the systems language?

Maxfield: Yeah.

Hendrie: Or were you going to write the operating system in assembly?

Maxfield: I lose track of. I'm sure there was a kernel of something there. But anyway, so, I mean, it's sort of interesting that we'd been at this for quite awhile by then, you know. We'd been in the computer business. We'd been in the PBX business, and we were still rather naïve in terms of, you know, how hard things could be, you know, or maybe we were a little overconfident. I don't know. But the other thing was that- okay, then the question was, well, even if a thirty-two bit machine, it couldn't handle, you know, multiple thousand lines. You needed multiple processors.

Hendrie: Yeah. I was gonna say.

Maxfield: So we came up with an architecture, a distributed architecture, multiple processes, processors, in a peer-to-peer network configuration, and the interconnections, fiber optics, forty-four megabit link, fiber optic links, and many, in many cases, 'cause you're not just communicating data. I mean, you're pumping all the voice bits around the whole network. So all of these machines were gonna be in a peer-to-peer architecture, and operate and function to the user as one system, and be maintained as a single system. And we set out to do that, and the idea was you could then build up from, you know, just one node, which could be several hundred lines, to I forget how many nodes, maybe sixteen in total, maybe several thousand lines.

Hendrie: And you maintained the redundancy concepts, of course.

Maxfield: Redundancy, yeah, redundant processors, redundant links.

Hendrie: Yep, all of that. Okay.

Maxfield: The whole nine yards. And, you know, it was about a year late and, you know, the first few months the first few were in, we had some real, real horror stories and learned a lot, but we got it working, and it worked. And in retrospect, you know, the number of things that we were doing simultaneously were just mind-boggling.

Hendrie: Exactly. Wow.

Maxfield: So that was a very trying time in itself, just, you know, took a lot of resources to get that project done.

Hendrie: Well, you must have had some very good people, though.

Maxfield: Oh, yeah. We had, yeah, great people. The software guy, Dave Ladd. Dave Ladd was the second software guy that we hired. The first guy was-- way back in the early days, the first guy was Steve Plant, who had been in the MIL-SPEC Computer Division, and was the one MIL-SPEC guy that wanted to move over and do the piece. So Steve Plant was the original, key software guy on the first release of the software.

Hendrie: Did sort of the architecture.

Maxfield: Yeah. Well, Dave came on about the same time, so Dave and Steve together did that. And then the VL software was pretty much Dave's thing, and then another guy, Jim White, who came in and was also a key guy as the project got underway. And then we had great hardware guys. I mean, it was a great team of guys, but, boy, you know, [there] was a lot of work to do. And Jim Cassidy was the VP of Engineering, you know, over the whole thing, got a lot of grey hairs over that one. So by the end, by the late '80s, we could, you know, we had a competitive product line all the way from maybe forty phones up to many thousand phones, and all compatible.

Hendrie: Wow.

Maxfield: All the features compatible on all of 'em. So, you know, by about 1980, '80, '81, we have gone, you know, sort of up this big ramp. We've gone from nowhere to the number two market share in the whole PBX market. One other thing I didn't mention along the way was, of course, we attracted a lot of attention because obviously during this time, our stock price was going through the ceiling, you know. And, in fact, to back up a little, we went public.

Hendrie: Yeah. When did you go public? Yeah. I don't think we talked about that.

Maxfield: In September of ’76, which was- ’76, yeah, ’76, which was we had been in production on the PBX for about a year, but it was still, you know, the jury was still out. We were having a lot of problems at that time, too. And we went public not because we needed the money, because we really, we didn’t think we needed the money, although, you know, our projections for ramp up and stuff.

Hendrie: For inventory, yeah, for a hardware business takes a lot of capital.

Maxfield: You know, it was a little iffy, so we just- but we really went public just for the visibility, because we, you know, we were competing against AT&T, and anything we could do to get visibility out in the financial market, the world at large, would help. And so we raised three million dollars in the initial round, is all we raised in the first public offering.

Hendrie: So you sold- how much of the stock did you sell? Do you remember?

Maxfield: Oh, it was just a few percent of the company at that point. I’ve forgotten what the value initially was.

Hendrie: So it really was not.

Maxfield: Yeah. It was- it was.

Hendrie: You were trying to raise money.

Maxfield: Yeah. We were trying to raise a huge war chest.

Hendrie: Yeah. You weren’t trying to- the founders weren’t trying to get liquid so they could leave.

Maxfield: No.

Hendrie: None of those things.

Maxfield: In fact, yeah, I mean, you know, it was nice for the founders ‘cause we could start selling a little bit but, you know, nobody just cashed in and bailed out. And the other thing was the year before we had actually raised an additional million dollars of venture capital, which I don’t remember if I mentioned it last time.

Hendrie: Oh, no, I don't think so.

Maxfield: Okay. You know, we had our original venture capital round in 1969, when we had the original MIL-SPEC Computer done.

Hendrie: Yes, right.

Maxfield: And that was six hundred thousand dollars, three firms that got about fifty percent of the company for that. And that was all the money we needed. We were profitable our first quarter after we started shipping computers, and profitable ever since. And then when we did the original business plan for the CBX product, the plan said if it all went well, we still wouldn't need any money, because we had a very profitable computer business. But we decided that it might make some sense, just to be careful, to raise an additional million dollars of venture capital. So we did do that in 1970…, maybe early '75, just before we started shipping the product.

Hendrie: Who'd you raise that from?

Maxfield: That came from a firm called Technology Venture, TVI, Technology Venture.

Hendrie: TVI, yeah, sure.

Maxfield: It was Burton McMurtry.

Hendrie: Burt, yeah, Burt.

Maxfield: But I'm not sure it was called that then. I think that was the early.

Hendrie: In '70, though, that was.

Maxfield: It was Reed Dennis, Burt McMurtry, a couple other guys.

Hendrie: Murtry and Burge Jamieson and one other guy.

Maxfield: Yeah, Burge Jamieson, yeah.

Hendrie: No. It was AVI, I think.

Maxfield: AVI. I believe that's it.

Hendrie: I think it was AVI. Yes.

Maxfield: And so, in fact, they had just formed that firm.

Hendrie: Yeah. It was formed in '74, I think. Yeah.

Maxfield: And we were the first. I think we were about the first investment that they actually made.

Hendrie: Who went on your board?

Maxfield: Burt went on the board.

Hendrie: Burt went on the board. Okay. It was a Burt deal.

Maxfield: Now, I probably haven't told you this story about how Burt fits in with all of this.

Hendrie: Okay. No, you haven't.

Maxfield: I never did. Well, that's another- well.

Hendrie: Yeah. Well, let's just take a little time.

Maxfield: If you've got time.

Hendrie: I have time. Stories are very important, are good.

Maxfield: Well, the story of- Burt McMurtry rates a special story, and at some point maybe you ought to interview him. Burt graduated from Rice in the '50s. Came out here, went to Sylvania, and got into lasers. Got his PhD working on the co-op program, and then came back to Rice every year after he started working at Sylvania, and would recruit the top two or three guys out of the Rice EE class to come

work for his group at Sylvania. And the attraction was you could come work. You can do fun stuff in lasers, or other things in Sylvania. I'll help you, you know, if you want to do something else, and you can get an advanced degree at Stanford University going part-time on the co-op program, and Sylvania will pay your way if you could get in Stanford, and so forth. So Burt, over the years, from the late '50s through about, you know, the mid-'60s, recruited.

Hendrie: He's sucking out the cream of the crop.

Maxfield: Some of the best guys, and in fact, and so Walter Longstern had come out here, was working at Sylvania. A lot of other guys, Don Caddis and some other guys, who all had been successful entrepreneurs, as well. But in particular, he recruited the year before I graduated, he recruited Ken Oshman. It was a year ahead of me at Rice. And then when Ken got there, the next year Burt was starting to then delegate responsibility. So he assigned Ken the responsibility to recruit me out of Rice, and so Ken and his wife, you know, wined and dined me when I came out to visit, and I had known Ken a bit at Rice, but not too well, 'cause he was...

Hendrie: Not in your class.

Maxfield: Not in my class. But I didn't go to Sylvania. I went to IBM instead, as I said last time. So that was one of the few failures Ken has ever had, I think. So that was great. But so as it turned out, you know, both Ken and Gene Richardson, who was in Ken's class, and Walter Longstern, had all- the reason we were all there was originally Burt McMurtry, who had come back and just kept taking people out.

Hendrie: Oh, my God. Yeah.

Maxfield: So now just as we start ROLM, you know, we found the venture capitalist, Jack Melchior, who was gonna do it. At that time Ken is still working for Sylvania for Burt. And Ken goes in to Burt, and says, you know, I probably have this a little wrong. We'll probably get it right when you interview Ken. But he went in to Burt and said, "Well, you know," and he had told Burt along the way that, you know, "I'm probably gonna leave and start a company." It wasn't any surprise, but he went in and said, "Well, Burt, you know, I've got my company going, and I'm gonna resign." And Burt said, "Good, you know, fine. That's no problem." And I'm not sure of the details here, whether Burt already knew or he found out later, but it turned out that unbeknownst to Ken, Burt had also been thinking about doing something different and had been talking to, about thinking about getting into venture capital, and had been talking to this guy named Jack Melchior, who had agreed to hire Burt to go in to work with him at exactly the same point in time.

Hendrie: Oh, my goodness.

Maxfield: And I don't think, you know, Burt was not involved in- he didn't know anything in detail about that Jack was talking to us, I don't think. But anyway, so the interesting thing is that Burt went into venture capital with Jack Melchior right at the time that Melchior made an investment in Ken's company.

Hendrie: Oh, my goodness.

Maxfield: And so then Burt then worked with Jack for several years, and then went off with Burge and Reed Dennis and started AVI a few years later.

Hendrie: Isn't that- oh, wow.

