

An Interview with
CAROLYN S. MILLER

OH 480

Conducted by Thomas J. Misa

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Abstract

Carolyn S. Miller graduated in 1968 with a degree in mathematics from the University of Kentucky, which had significant computing courses at the time. She took a job at Bell Laboratories military division in Whippany, New Jersey, working on the Safeguard Ballistic Missile Defense System while gaining a master's degree from Stevens Institute of Technology. When Bell canceled the missile project, she moved with other Whippany staff to Bell Labs in Naperville, Illinois, to work on software for ESS (Electronic Switching System). The interview discusses affirmative action and the women's movement. She left Bell in 1976 for General Electric and then North Carolina State, where she experienced significant gender differences in teaching introductory computer science.

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Misa: My name is Tom Misa. It's the 1st of December, 2015, and I'm talking today with Carol Miller. I'd like to ask her a set of questions about her experience working in the computer industry. So thank you for joining me today, Carol. I'd like to start out with your background and childhood and high school years. Were there any activities or hobbies or interests that might have inclined you toward a technical-oriented career? Things you might've done in grade school or high school, prior to college.

Miller: I was asked that question by one of my supervisors at Bell Labs, and I responded to him with 'I couldn't think of anything,' but he was sure that I had taken apart bicycles or something like that. [Laughter.] Because that's what guys do and that is what leads them to engineering careers. I was raised in a small town in eastern Kentucky. Poverty. There weren't many opportunities to have enriching activities that might have otherwise been available. I guess the only thing [is] I learned how to sew, you know the whole idea of patterns, and modifying that. So a little bit there, but other than that, no, I didn't have any hobbies as such, that looked like it was going to lead to computers. I did love math from the get-go.

Misa: Okay.

Miller: And I had a high school teacher who recognized that my abilities were above average, and she enrolled me in some competitions that were state wide. So I don't know if we can count that, but that gave me a feeling that yes, maybe I am pretty good at this and it might be something to consider for my career.

Misa: So there was a high school teacher that spotted your facility in mathematics?

Miller: Yes.

Misa: Were there any other people in the community or family members that saw something similar?

Miller: No, that one math teacher made all the difference.

Misa: It's an important thing to recognize.

Miller: And it was a woman teacher. [Laughs.]

Misa: A woman, yes. When you were thinking about education beyond high school, what kinds of options did you consider?

Miller: Only one, that I would go to the University of Kentucky. I actually received a scholarship in music. You know, I think there's a connection between music and mathematics.

Misa: Many people think so.

Miller: I did receive a scholarship in music, but it was to a smaller state college rather than THE state university. There was only one university in Kentucky. [Laughs.] The small college didn't have a mathematics degree and so I'd already homed in on I wanted to do mathematics. I didn't want to do music, I didn't want to do elementary teaching, or the other careers that I saw that were for women.

Misa: The University of Kentucky had a major then in mathematics?

Miller: The University of Kentucky did. And it was in the Arts and Sciences college at the university, not in the engineering school. There were three women who were math majors in my class, and there was one woman in the college of engineering. And she was older, and married to an engineer so she was different. But we were all three in the math department and interested in math.

Misa: Three women, would that have been out of just roughly 20 or 50 or how many math majors there might have been? I'm not looking for a specific number, just a guess.

Miller: I don't know, I'm going to guess 100 or more. I was thinking the first year my classes were calculus, and those were large classes. We were easy to identify as the three women. [Laughs.] I always signed my name on my exams as C.S. Miller rather than Carol because I didn't want them to know I was a girl in the class. And of course they knew it was the girl in the class because I was the only one that was signing my initials. [Laughs.] I was very sensitive about being singled out.

Misa: Can you say something about your recollections of the faculty members at the University of Kentucky, the math faculty particularly? Did they seem to take a real interest in students, or women students, how did that interaction go?

Miller: I had very little interaction with most of the math faculty. I did have an advisor. I actually started out with the intention of becoming a secondary education mathematics teacher, a high school math teacher. I was taking the courses in the college of education so I could do that down the road. After, I guess, one year, I really did not like the courses in the education college, and so I decided I needed to think about what else I would do with a math degree. It probably was sophomore year when you had to go see your advisor, to talk about what courses you were going to take the next semester. I don't know if we had to get a signature, I don't remember the process. I do remember talking to Dr. James Eaves, my advisor, and I said, 'What am I going to do with this degree when I get out?' 'Well, you can continue on for your Ph.D. and become a professor like me.' I thought okay. Or, he said, 'We have these classes that are being taught now in computer science and we don't have a major, but you could take some of those classes and see if you like that. There are computer programmers out there who use the computers.' So anyway, I thought okay. So I took a FORTRAN course and I *really* liked it. I think I ended up with six or seven computer science courses before I graduated. So I didn't have a major, but I did have a lot of computer science and I knew that I liked programming.

Misa: Mostly programming classes, or also things about databases, or theories of computation, or other kinds of topics?

Miller: They were varied. I can remember a course on compilers, an assembly language course — FORTRAN was actually the only higher level programming language course — had a course in simulation, and those are the only ones that come to mind right away. So they were varied. I think the year after I graduated in 1968, probably the year or two after that they had a full-fledged major department rolling at that point. A lot of those early departments, you know, were affiliated with the math department.