Maxfield: And then came on our board as the representative from AVI on our board for several years.

Hendrie: Very good. And Jack Melchior, did he stay on your board?

Maxfield: Oh, yeah, Jack stayed on the board.

Hendrie: Yeah, all through the- okay.

Maxfield: So anyway, so Burt really, you know, if you were to trace all of the people that Burt got out into this area, and all the companies, of course, he's invested in over the years...

Hendrie: You'd find there's a lot of connection there.

Maxfield: There's a lot of connection. He's a great guy. Okay. So where were we here? So we went public in '76, and then, of course, these things being the way they always are, the very first quarter that we had after we went public was a bad one. So, you know, you can't predict these things, and so the stock went out at about, I think it was fourteen, and within a few months after the first quarter that we reported, whatever, it was down to about ten. And it stayed around ten for quite awhile, maybe another almost a year, because we were sorting out our problems. But then the orders started coming and ramping up, and so the stock was a real darling of the market for the next several years.

Hendrie: And there wasn't that much of it out there, either, in one sense.

Maxfield: Yeah. Well, yeah. And along the way we did a couple of additional offerings.

Hendrie: You did some secondaries.

Maxfield: To raise some serious capital, some secondaries, yeah. So we needed to finance the business, 'cause we were growing so rapidly. But the interesting thing is, of course, at that point, once everybody says, "Wow, this is great," a lot of venture capitalists said, "Wow, that's a great market." We need to, you know, there's not that many players there. ROLM's the only new kid on the block. Everybody else is a bunch of old line guys that are...

Hendrie: Old fogies.

Maxfield: Yeah. You know, and we got a bunch of bright engineers. Let's go fund some companies. So actually at least two companies got funded, big-time money. I mean, in those days thirty or forty million bucks.

Hendrie: That was really big-time money.

Maxfield: In the late '70s to come after us. And the interesting thing is that.

Hendrie: What were those companies?

Maxfield: Well, I was just trying to think of those a little while ago. One of 'em was actually- one of the competitors was actually an old line company, but a small one, called Wescom, that I think got some additional funding, but there were two. One was called, I believe, CXC Corporation. The other one was on the east coast, and that name has just- I just can't drag it up. But the interesting thing was that those guys, because they were starting about three years after we had started the hardware design, they were a little bit more up on the hardware technology curve, so their hardware was a little bit more advanced than ours, and potentially cheaper and, you know, smaller, and all this. So anyway, they were a real threat from the hardware point of view, but they failed. And the reason they failed is software, because the problem wasn't so much that they couldn't do what we had done. It's that they couldn't catch the moving target, 'cause you think about it, you know, it takes a couple of years to do a product from scratch, and so obviously what they did was they looked at our specifications for everything we had in our product when they started out. And so two years later, when they came to market, they had what we had two years before, but by then we had all this other stuff. So they were unable to keep up on the functionality, and they were never able to really get traction because of the cumulative software advantage. At least that's my take on it. And, of course, by then we also had well-established distribution channels that were very loyal to us. The interconnects that we had weren't about to go jump ship with someone else.

Hendrie: The classic problem. Somebody who has, you know, lots of momentum, you know, is well managed, has dominant market share, at least my experience is that you've got to be different, significant difference.

Maxfield: Yeah, big difference.

Hendrie: You got to have a big difference. Just being better won't cut it, 'cause nobody cares. They're gonna- by this time everybody's gonna buy your product 'cause it's the safe thing to buy.

Maxfield: Yeah. Yeah, by then we're the safe buy.

Hendrie: You're the safe. You're the IBM. You're the safe buy. So anyway.

Maxfield: So that takes us up, you know, so now we're king of the hill, you know, 1980, '81, and it was a great ride. And so now sort of segue into the time period from about, you know, 1980 to '83, thereabouts.

Hendrie: Well, before, yeah, couple of questions. Tell me a little bit more. Give me a little bit more flavor about, you know, you did a system implementation language. I mean, it was just for you, so you just had to maintain it, and you wrote the application, fundamentally wrote the application in that for the new machines.

Maxfield: Yeah, right.

Hendrie: Okay. Yeah. Alright. And you never had any intention of it going anywhere else.

Maxfield: No.

Hendrie: It was just in-house, an in-house scheme.

Maxfield: Yeah. It was called "RPL, ROLM Programming Language."

Hendrie: Okay, alright. Okay. Good, okay. I just want to make sure.

Maxfield: Yeah, yeah. We didn't.

Hendrie: You weren't.

Maxfield: We weren't gonna go into the operating system business or any of those things.

Hendrie: Or any of those things. Yeah. There was no need to do that. Okay.

Maxfield: It was just our own set of tools. And, of course, if we had done all of that, maybe as little as four years later, we could have picked up all this stuff. You know, there were thirty-two bit microprocessors that would have had the same performance. We could have picked up, you know, the languages I'm sure advanced, and there were languages we could have picked up. But at that point in time, we were right at the edge of when everything started to become standardized, you know, microprocessors.

Hendrie: Exactly.

Maxfield: The ROLM phone.

Hendrie: Unix wasn't that.

Maxfield: Yeah. Unix, we could have done a real time Unix. Picked that up perhaps, would have been one option. And, in fact, yeah, 'cause AT&T was using Unix in their central office switches, I believe.

Hendrie: Yeah, exactly.

Maxfield: So, I mean, Unix could be used as a real-time operating system.

Hendrie: Back in the MIL-SPEC days, what operating system did you sell? Did you have a license for Data General software?

Maxfield: Yeah. We had a license for all of Data General's stuff.

Hendrie: So you used RDOS.

Maxfield: RDOS. And we did invent RTOS, Real Time Operating System, non-disk based for same kind of reason, a, you know, small, embedded computers, embedded in systems. So, yeah, we did our own flavor of a real-time operating system, very small, you know, core-based or memory-based.

Hendrie: Yeah. For something that was flying.

Maxfield: Yeah, yeah.

Hendrie: That didn't have a disk or drum in it.

Maxfield: Yeah.

Hendrie: Okay.

Maxfield: But you could use RDOS as your development environment, and we made a lot of the calls compatible so, you know, you could sort of run it under RDOS, and then you could strip it down and not do too much to it, and run it under RTOS in the application.

Hendrie: Cool. Alright.

Maxfield: So after we sort of got through- so then we sort of started running out of-- this is now around 1980. We're starting to run out of pure voice applications that we had, you know, that we hadn't thought of. We've now done most of what we could, you know, what the customers wanted. We could enhance 'em a lot, and all. We had covered the line size from forty to multiple thousand lines. And so then the question is, well, what's next, you know. How do we keep running fast? And now we get into, well, the merging of voice and data, you know, back to.

Hendrie: Oh, yes.

Maxfield: And, well, there was one key thing that we did, probably the next best thing that we did. Well, I talked about the ROLM phones. That turned out, you know, in the late '70s, early '80s, that was huge, because that set us apart again from our competitors, because the functionality and the cost point. You could get a real, fully featured, neat phone that had data capability and everything else for no significant premium over just a plain, brown phone.

Hendrie: Right. And you had the technology and the volume to do that.

Maxfield: Yeah, yeah. For example- yeah. And in fact, we designed that. That was another key challenge, because although we were building lots of PBXs, not like we were building millions and millions of anything. But if we were gonna- if we could sell- if we could get the customers to buy our telephones and buy almost all the phones in their system from us instead of buying a bunch of plain, brown phones, and a few feature phones, we're talking huge volumes. So we had to design the Rolm phones to be high volume manufacturing day one, which wasn't something that was a real expertise of ours. And so, you know, we got some of our best guys and said, "Okay, guys, we're gonna do this, and we're gonna do it right. We got to design it for manufacturing. It's got to be low cost, 'cause we're gonna price it." The other strategy we had was we're gonna forward price this thing, you know. Rather than waiting for the volumes, you know, chicken and egg on building volumes, we said- I forget what the price point. Well, I think it was something like ninety dollars installed. That included the interface in the switch and the whole thing, as opposed to several hundred dollars for others. And we're gonna price it. You know, what do you think you can build this for in large quantities two years out? Okay. We're gonna price it on the basis of that.

Hendrie: Okay. Yeah.

Maxfield: And we made it, and we just did it. And, you know, we were gonna lose money on the first ones we bought, but we had to get the customers. We had to ramp up the volume. And the guys, you know, it worked great. It was the most successful project, one of the most successful projects, I mean, because they got it done. It went into production. It worked. The feature design, the human interface that the product marketing folks had done for the phone, was right on. They got all the features just right. In the first year we sold something like seventy million dollars of these telephones in the first twelve months of production.

Hendrie: Oh, my goodness.

Maxfield: And, you know, the whole division was doing maybe three or four hundred million by then. I mean, so it was huge, just this one new product. Boy.

Hendrie: Wow. Right out of the gun. Now, did you manufacture it on the same lines?

Maxfield: No. We set up a special line, and we had, you know.

Hendrie: But you still did it domestically.

Maxfield: Yeah, yeah. We did it in-house.

Hendrie: Okay.

Maxfield: And, you know, had all kinds of automatic insertion machines, and lots of new equipment, and test equipment, and so forth. Yeah, the team that did that was great. Guy named Ken Laveso [ph?] was sort of the honcho, and the manufacturing guy was Dirk Spese, and the product marketer was a woman named Kathy Holman, who many years later became my wife actually.

Hendrie: Oh, alright. Okay.

Maxfield: So that was a great project.

Hendrie: Cool.

Maxfield: So let's see. Then, okay, so that was 'phones. Now the next- another great product we did around the early '80s was what was called "Phone Mail," and that was voice messaging. That was another capability that had just started to come. There was a company called.

Hendrie: Octel [ph?].

Maxfield: No. This was before Octel. Voice- Voice Mail. They were in Dallas. But anyway, they had done a voice messaging system. It was a stand-alone system, and it was designed to be sort of a service bureau thing. You called into it to get your messages. And so if you called in, you had to- and the big problem with the concept was you had to dial in to something to find out, and go through your access code, to find out, no, you don't have any messages. And so that was a real problem, you know, in terms of acceptance. And so we decided, well, what we're gonna do is add a box that's gonna be well integrated functionally with the PBX. It would have disks in it and would do the voice compression, and do all of the what's now everybody knows as voice messaging. We called it "Phone Mail." And it was an adjunct box that plugged into our PBX, but was integrated in terms of functionality. And that turned out to be a wildly successful product, as well. And it was another one of those cases where there was an opportunity there to do a product to go with anybody else's PBX, as well. But because of our sort of unique position, we were conflicted, because if we sold the phone mail system to go with other peoples' PBXs, it would help them compete with our PBX, and so, you know, on the one hand there was a faction that didn't want to do that. On the other hand, we also- the difficulty of interfacing with a bunch of other PBXs, 'cause there weren't standard interfaces.

Hendrie: Yeah, of course, yeah.

Maxfield: Like there are now. And so it turned out that we did quite well, but it was basically limited to voice messaging on our PBX base. And so the whole rest of the PBX base was up for grabs, and other companies came out, like in particular Octel, came out with a nice product that would cover the other bases, so there was room, and they became a very successful company, as well, you know, doing a more generalized voice mail product. So that was the early days of voice messaging, and that was a lot of fun.

Hendrie: Wow. Okay. So you kept coming up with these innovative ideas that somehow...

Maxfield: And then the next, sort of the next phase, was the quote- all this was sort of tied together, as well, but there was this thing we called the "Office of the Future," you know, the merging of voice and data.

Hendrie: Yes.

Maxfield: The paperless office. There were statistics floating around. For example, the number of office workers had crossed- had overtaken the number of manufacturing workers about that time, as I recall. And it was a buzz word, and everybody knew that the paperless office...

Hendrie: Was coming, of course.

Maxfield: And, of course, to us

Hendrie: The HP printer division shows you that it didn't get here, did it?

Maxfield: Yeah. They're still talking about this.

Hendrie: Right.

Maxfield: Well, in our- the way we describe it, a lot of it was integrating voice and data, which of course, today is still being talked about. Now we're talking about voice over the Internet.

Hendrie: Right. And it may get integrated.

Maxfield: And maybe some day, you know, it will.

Hendrie: Backwards that way, right.

Maxfield: Yeah. So, of course, and our version of that was, okay, we want to own the desktop. We already got the phone on the desktop. Let's own the terminal on the desktop, because everybody owns a terminal. People were staring to have terminals connected to minicomputers, and the terminals were all basically the same. They were just keyboards and a display. So we said, "Well, why don't we do integrated voice data terminals," so that you have one nice looking terminal, and it's got a screen, and a keyboard, and a handset. And it'll connect via ROLM Link, back to the PBX, and then the data part will go wherever you want it to go. And that'll be our next big thing. And so we did. We developed a series of things. The first thing we did actually- I'm not sure which one we did first. I guess the first thing we did was probably a terminal called "Cypress," and actually if you want to cut the tape off a second, I think I've got a picture.

Hendrie: Absolutely.

<crew talk>

Maxfield: So this was the Cypress terminal, and it had a display. It had essentially a telephone keyboard. And down here was a pullout, full, regular keyboard, a data keyboard you could pull out, and then the integrated handset. And then, of course, this connected back to the PBX via ROLM Link, which was a single twisted pair with both voice and data on it. So the idea here was that you could integrate, lots of possibilities. You could have a directory of numbers you could call and, you know, just call 'em up on the screen, and punch a button, and so forth. Or you could use it as a data terminal and connect to any computer in the network. And we sold a lot of those. And then the next version, this was remember about the time that the IBM PC hit the market, in the early '80s. The Apple PC has been a wild success in the late '70s. IBM has just entered with the PC, and is now making big inroads. And so the next idea we had was this is great but let's make it a PC. And so what we did was- and unfortunately I don't think I have a picture of that one handy, but it was a terminal. It was basically the same look, except it was a little thicker, because buried in it it had an IBM- I mean, an Intel whatever it was at the time, 80286, I guess it was.

Hendrie: Yeah.

Maxfield: It ran DOS, you know, we licensed DOS from- because the PC was an open architecture, and even I think at this time Compaq even was already on the market with their machine. So we did an IBM compatible called "Mesquite," which had two floppy disk drives, five and a quarter disk drives.

Hendrie: Oh, wow.

Maxfield: One maybe, or two. I've forgotten. And memory, and it would run. It would run PC applications.

Hendrie: Yeah, anything.

Maxfield: And, of course, we had some special applications for like the phone list and things like that, so that you could run that. And, again, it could talk over the network. The interesting thing there was, and we sold some of those. The problem there, of course, which the rate, you know, the thing that I guess in retrospect was obvious, but we didn't really think too much about it, was that when you had a company like IBM with an open architecture, and a lot of guys out there jumping into this huge, new market, we weren't gonna be able to keep up with the functionality of a PC based in this terminal, 'cause we simple couldn't afford the product development to keep, you know, moving at the rate the PC industry was.

Hendrie: Exactly.

Maxfield: And so within about a year, you know, ours was essentially, was an obsolete. It was nice, but as a PC it was obsolete. Well, with some people, you know, years later, I would see people had this thing- had the Mesquite terminal on a desk, and next to it was a PC, because they still used the voice, integrated voice data functionality of their Mesquite terminal with their phone list and all of that.

Hendrie: Oh, wow.

Maxfield: So that was our. And then the other thing we did about the time the IBM PC came out, is we did a card that would plug into the PC. If you wanted to just have a handset and a real PC, then it would plug in and do essentially the same functionality as the Mesquite terminal, only the PC part was a real PC. And so we did those things. We were also working on, you know, again, electronic mail at that time was new. I mean, you know, a few companies had it in some form or another. There was no such thing, of course, as the Internet at this time. IBM, for example, had a company-wide system called- the name escapes me now, but they actually had electronic mail intra-company worldwide, of course, mainframe based. But the concept of electronic mail, because everybody had terminals, and I guess some of the minicomputer companies had mail packages that you could do if everybody was connected. So we did an application called "ROLM Mail," where we actually had, where the switch itself would, if you had data terminals, you could type in text and it would save messages, and send them around the company. That was more sort of a prototype card that we launched to see what would happen. So that was the direction we were ready to go.

Hendrie: Yeah, exactly.

Maxfield: The direction we headed was not try to bury all that functionality in the processor that's running the communication system, but to have what we call application processors that would sit in the same room with the switch, but would essentially be stand-alone computers running applications that were integrated into.

Hendrie: Yeah. And so you could-

Maxfield: It was like electronic mail.

Hendrie: Yeah. So they were add on sales, and you could just plug 'em in, and you didn't have to worry about running all of these applications and making them all run in the communications, which could easily cause you some serious problems.

Maxfield: Right. As we got into this, I mean, what became clear, was that, you know, for a company like- I mean, we were getting to be a good sized company. Actually we were a Fortune 500 company about this time. We were number three seventy-six, or something like that I think we got up to.

Hendrie: And probably about how big in revenue by this time?

Maxfield: Close to a billion dollars in revenue.

Hendrie: Wow. Okay.

Maxfield: At the peak I think it was just under a billion. But we were still small compared to big computer companies, the IBMs, the Hewlett-Packards.

Hendrie: The DECs.

Maxfield: Yes. They were all after the same market, more or less. I mean, you know, now we're starting to get into competing against those guys. And, you know, we had very limited resources relative to them. The other phenomenon that was going on here was that, you know, I mentioned we had sort of run out of ways to differentiate ourselves as a PBX, you know. We were adding on voice mail. We were adding on terminals. In the meantime, our competitors, AT&T, Northern Telecom, although they had been behind us for a number of years, you know, eventually they caught up, because they hung in there, and they had the resources to hang in there, you know. They were monopolies. Northern Telecom actually made...

Hendrie: Telephone switches were a core business for them.

Maxfield: Yeah. And they weren't gonna relinquish that business, no matter what happened. So they hung in there all the way, kept enhancing their products, and enhanced it so that the differentiation got less and less. And they were willing to compete on price, if they had to, because they had the resources to do that. So it started to be a very price competitive marketplace. So we were getting squeezed, you know. I mean, we wanted to do things, but we were getting squeezed in terms of having the resources to do it. And so we started thinking, well.

Hendrie: Excuse me. Can we take a pause? Yeah. I think we're almost out of tape.

Hendrie: All right, we're back.

Maxfield: So I mentioned that, you know, we had price wars going on in the marketplace, another issue was that the market was not growing as rapidly as it had, because one of the dynamics is-- one of the key facts that people have lost sight of, from time to time, is that every business needs a PBX, that's the good news. I mean, any business of any size has to have a PBX. The bad news is, they only need one at each facility.

Hendrie: And they don't need a new one very often.

Maxfield: And they don't need a new one all the time, if the one they have can be upgraded, blah-blah-blah. So what made the market so dynamic, and what was such an opportunity for us in the '70s, was that we were turning over an entire install base of obsolete products, because there were thousands, and tens of thousands and hundreds of thousands of PBXs installed, that had been installed over a 50 year, 100 year, 50 year time period, all of which were obsolete, were made completely obsolete by the computer and eventually by digital switching. So what was going on was, that the reason it was such a great market was that everybody was replacing all those products. When you get them all replaced, the number of new facilities, each year, you know, new buildings going out, where you're throwing out, where you're literally adding a new building, is not that great. You know, it's two, three percent a year. And so, eventually, the market got fairly saturated, and so things were getting tight, and it was, you know, our problem was that our two chief competitors, both had monopoly profits in other businesses, were intending to stay in this business, and therefore it wasn't clear, how much longer we could really hold our own. You know, so and so we--

Hendrie: Yeah, and what you could do to, you know, you had grown partly by just replacing all these, but also by enriching, constantly enriching your product, and getting new revenue streams, like, you know, like voice mail, and phones, but--

Maxfield: Yeah, and so maybe--

Hendrie: And the PC was not-- did not look like it was going to explode like the rest of them, your terminal on the desk. That was pretty clear?

Maxfield: That would have been a niche market as well, just because it was uniquely tied to our PBX, and so--

Hendrie: But that-- how well did that do? How well did that product--

Maxfield: Well, we sold some, but as I said, you know, within a year or so, we just couldn't keep up, and so it sort of-- it was--

Hendrie: And even the integrated terminal, weren't they--

Maxfield: The integrated terminal stayed around for quite a while, because people that didn't need PCs, that, for example--

Hendrie: Had timesharing, yeah, had a minicomputer timesharing.

Maxfield: Lawyers, take lawyers, lawyers that want to get into the Lexus-Nexus database, it was perfect for them, because it was a data terminal, you know, so anybody who, all they needed was a data terminal and a telephone. And you know, it was a long time before everybody had to have a PC on their desk. You know, you remember, it was PCs--

Hendrie: Right, exactly, it took a long time. Okay.

Maxfield: But so we decided, okay, well the strategy then needs to be, what we have to do is strategic partnership with somebody, preferably one computer company. In other words, if we could get into some kind of a strategic alliance, where we could use the synergism between what we're doing and what those guys are doing, and keep driving this integration and all of the things that we wanted to do, but we didn't have the money to do, to develop, or the marketing clout to go sell, and so our idea was, well, let's go, let's go approach a-- see if we can do a real major strategic alliance with a major computer company. And we actually approached Hewlett Packard, because they were right in our back yard. They were a company that we had huge respect for.

Hendrie: Very well run.

Maxfield: In fact, we had sort of modeled ourselves on HP in the sense of-- and I'll talk about this maybe in a minute, in terms of the sort of, style and the culture of the company, and the kinds of things you do for your employees. You know, HP we just thought was a real model for that, and we knew a lot of guys at HP, and a lot of our employees had come from HP, and we knew them socially and so forth. So we approached HP, and had several discussions, high level discussions with Hewlett Packard, but--

Hendrie: Who was running HP at the time?

Maxfield: John Young was running it.

Hendrie: John Young, okay, it wasn't Lew Platt's regime, yet.

Maxfield: I'm trying to think. Yeah, John-- no, no, this was-- I believe it was John Young. But the guy that we dealt with at that point, and I forget exactly, I think he was one level below John, was Paul Ealey [ph?] and also Joel Birnbaum had just taken over HP Research about that time, and we had some discussions with his guys. And the net of it was that we-- everybody was interested, but we couldn't figure out a way that people were comfortable with, and so nothing came of it. Then, this is now, you know, a month or two or three later.

Hendrie: And what year is this, probably?

Maxfield: We're now up to '83, early '83

Hendrie: Early '83, okay.

Maxfield: And we are-- we have a management off site, which, you know, you do every six months or so, and try and get out of the day-to-day things, and take the longer view.

Hendrie: Right, exactly.

Maxfield: And where you're going from here. And we were talking about this, and we were talking about-- <Telephone rings> Why don't you stop the tape?

Hendrie: Yeah, why don't you go get it?

Maxfield: Otherwise..

Hendrie: All right, we're back.

Maxfield: So we were talking about that we were disappointed that it didn't work out with HP, and we were talking about, well, what should we think about next? And well, you know, the obvious, if you had your choice of anybody, why not IBM, why not the biggest computer, you know, the most successful computer company in the world, which, of course, you ordinarily think of it, and think, well, forget it, but it turned out that Ken Oshman had and I forget exactly.. he had served on some board or some industry association board or something, with Jack Koehler, who was a very high up guy in IBM.

Hendrie: Oh yeah, he was-- yeah, he became president, right, yeah, yes.

Maxfield: And I'd gotten to know Jack, and--

Hendrie: And Jack was a technical guy.

Maxfield: Jack-- yeah.

Hendrie: Unlike most engineering guys.

Maxfield: He came from the technical ranks.

Hendrie: Which was very unusual.

Maxfield: Anyway, he became president, it was very unusual. The first time an engineer had ever become president of IBM, I think.

Hendrie: Yeah.

Maxfield: At the time, John Akers was president, who had come up through the <inaudible> ranks as everyone else had. And you know, Ken, I mean, Ken was one of those guys, that, I mean, there-- there's nothing too outlandish that, you know that would intimidate him from doing anything, so we're sitting there saying, "Well, you know, IBM would be the company." And Ken says, "Well, you know, I know Jack Koehler, maybe I'll just pick up the phone and call him." And there was actually a reason why it-- there was a possibility that maybe there would be some reception there, because here's what was going on at

the time. First of all, this was in the breakup of AT&T was underway, was about to happen. It hadn't happened yet. But you remember that about '83, 84 timeframe, or some time in there, AT&T agreed to break itself up. They had been under pressure for some time, by Congress, initiated by their own actions, actually, in my opinion, because remember back in the early, mid '70s, they were trying to roll back competition in the interconnect business. Did I talk about that last time?

Hendrie: Not really.

Maxfield: Okay, well I hate to keep going off on digressions, but--

Hendrie: No, no, no, that's fine. It works fine.

Maxfield: This is a key point, as to what-- how-- one of the reasons we were able to be successful, which is in the luck factor, things that are outside your control. When the industry was deregulated in '68, AT&T no longer had control of what was called terminal equipment, telephones, answering machines and so forth, which was what spawned the competition, allowed people to go sell PBXs, and telephones and everything else. In the-- in about 1975, AT&T just decided, we don't like this. This is not good. We're-- we don't want people hooking up things to our network. They went back to the FCC, and said, "We want you to roll things back. We're tired of this, we want you to just rescind the <inaudible> decision, and get rid of the competition." And the FAA said, "No, we're not going to do that." So AT&T said, "Well then, we'll just go pass a law, we'll have Congress pass a law." And the next thing-- and so in 1975, in the Congress, there came a bill. It was called the Consumer Communications Reform Act of 1975, I think it was, the Consumer Communications Reform Act.

Hendrie: Oh yes, they always name it innocuous.

Maxfield: When it hit, when it was introduced, at the time it was introduced, it had 150 Congressmen as official supporters, and about, I forget the number, maybe 40 or 50 Senators as official sponsors of the bill.

Hendrie: Oh my God.

Maxfield: Because, of course, AT&T has a million employees scattered all over the country, at that time they did. They had three million shareholders, or maybe I've got that vice versa. Those are the two numbers, I remember. And obviously because they're in each local thing, they make a big deal of local citizenship, and so AT&T executives are expected to be well plugged in to all the communities and the politics and all of that. So they had a tremendous political machine, you know, based on if the whole company goes out and starts working on things. And they came within an ace of having Congress pass a

law that year, in 1975, that would have wiped out the entire competitive industry. Here we were just launching our new product. And so if that had gotten through, it would have been the end of the story right there. And the fact is, it almost did, but it didn't. The nascent interconnect industry had a little trade association, and they got their act in order, and they went in, and they were able to just barely keep this thing from getting passed.

Hendrie: Wow.

Maxfield: And then what happened, is, every year after that, for the next three or four years, same thing, AT&T is back, trying to do it again. And so-- but what happened was, and this is now my sort of take, was that what happened was that, over the years, we-- the competitive industry managed to educate Congress, as to the benefits of competition.

Hendrie: And essentially point out that the technical arguments that AT&T would use, that would ruin the network weren't true.

Maxfield: Oh yeah, their arguments were absolutely wrong, and they were possible to be proven wrong. Not only that, but AT&T, in the early '70s, did a lot of actions that caused them to have antitrust suits filed against them, and you know, I don't want to throw rocks at them, but, you know, I don't know whether-- what happened was, that they, you know, they were doing their best to fight competition in the early '70s, and the methods they used were arguably illegal, in some cases, and they got a bunch of antitrust suits from private-- and to the best of my recollection, they never won a single one of those lawsuits. They settled them all, when they had to. So anyway, the net of it was that, over time, Congress actually got more and more pro-competition. Then they started saying, "Well, gee, you know, long distance costs are too expensive, and why isn't there more competition here, and why isn't there more there, so actually the Congress now became pro-competitive, and now AT&T started fighting a bit of a rearguard battle, but the other thing that AT&T-- but who's the guy who was president at the time? I think, Brown, [ph?] Brown, I think--

Hendrie: That's okay.

Maxfield: Anyway, the other thing, of course, was that AT&T was a great technology company, and they had lots of computers that they were-- they developed Unix, they had great computers in their central offices, and they thought, "Well, gee, you know, if people are going to give us a hard time in the telephone business, maybe we should go into the computer business."

Hendrie: I remember that.

Maxfield: Because we're regulated. So well, you know, and so maybe we ought to, maybe breaking up isn't such a bad idea. We'll take all the regulated stuff and put it over here, and then we'll unleash our engineers, and all this to go in their computer business, and we'll go put IBM out of business. And that's-- and so that's the reason that AT&T, at some point, started to let themselves get pushed into this, and started negotiating for what, you know, what can we get in return, and that led to what the ultimate breakup was, with the Baby Bells, and AT&T Long Lines and Western Electric being all, sort of separate things. But at that time, of course, IBM, although they-- IBM was-- they were very confident guys, and they knew they had-- that they were good in the computer business, and they didn't, you know, they took AT&T seriously.

Hendrie: Yes, they said, "Here is a huge corporation with immense resources."

Maxfield: Here is a huge corporation-- one of our biggest customers, for one thing, and what if they went into the computer business? Well they're going to bring to it a set of skills-- they're going to come and have all this integrated voice data stuff, because that's their strength, too. And IBM had recognized that, for several years, and had been working on developing internally, PBX products, and they had actually had one in Europe that they had put on the market in Europe. This was several years before, which was essentially a switch tied onto a computer.

Hendrie: Yes, okay.

Maxfield: Not a mainframe, I think they tied it onto the, maybe the 1130 computer, one of their--

Hendrie: Oh, their real-time process control computers, yeah, like the 1100, or 1130, or--

Maxfield: It may have been the 1800 they hooked it to.

Hendrie: Yeah, or the 1700, yeah, something like that. Okay.

Maxfield: So I'm-- and they actually were known to have a very intensive PBX under development in their European research labs, and I believe the code name.. I think it was card.. I've forgotten. Coronation, coronation, or maybe that was the name of the-- it always gets fuzzy when I'm trying-- but anyway, and so this-- so now we're '83. Well what had happened in 1982, about a year before where we are, you know, in '83, IBM had-- we kept expecting them to launch this product any day. You know, we expected, in fact, at this point in time, we thought the biggest threat to our future success was IBM coming into the PBX market.

Hendrie: Okay, yes.

Maxfield: But there was another competitor that I failed to mention, because they weren't quite as-- they didn't-- it was a Canadian company called Mitel, that had actually started out in small PBXs, analog, they were even analog, and eventually, at the low end of the business, so we didn't see them very much competitively, but they had announced in maybe '81, they had come out of the woodwork with a digital computer-controlled large PBX, and I forget now what they called it, but on paper, it looked really good. And they were starting to market in the US, but, and sometime in 1982, I guess it was, all of a sudden, IBM and Mitel announced a partnership. And you know, they-- and the plan was, they were a little vague on the details, because-- but that they were going to take this Mitel digital switch, and they were going to integrate it with their computer systems, and market it as an integrated voice data system of some sort.

Hendrie: Oh, okay.

Maxfield: And now, the thing was, and we tracked that project, that Mitel thing, as closely as we could, and it looked to us, what we were seeing in the marketplace, and sort of reading between the tea leaves, that they were having trouble getting this thing to work, in particular the software, guess what?

Hendrie: Oh yes. Hardware companies just, very often die on some--

Maxfield: Yeah, but what they had done is they picked it up-- by that time, see, and this is what really scared us, is that they had picked up a commercial microprocessor, I forget which one it was, maybe Motorola or something, and they had picked up an off-the-shelf real-time operating system from somewhere, maybe even a version of Unix. No, I don't think it-- but they went ahead and sort of-- they were cobbling together some of these. You know, they hadn't invented it from scratch, and they were cobbling it together. Nevertheless, you know--

Hendrie: Still could be very-- if they could make it reliable--

Maxfield: If they could make it work, it was a real threat.

Hendrie: Yep.

Maxfield: Well, and it turned out that they-- that we were starting to get indications that maybe it wasn't going as well as they thought, and so, at this particular point in time, when we were-- when we had approached HP, and that hadn't worked out, and then we said, "Well, what about IBM?" And said, "Well, you know, they announced this thing with Mitel," and that was about a year ago, or six months or eight

months ago. You know, maybe things aren't going well in that program. You know, maybe they're starting to say, you know, this is going to be harder than we thought, or, you know, for whatever reason. And so we decided, well, okay, let's pick up the phone, and call them, and see what happens.

Hendrie: It's reminiscent of the Data General call, isn't it? Yes, it's-- exactly.

Maxfield: Yes, yes, it's like that call, <inaudible> yeah, and exactly. So that's what Ken did, he picks up the phone, and calls Jack Koehler, Jack Koehler says, "We've got to meet." And within I don't know, it was probably less than-- within less than two months, we had agreed to form-- to do a strategic joint venture. See, the original relation between IBM and ROLM was to be a strategic partnership. And I forget-- I'll get some of the details a little wrong here, but basically what they did, is they made an investment in ROLM, they bought something like 10 to 15 percent of the company, they-- and they had the right to buy on the open market up to an additional percentage of the company, one or two, so that maybe, if they could have, at most, owned maybe somewhere between 20 and 30 percent, of the company, and, what we were going to do was, the marketing folks were going to work hand-in-hand, their marketing sales guys and ours, going to the customers, talking about integration of voice and data, and all the product functionality. On the product development side, we were going to interface with all of their product development groups, in particular Raleigh, who had-- they had the system network architecture with all the communications gear in IBM, and including the local area networks and all that stuff. And so we were going to develop great products, and they were going to jointly market them together.

Hendrie: Right, okay.

Maxfield: That was going to be great. So that actually then, happened about the middle of 1983, and you know, it was one of these things, that, you know, IBM was very interesting company, because they did their due diligence on this thing within weeks, and it wasn't-- there were only a handful of people involved. You know, what happened was, John Akers, and Jack Koehler, and Paul Rizzo, were the top three guys at IBM, they simply put a team together, they just reached down in the organization and plucked about six or eight people, engineers, and various types, and told their bosses, and their boss' boss, and their boss' boss' boss, "These guys are doing a special project. They'll be back when they're back." You don't need to know any more than that. These guys came out, and we did the same thing, because obviously this kind of thing had to be kept very quiet. And they came out and spent a lot of time with us, and we worked through it, and everybody got excited and it was-- it was done.

Hendrie: And it happened.

Maxfield: Just in a matter of weeks. So and of course, that was a big deal, and of course the stock bounced up, and it generated a lot of buzz, and we really-- so then we--

Hendrie: Had you had some-- had the revenue started to, you know, sort of--

Maxfield: It was growing, but it wasn't growing as rapidly.

Hendrie: So you were coming up toward the top of the hill. Yeah, okay.

Maxfield: Yeah, <inaudible> we still had a lot of good stuff in there.

Hendrie: Yeah, exactly, it wasn't like you were dying.

Maxfield: But, so we all charged off with all of these great plans, and then what had turned out, was that it couldn't work the way we wanted it to work, because now you've got to go back again in history, to understand how IBM works. In the 1950s, IBM, of course, owned the market in computers, and the Department of Justice filed an antitrust suit against IBM in the '50s, which was settled, I believe, in '56, with a consent decree. IBM said, "Okay, you know, if you get off our back, we'll do, to settle this case, we'll do all these things, you know, going forward, in terms of business practices, to make sure that we compete fair and square. In fact, they, you know, you could argue they always had. And anyway, they agreed with the Justice Department, to a very rigorous set of things, which basically meant having lawyers involved with everything that goes on in the company, literally every organization every division, and every-- had their own legal counsel and-- as part of this legal effort, that made sure that, in no way, shape or form, could IBM ever do anything that could be construed as not appropriate under the antitrust laws. And that culture had really permeated IBM, I mean, to an amazing degree, which we were completely unaware of. And it turned out that, literally, I mean, almost nothing could get done in IBM without the legal guys blessing it, and what happened was, almost immediately, when we started doing these-- trying to do joint marketing, for example, the lawyers would say, "Well, wait a second, Mr. IBM salesman, you want to take a ROLM salesman in to a customer and make a pitch that you should buy our products as well as the ROLM? In other words, you're going to essentially recommend the ROLM product over any other telecommunication product." Jack says, "Yeah, that's what we're doing." And the lawyer says, "We can't do that. We have to be-- we have to offer, if we're going to offer a non-IBM product, we have to be willing to do the same thing with any other competitor, so if we're going to walk in with ROLM, to a customer, then we should be prepared to walk in with AT&T to a customer, or something, more or less, that's <inaudible> And on the product development side, they said, "What's going on here?" Well, we're going to get together and we're going to develop this joint thing, and we're going to trade technical information and we're going to make these products work together, and so forth, and the lawyer said, "Wait a minute, you can't do anything that you wouldn't-- you can't disclose any IBM information to ROLM, that you wouldn't disclose to AT&T, or any of ROLM's competitors." We said, "Huh?" And so the net of it was, we spent about a year trying to execute all of these sort of plans that we had tried to do, and we just kept getting all these conflicting issues, and things just sort of ground-- they didn't proceed very fast. You know, we would make progress, but it was really, really slow going.

Hendrie: Wow.

Maxfield: And finally, there came a day where we woke up and said, "You know, this ain't going to work like this.

Hendrie: Right, yes. This plan won't work.

Maxfield: So now you've got two choices. You can get divorced, and each go your own way, or you can merge, and IBM can acquire ROLM. And you know, given where we were, it was sort of like being half pregnant, it's pretty hard-- it was pretty hard to envision going your separate ways, and trying to unravel everything we'd done, and deal with the aftermath in the market, of why did this happen, and what happened, and blah-blah-blah. So the net of it was that it became clear that it was the right thing to do for the company and the shareholders, and employees and everybody else, was to do a merger, and so that led to--

Hendrie: And IBM wanted--

Maxfield: Oh yes.

Hendrie: They came to the same conclusion. They wanted to make this work.

Maxfield: When we first approached them, their initial reaction was, we'd like to acquire you now. We said, "No, no, no, we don't want to be acquired, we want-- we'd rather have a joint venture." So they were-- had been amenable all along.

Hendrie: Ah, okay.

Maxfield: So that takes us to-- so, in September of '84, about, thereabouts, we did a negotiation and we did a merger, and we became part of IBM.

Hendrie: Now, what was the basis? You know, what was the valuation, was it cash and stock, or how did it work?

Maxfield: The valuation, the total valuation on the company was 1.8 billion dollars, of which IBM already owned some percentage of it. So they were buying the rest of it, essentially.

Hendrie: And what were your sales, sort of, at that level?

Maxfield: The sales were roughly a billion dollars.

Hendrie: Yeah, okay.

Maxfield: And the transaction was not stock for stock, it was a cash transaction, paid-- it was, where, in exchange for ROLM stock, you got an IBM-- I think this is right. You got an IBM convertible debenture. And, but those were publicly traded, so I mean, you could cash it in. Yeah, they were publicly traded, so what you had was a convertible debenture, which meant that if you held onto it, you would get a coupon payment every year, of some percent on this. And if IBM stock got to a certain point, let's see, you could trade it in for IBM stock, but I think IBM stock had to go up quite a bit, and then you could trade it in for IBM stock for a certain number of shares of IBM stock, at such-and-such a price. And so it was basically-- it was viewed as a cash transaction. And since these debentures were publicly traded, if you took your debentures, you could go sell them tomorrow, and it was like a bond, effectively.

Hendrie: Yeah, and it sold at a-- near par, as opposed to, it didn't have the volatility of a stock.

Maxfield: Yeah, well it had some, a little more--

Hendrie: And more than a typical bond, right, but not as much as a share stock. Okay.

Maxfield: And so that was-- ROLM became a wholly owned subsidiary of IBM, and then over the next-- Oh, and I guess one of the things that I'm proudest of, in terms of what we did for our shareholders, if you had bought a share of ROLM stock, in the public offering, back, and this is now 1976, and then held it all the way until, for eight years, till middle of '84, you would have made 40-to1 [return] on your investment. So our stockholders were quite happy with the outcome.

Hendrie: Very good. Excellent

Maxfield: So, and then--

Hendrie: So now we come to the integration problem.

Maxfield: Yeah, and, you know, I could go on forever about that, I just-- basically, things didn't-- the net is, I think, if you talk to people in IBM, they would say, they were disappointed in the outcome and that

they thought-- they wanted to see better things happen. And, but they-- most of the ones I've talked to, it's not that they-- if they blamed anybody, they blamed themselves. And you know, ROLM people sort of feel the same. You know, it's not like finger pointing, where you guys screwed it up at all.

Hendrie: Or, like, you guys lied to us, or all that-- none of that kind of thing.

Maxfield: It was just, everybody was disappointed we didn't get more done. The IBM did a couple of great things. I mean, they're a great company, I have great respect for them, and they really did, I think the best they could do in terms of this huge company, with 350,000 employees, and this little company, ROLM, that has 10,000, employees, and, for example, in IBM, there are-- there were at that time, anyway, I believe the number was 21 staff organizations. And if you were a profit and loss manager running a division in IBM, you had 21 different corporate groups that you had to talk to every-- in terms of your plan, your strategy, because there was one for quality, there was one for you know, technology, there was one for this, one for that, one for that, one for that. And so if you were in the IBM culture, you knew how to deal with that. You know, you knew how to get assistance to do all-- to go run and get presentations and you know, keep people out of your hair, and all that.

Hendrie: Yeah, right, exactly.

Maxfield: But you know, ROLM, we-- they knew good and well that we would have been buried, you know, because we'd have thought, well, you really need to, you know, you've got to deal with each of these guys, and answer their questions, and you know, do whatever they ask you, whereas, you know, the other guys knew how to sort of keep from getting too carried away. So the first thing IBM said was, okay, staff organizations, there's only two of you guys that can talk to ROLM, period. Finance, you can talk to ROLM, because we've got to roll up the numbers. HR, Human Resources, you need to talk to ROLM, only because, from a strategic point of view, because we have two different sets of benefits and you know, compensation programs and so forth, and the problem is that we want to be able to freely move people back and forth from ROLM into an IBM group of someone from an IBM group into ROLM, so, over a reasonably short time, a year, two years, we need to sort of merge the HR policies in such a way that people feel comfortable moving back and forth between the two companies. Nobody else can talk to them, that's it.

Hendrie: That's a brilliant-- that shows real insight.

Maxfield: And the guy-- and the other thing they did, was they said-- they offered, which we accepted, to have an IBM executive come in to various parts of the organization, just as a staff guy to, like, we had several divisions at the time, and each division, an IBM guy came in, and his job was just to help that division interface with the rest of IBM, and run interference, and all that. And, of course, if you were paranoid, you'd say, "Oh, it's a spy." You know, they're trying to come in, but that's not it at all. These

guys, they were absolutely great, and they all fell in love with ROLM, and enjoyed their time there immensely, and we enjoyed having them and--

Hendrie: And they really helped, because they knew the ins and outs of the mother organization.

Maxfield: Yeah, they'd come in and say, you better be careful there, and let me go run interference for you here. But the other thing that was going on at the time, which got in the way of doing everything we wanted to do, was resource limitations, because that was the time, that was about the point in time where IBM started to have financial problems. Remember in the late-- and by the late-- where am I?

Hendrie: We're in '84.

Maxfield: Yeah, well, yeah, and by the late '80s, IBM was really troubled. You may remember.

Hendrie: Absolutely.

Maxfield: You know, and it led to Akers, going. Well no, Koehler took over, and then, I believe, then when they brought in--

Hendrie: Gerstner [ph?].

Maxfield: Gerstner. And that was made what, early '90, or thereabouts. But anyway, but long before it was sort of publicly, where all the analysts were starting to talk about it, internally, the pressure was really building, and being part of IBM, you know, you could see it. You know, it was starting to get into financial binds, and the net of it was that all of the-- some of the strategic product investment kinds of things that they wanted to do with ROLM, and we wanted to do, got scaled back, and although they scaled back the other stuff a lot more than they scaled the ROLM stuff back, I mean, they-- IBM bent over backwards to try to make the thing a success, but it just, you know, for the kinds of reasons I've talked about, it just didn't go as well as everybody wanted it to.

Hendrie: Now what did they do about the field sales force, because that's often--

Maxfield: You know, for about a year, that-- yeah.

Hendrie: That often can be a big problem.

Maxfield: That was a big issue. Initially the plan was, leave it like it is. And about a year, it was about a year, I guess, or a little more, when they decided, and they had had some management changes back at their end, and they made the decision to merge the two sales organizations. And you know, that didn't help in terms of the ROLM marketplace, just because the IBM sales group was not as focused on our stuff as we were. But they felt that, in the long run, that was a good thing to do. And the net of it was-- Oh, and then from the management point of view, right after the merger, Ken Oshman was still the President of ROLM, and he stayed for about-- a little over a year, and then he decided to move on, and Dennis Paboojian was made president, who had-- he was another of the key guys that came on early on. He was our first manufacturing guy. And then he had grown with the company, and managed divisions, and, super guy, and so they made Dennis president, and he stayed for a year, and then it was under his tenure that they merged the two sales organizations, and he was, you know, he was opposed to that. And, but anyway, so he decided to move on, and so then they-- so this is now two years into it, and then they brought in an IBM guy for the first time, to run ROLM, which was Ray Abuzayyad who had been running the IBM San Jose disk [drive] operation.

Hendrie: Oh, okay.

Maxfield: You know, long time good IBM guy came in and gave it his best shot. And by-- and then by--

Hendrie: Now where are you in all of this. Were you still here, or what are you doing?

Maxfield: The.. well, you know, we're going to edit this, so maybe we can leave this in or out. But what happened was, right after the merger, about four months after the merger, one of my daughters got diagnosed with leukemia, and so I basically, I said, "Hey, guys, I'm, you know, I'll come in when I can, but I'm out of here for the-- until this--"

Hendrie: I have more important things to do than--

Maxfield: So, and she lived for a year. And so during that year, I was, you know, doing what I could do with her, and so then, at that point, just about the time that she died, Ken left the company, and Dennis took over, and I said, "Well, Dennis, you know, what I'd like to do is sort of ease back in a little bit, and maybe work part time or whatever, but-- and the net of it was, that, I mean, it was-- you go through something like that, and it's a long time after it's over, before you--

Hendrie: Oh yeah, before you really feel like you-- yeah.

Maxfield: So, I sort of came back on a part-time, sort of advisory role, and then when Ray Abuzayyad came in, I was advisory to him for a while, too, but basically just part time. And I just really never sort of

got-- you know, I was sort of ready to go on to other things, but I still felt a loyalty, and wanted to help any way I could.

Hendrie: Right, yeah.

Maxfield: I didn't have any real interest at that point in getting back in--

Hendrie: And running a division or something like that, yeah, yeah.

Maxfield: And so, but I was sort of part-time, and I would work on things that Ray wanted me to work on, but then in 1988, you know, other things were going on at IBM, and then they made the decision to sell the company to Siemens, which happened in 1988.

Hendrie: Now what had happened to the revenue after IBM bought it? Do you remember sort of what that curve was?

Maxfield: It didn't grow much, if at all. I don't know whether-- I really don't remember.

Hendrie: Don't remember whether it went down or-- but a fundamentally--

Maxfield: <inaudible> was always disappointed, either it was never growing as much as we wanted, or it was going down--

Hendrie: Or it was flat.

Maxfield: It wasn't dramatic, I mean, it's not like it fell off a cliff. But I would guess probably revenue probably held up pretty well. The profits probably didn't hold up so well, simply because we were starting again, you know, you get acquired by a big company, you start building in even more costs, just in interactions, and--

Hendrie: Yeah, exactly.

Maxfield: It was very diff-- the profits were hurting more than the revenues were hurting.

Hendrie: Okay.

Maxfield: You know, whether, did it lose money? I guess yeah, the point, I think it got into a losing-- not a lot, I mean, you know, not gigantic amounts, but-- And of course, IBM as a whole had profit problems, and so--

Hendrie: They didn't-- yes.

Maxfield: So eventually they decided that this--

Hendrie: And probably local area networking, by this time, had, you know, by '88 or '89, it was clear how digital communication was going to be, and you know, digital PBXs were-- didn't look like where the world was going to go.

Maxfield: Oh sure-- Yeah, the idea that everything would run through the PBX was long gone by then. There were lots of other things, though, I mean, it was more the-- excuse me, the enterprise application kinds of things. There was lots of good stuff going on there.

Hendrie: Yeah, there was plenty to do. It just--

Maxfield: There were a lot of good products that got in the door at this time, that, between ROLM and IBM. Some call centre products, you know, since I wasn't as heavily involved at that time, and they were not as fresh in my memory as they should be, but there were some good products, you know, good integration, but more at the application level, so you could even have a LAN down here, doing stuff, but still communicating up and seamlessly integrating in voice data applications at the corporate level. But they made a strategic decision that they had bigger problems. I mean, they had to focus on--

Hendrie: It's called--

Maxfield: Throw some things off the boat.

Hendrie: Yeah, exactly, it's called going back to your core, deciding, what is our real core business, maybe we shouldn't expand, you know? They got rid of copiers, they got rid of a lot of things that--

Maxfield: In the meantime, Siemens, of course, is a European company, huge European company, that had been in telecommunications forever, and had been trying to get in the US market in a major way for a long, long time, and it--

[audio ends abruptly]

Hendrie: I think we're back on now; yeah you were talking about Siemens.

Maxfield: Yeah so Siemens had been trying to establish a market presence in the US for many years, more or less unsuccessfully or not at least to the level they wanted and so Siemens was interested in the possibility of acquiring ROLM from IBM and using that as their entry in the US market and so that's what happened and it went in two phases. Initially what IBM did is they took the product development manufacturing operation and Siemens bought that and then the sales service which was now integrated more or less with the IBM. What they did was they did a 50/50 joint venture where they would each own-- so I guess what they did then, I guess IBM carved out the people who set up a joint venture, the sales service people and they owned it jointly so Siemens owned the manufacturing, they jointly managed it of course and they jointly owned the sales service organization and IBM managed that; that's at least my understanding of what the structure was. And then after probably two years later then IBM sold their interest in the joint venture to Siemens, so then Siemens owned the whole thing and so did they. But they already had operations over here, they were making some small switches and some telephones and other stuff and so they immersed it altogether and they took over. Now that's the point which I'm out completely because when I got the word that Siemens was gonna acquire the company, I said "Well, you know, I'm done."

Hendrie: This is a perfect time to.

Maxfield: Yeah that was a perfect time because, you know, I did my best to educate IBM as best I could on what the company and the market was all about, but I don't wanna do that again with yet another new boss so that's the time in which I resigned and was no longer involved. So then Siemens came in and they, you know, built the thing up, the good thing about Siemens was they understood the PBX business a whole lot better than IBM.

Hendrie: Yes of course.

Maxfield: Because that's what they'd been in, so in some respects, you know, people I talked to that stayed through all of these transitions said, you know, they thought Siemens was good because I mean they enjoyed working for Siemens in the sense that they didn't have to educate 'em so much about the nature of the marketplace, the nature of the products, you know, they liked IBM but IBM you had to keep educating them as to how these things were different from the computers and so forth. So, you know, Siemens-- and as far as-- and of course Siemens kept the brand name for many, many years.

Hendrie: Oh really, I was gonna ask whether they kept the brand name.

Maxfield: Yeah <inaudible> I was just trying to remember, I believe it wasn't that long ago, it was maybe 1997 or thereabouts that the ROLM name came off of the PBX products and the phones. So the telephones that all said ROLM on 'em, now say Siemens on 'em and that's only been, you know, in the maybe it's been longer, I lose track of time. But so for many years they kept.

Hendrie: They kept the brand name, so they understood.

Maxfield: Oh sure.

Hendrie: They understood the business way, they understood to keep a well known accepted, you know, what was a great brand.

Maxfield: You know, I don't know, I've never talked to anybody from Siemens in terms of <inaudible>.

Hendrie: Well it would appear that you would think if you had took a marketing course that they'd tell, you know, "Hey if you've got a great brand, you know, don't throw that away, just because you own it."

Maxfield: Yeah so that's as far as I can go. The one thing I would like to do before we wrap up is go back on some things that I think at ROLM we were all real proud of, I mean and I think if you talk to ROLM people you'll find that, you know, this is real not just sort of a lot of hype as we managed to build a really interesting culture and we tried very hard; in fact one of our sort of key management goals was we wanted ROLM to be a great place to work and that's sorta the way we couched it and we tried to do that as best we could and there were a lot of things that we innovated I think and that now are sort of almost expected in companies. For example.

Hendrie: Yeah talk to me about some of those that's very interesting.

Maxfield: First of all, you know, since all four of us were engineers that started the company one of the things we sorta said to ourselves was we'd like any company that we're running to be a place where we'd like to work if we were as an engineer and we had all worked as engineers in companies and so the test of things was well, you know, would we like that policy if we were young engineers starting out. And we also of course used HP as a model because they've been at it a long time and they were known for doing things right. But one of the first things we did early on was we instituted a sabbatical program and the idea was that when you worked for the company for six years, at the end of your sixth year, in your seventh year you were eligible to take a three month sabbatical, time off with pay and go and do whatever you want; renew yourself and then come back and then at the end of the seventh year thereafter you get another one, so every seven years you had a three month paid sabbatical and we instituted that when we only had maybe 100 or 150 employees. I had been the guy who sort of resisted it for a couple of years

when we were a little smaller because I figured well, you know, the first time anybody's eligible, we're gonna lose half our company because we didn't have any turnover <inaudible> keep the doors open. So finally we got to the point where we thought we had enough critical mass that we could get by and I remember one of our-- when we first proposed this idea at a board meeting, one of the directors said "Well that's a good idea and I guess that would just apply, to top employees right? Just a certain number of top people?" We said "No everybody." They said "Everybody, you mean assemblers?" Well "Sure." They said "Well yeah but, you know, some people like, you know, might not know what to do with that kinda time off" we said "Oh we think people will find out what to do with it."

Hendrie: They'll figure it out.

Maxfield: And the interesting thing was that the very first person that took their sabbatical was the first assembler we ever hired, you know, assembler, you know, solder things and she was a wonderful person. Anyway and it was amazing, you know, the first person and she spent the whole year before her sabbatical planning every minute, I mean man she had that three months planned and all the things she was gonna do. She had a great time, she got more out of it than-- and then of course so it turned out that the people that you would think that wouldn't enjoy it as much, they enjoyed it ten times as much because they planned ahead, they thought about it and...

Hendrie: And it was especially valuable, they never conceived that they could do that.

Maxfield: And then actually a few years later we realized that we needed to make a change because it turned out that some of the lower paid people, the problem was that since, you know, they could just barely make their house payments on their salary. If they had three months off they didn't really have that-- even though they didn't have to, you know, they were making their full salary they didn't have enough extra to go take a nice vacation somewhere or, you know, travel or some things.

Hendrie: Or really do anything yeah.

Maxfield: Yeah and so we said "Well okay we'll make a change; you can either have three months at full pay or six weeks at double pay." And so now they sort of have an extra salary for six weeks, so now they can take off and.

Hendrie: Go on a cruise or something like that yeah.

Maxfield: So that was one thing we did. And that's something that caught on in the valley at least for a while, I don't know if people are still doing it or not. The other thing that we sort of pioneered in is as I mentioned, we acquired this sorta campus which actually had space for I think it was, probably get the

number wrong, maybe 700,000 square feet of total space but it was a big thing and we landscaped it very nicely and.

Hendrie: Now where was that?

Maxfield: This would have been-- we acquired the site and moved in there in about 1977 just as we were getting into the PBX business.

Hendrie: And where?

Maxfield: Oh where, it's right up by Great America Park, just across on the other side of 101. And so first we built three buildings and then three or four years later we built another with the remainder of the site, another three buildings. But when we were getting ready to do that second phase of building, we decided to put in a recreation center as one of the things and so a full gym, handball courts, big swimming pool, Jacuzzi's, you know, everything and tennis courts.

Hendrie: Put in what would cost a lot on a monthly basis for a health club.

Maxfield: Yeah I mean in those days, you know, there weren't that many health clubs around.

Hendrie: Right and they were expensive.

Maxfield: A club on every corner like it is today and the ones that were there didn't have, you know, all the amenities like swimming pools or...

Hendrie: Yeah exactly.

Maxfield: The interesting thing was that we ran the numbers and realized that one of the traditions we'd had since the early days was the company Christmas party of course which a lot of companies have and of course as you get bigger this thing just gets bigger and bigger and bigger and you can't find places to hold it and it's expensive. It gets to the point where nobody has much fun because it's too big and you wind up having to break it into two or three <inaudible>.

Hendrie: Yes and you have an engineering Christmas party and a finance Christmas party.

Maxfield: So it gets to the point where nobody really enjoys it but nobody wants to be the bad guy and nobody wants to say "Let's cut it out." Well I don't remember whose idea it was, it wasn't mine but it was a brilliant one, which is we added it, we said "What is this Christmas party cost every year?" And if you were to say, you know, what's the time value of money of a recreation center. In other words if you amortize the cost of the recreation center it turned out to be basically a wash that for the, you know, if we were amortizing the recreation center, the yearly amortization would be about the amount that the Christmas party was costing. So then we went to the employees and said "Hey we have this idea, you know, we'd like to, you know, what do you think?" and went out and took a poll, I forget but, you know, would you rather have a rec center with these things in it or would you rather have the Christmas party and give up the Christmas party or do you wanna keep the Christmas party <inaudible> of course, you know, it was unanimous.

Hendrie: Is that right, there was no question?

Maxfield: There was no question, everybody, you know, and so we did the rec center and it turned out to be great, it was a great recruiting tool and everybody got a lot out of it and it was great for building teamwork because, you know, we had club sports, we had things together, so people would go over to the rec center and they'd be involved playing basketball games, you know, with people from different divisions or the marketing guys and the engineering guys which might fight like cats and dogs during the day, you know, they go play basketball at night and they get along a lot better. So it turned out to be great. So, you know, that's two of the things that I think and I think, you know that we sorta set a tone that I think influenced the valley a lot because a lot of other companies picked up and did very similar things and whenever I run into the ROLM people now that were there in the old days, you know, they almost always say, you know, "Those were the best days."

Hendrie: Yeah and that it was a great company to work for.

Maxfield: Yeah.

Hendrie: Was it a reasonably egalitarian culture, I mean, you know that in terms of, offices and…?

Maxfield: It was basically everybody, engineers or certain levels, engineers and product marketing people, certain level of professionalism all had offices, they were all the same size. There were maybe a half a dozen offices bigger than all the rest that the vice presidents had, a little bit bigger. There were no personalized parking places, if you wanted to get a good parking place.

Hendrie: You had to come to work early.

Maxfield: Early in the morning. There were no, yeah I mean we tried very hard to make it-- stock options were spread very widely through the company, we had a profit sharing plan that everybody participated in, paid out a percentage of the profits everybody. Tried very hard to have <inaudible>.

Hendrie: Those are all great things to sort of make everybody really think, it's their company, it isn't them versus us.

Maxfield: Oh another tradition that was really great, it was the Halloween party, every Halloween everybody came in costume, well not everybody but a lotta people and it was a big deal because we had competition for costumes at the end of the day and departments would have their whole-- we'd have group things where departments would like Snow White and the Seven Dwarves or all kinds of things, you know, and that was always a lotta fun. So at the end of the day we'd have a judging for the best-- we had a little outdoor amphitheater that you could actually get everybody around more or less and at the end of the day-- and of course we had <inaudible> on Fridays once a month or there abouts, you know, things that, you know, <inaudible> always known for.

Hendrie: Yeah coffee and...

Maxfield: Oh yeah free coffee, free coffee, tea, soup that kind of stuff always.

Hendrie: Oh that's great.

Maxfield: Never got away from that, at least not while I was there. So yeah it was great experience.

Hendrie: So to just finish up on the personal, not personal, personal but in terms of so since you left ROLM in say 1990, 89, 90?

Maxfield: End of '88.

Hendrie: '88 just let's fill in a little bit what you've done.

Maxfield: I just decided to go off and experiment with things that I had an interest in and didn't have the time to do, you know, building a company, you know, I had a PhD in engineering, really in mathematical systems theory and control theory was really what my PhD was in which of course had no applicability to running a company directly. So I one of the things I did was get involved as a consulting professor at Stanford with my old thesis advisor who was chair of the Engineering Economic Systems Department in the early '90s and sort of reeducated myself on some of the mathematical system stuff that I'd be

interested in and he was interested also at that time in finance theory of applying these kinds of mathematics to finance theory and that was interesting as well so I did some work there and I also was interested in economics. One of my interests had always been since college days was that I could never understand economics. I took a course or two and it didn't seem to make any sense and it was only many years later that I formed the conclusion that it really did make sense, these guys, the economics profession made us an interesting set of things but as near as I can tell no real relation to the world. So I was interested in trying to maybe, you know, see if there was something that I could learn better or maybe help 'em out or whatever, so I studied economics for a couple of years and that was fun and so I wrote a couple of papers and worked with some PhD students on their thesis topics as sort of an advisor and I taught a course in the engineering school at Stanford called "Business Management for Engineering students" and it was taught for graduate PhD and MS engineering students as the way I couched it was it was a one quarter sort of, you know, an elective, it was what I wish somebody had taught me before I went out and started a company as a young engineer. It was really a first introduction to business because most of these kids have never taken a business course of any kind and it used the business school case method, solve a bunch of cases and, you know, the grade was based on not, you know, how well you could sit down and regurgitate something on an exam but it's how well you participate in class in terms of discussing the cases and in group projects where you had to get together and do things as a group and your grade on that project was the whole group got the same grade and, you know, for a lot of these engineering student that was a real eye opener. But they loved it, they had a good time and of course they were self selecting, they were the ones that an interest in business. So we divided this section it would be several lectures or class sessions on marketing, product development, how do you process a product development, how do you manage that, manufacturing, what are the issues that manufacturing people worry about. Finance, one of the things was, you know, engineers need to be able to read a P&L statement and balance sheet.

Hendrie: Exactly, know what each line means.

Maxfield: So one of the homework assignments for the first half of the course in addition to everything else was here's a self-paced accounting workbook, it's gonna teach you the basics of accounting and you need to go work through this on your own and then when we get half way through the course I'm gonna give you a quiz on that on how much you've learned and then we're gonna have several sections on we're gonna get-- what I would do is I'd pass out the annual report of Apple and Sun and IBM or something like that and say "Okay the assignment for next time is to analyze these annual reports and come back tell me what you can learn about the company out of reading the annual reports and looking through the financials" and talking about financial ratios and stuff and so, you know that was the idea was to make them comfortable with finance and then we'd have a session on venture capital, you know, and I'd get Reed Dennis or <inaudible> or somebody to come in and talk about venture capital.

Hendrie: Yeah in 20 minutes how venture capital works right.

Maxfield: Well we would do a case history of a start-up and in one case the start-up was Stratus Computer and Reed Dennis was the guy that financed Stratus came in as the guest lecturer.

Hendrie: Perfect.

Maxfield: And what I would do, I'd do that like at the Sun, we had a Sun case and I would get Scott McNealy to come in. But the way we would do it is that the students would do the case and discuss it and all that and then at the end of the class the last 20 minutes or whatever, the guest, I would introduce the guest who was there during the case.

Hendrie: During their discussion yes.

Maxfield: He's listening to their discussion and also was there <inaudible>.

Hendrie: Was part of the case yes.

Maxfield: So then he would talk about well, you know, what happened or some of the things that maybe the case didn't bring out that were actually crucial in the actual decision that was made and, you know, talk about, you know and the students got, you know, a lot outta that.

Hendrie: Oh yes they'd love that.

Maxfield: So I did that, been involved.

Hendrie: That would sound like something you could do forever.

Maxfield: Well I did it for about three years and then but, you know, I found that it was great except that I really needed to keep up with new cases and things and I just got a little old, you know and so what I did was I found somebody else that sort of was-- but then I'd sort of got the thing organized to where to do it the way it was sort of set up. You needed somebody who had sort of been there, you know, for a business school professor to do this would have been a very different course. So I got David Liddell to pick it up and he did the same thing for about three years and then as they usually do it, he passed the baton to Fred Gibbons who was the founder of Software Publishing and Fred did it for a number of years and so it's turned into something where, you know, some guy does it for three or four years and then when he gets a little tired of it then he finds somebody who's fresh to go into it.

Hendrie: That's great so it's self-perpetuating, yeah so it still exists.

Maxfield: Actually I mean at that time this was the only thing that was even close to a business class for engineers and of course the business school wouldn't let engineers take business school courses. But now, you know, because of this and other forces at work, I mean now there is quite a complement of.

Hendrie: Entrepreneurship courses and things like that.

Maxfield: Business management, there's a whole curriculum in the engineering school so, you know, this <inaudible>.

Hendrie: MIT's done the same thing.

Maxfield: Some form or another but it's not nearly as unique as it was in those days. And so I've continued to do venture capital investing, you know, through-- I was a venture partner with Kleiner Perkins for several years in the early '90s and but, you know, it was interesting to see it from the pure venture capital perspective.

Hendrie: Yeah see it from the inside.

Maxfield: Realized being a pure venture capitalist wasn't really my thing, you know, I don't mind losing my own money on investments I make but the thought of investing a lot of money for other people and really the problem, the real problem was that venture capital is just to do it right is just as time consuming and all-encompassing as running a company.

Hendrie: It's totally, totally time consuming, yes exactly, you cannot do it as.

Maxfield: I sort of thought well I'll do one deal a year and, you know, be involved a little bit and I did. I mean I did it on my terms but the problem was that I realized that I wasn't doing as much as I needed to do to really hold up my end as a venture partner and on the other hand I didn't wanna do a lot more because I had all these other interests I wanted to do so I did that for a few years and then decided, you know, I'll just invest with you guys. So I've been investing in funds ever since. But and I've done some, you know, sort of private investing and just things that I stumble across and.

Hendrie: Do a little angel work.

Maxfield: Angel work; and I've been involved in a number of startup companies over the years as the director/investor and so forth and some of them have done very well, some of 'em haven't done so well but, you know, the usual mix and it's great. You know I enjoy working with young entrepreneurs and in fact one of the companies was during the height of the Internet bubble and got involved with some 20 somethings from Stanford that were starting their own company and called Fogdog Sports, I don't know if you ever heard of it.

Hendrie: No.

Maxfield: This was e-commerce for sporting goods in the early e-commerce days and the website's still there, they got acquired, they went public about six months before the crash and then after about six months after or a year after the crash they got acquired by a company that had done a little bit better and that has continued to do quite well so it turned out to be an okay thing even though there were a lot of others that totally disappeared. So anyway yeah it's been a lot of fun being involved in many different kinds of companies and involved with other things like Santa Fe Institute, which is <inaudible> outfits.

Hendrie: Yeah you had talked to me about that the last time.

Maxfield: And that's been fun to be involved with and help it grow and develop. Indulging a lot of passions that I always had but never had the time to do like flying. I always wanted to be a pilot, either never had the time or the money and then, you know, late '80s decided now I can afford it and I've got the time so I'll be a pilot. So I went and did that and my wife and I like to travel and do all kinds of stuff. Now I have a granddaughter that's almost two years old so that's been the fun off the last couple of years that's the real highlight.

Hendrie: Oh very good, very good.

END SESSION TWO (TAPES 5–8)

END OF INTERVIEW