Misa: Actually, that sounds like a pretty good computing curriculum. In 1968-69, the field is just being defined and what it is isn't at all clear, so it sounds like the University of Kentucky had some pretty strong course offerings.

Miller: Yes, they were off to a good start. I remember the compiler course was taught by a Polish professor, and the simulation course was, I think, someone from the Netherlands, so they were pulling faculty from other parts of the world.

Misa: You mentioned there were three women math majors. Were there also a cluster of women who were focusing on computer science courses or computing courses?

Miller: Very few. There was a sprinkling of women in computer science courses. All three of those women who were math majors, by the way, we all three went on to be

programmers. So we graduated as math majors but we all three went into computer programming.

Misa: Were they also taking some of the same courses, because it sounds to me like you fell into a very supportive environment for somebody interested in math?

Miller: We clung together. [Laughs.] I think we were so aware that there were so few of us, and we were doing something different, so we always took the same [courses]. We didn't take the same non-math courses, but we took the same math classes [and] we took the same computer science classes. We took a couple of engineering classes like surveying and drafting, but we stuck together, very much. We went to work at three different places. I think Mary Sue went to Pratt Whitney. And my other friend was Gay, she went to Boeing. And we're friends to this day. We're living in different parts of the United States but we keep in contact, became sisters. [Laughter.]

Misa: It sounds like this group of women was very important to you. When you were thinking about graduating, you said in 1968, what kinds of options did you think about, this idea of becoming a professor or going to work?

Miller: I didn't think I wanted to become a math professor. Math courses got more and more abstract. I had less and less interest in the mathematics. I really think I'm an engineer at heart, so the computer science was definitely pulling at me. As far as getting that first job, I went to the placement center at the university and signed up for every

interview that indicated they would like to talk to a math major. There weren't a lot that wanted to talk to me. I was surprised at that. I talked to IBM. I went to the NASA Space Center; I didn't get an offer. I went to Bettis Atomic, which is Westinghouse, [and] got a good offer from them. And Bell Laboratories. I can't remember the other places, but as soon as I got to Bell Labs, I was home; I would've worked for them for nothing. [Laughs.] They were offering something very exciting to me.

Misa: I want to talk quite a lot more about your experience at Bell Labs, that was I'm sure a very exciting place, but I wonder if we could take a look at those recruiting advertisements from *Datamation*. They're from 1967, you might've been seeing something similar. I think I sent five of those images. Do you have them in front of you?

Miller: Yes, I do have them in front of me.

Misa: I'm not asking for deep insight, but your first reaction about what intents the different companies — there's five of them — might've had. The first one is Bell Comm, a branch of the AT&T system; it says computer specialist across the top.

Miller: Yes, I saw that. I never even heard of Bell Comm. 'Manned missions' so maybe they were working with space programs, that was a big deal when I was just getting out of school. That was interesting to me but they would've placed ads in *Datamation* [and] at that time I don't think I would've heard of *Datamation*. It's interesting they chose a female symbol there, at the top they have male and female symbols.

Misa: Yes, the moon on the top but then the male and female symbols.

Miller: [Laughing] I don't quite get that.

Misa: Yes, who knows what they put into advertisements, but that one sort of struck my eye, too. *Datamation* you probably know is a pretty important trade magazine, so not necessarily professionals, but a lot of companies advertised there, and it was a way of I think reaching out to people in the industry.

Miller: Yes, and I think for those already with jobs. I mean, it wouldn't have been the place to look for my first job, but it would've been a source to become aware of other jobs once you're in the industry.

Misa: The second ad is from Lockheed, also about 1967.

Miller: Right. That's interesting. The job that I got at Bell Labs was on the East Coast in Whippany and it was defense work. Everything was defense work in 1968. [Laughs.] Oh I'm sure Lockheed; and the first two we've looked at, Bell Com is talking about 'advanced manned mission systems' and that's what Lockheed was all about defense systems, space programs, government work was where the jobs were. It says 'Where can man go?'

Misa: A little different than the first one, isn't it?

Miller: Yes, and they're in Sunnyvale, California. Guess the first one was in Washington, D.C.

Misa: Yes, Sunnyvale at the time was a center of early programming activities. It's in the middle of Silicon Valley today, one of the places programmers were being hired.

Miller: And then the next one is RCA, and we're talking New Jersey. Yes, a lot of the jobs were also in the Boston area. I think there was a Route 128 that went out from Boston.

Misa: Oh yes, the ring route, 128.

Miller: That had a lot of companies starting out there. 'Look into RCA, you're our kind of man.'

Misa: Well, that's a different message then, too, isn't it?

Miller: Yes. [Laughs.]

Misa: So the fourth one is TRW?

Miller: Yes, I'm familiar with them. Bell Labs did a lot of research with TRW. They were affiliated. Linda Howard, okay. And they're in the space program business here, it looks like, to attract people.

Misa: That's interesting because it has a woman's name and a woman's face.

Miller: Yes, quite interesting.

Misa: You mentioned that you weren't really looking at *Datamation*, but if you'd seen an image like that, do you think you would have recognized yourself as more appropriate for certain of these jobs or companies, rather than others?

Miller: I think that would've been a good thing to see that. I guess I was very naïve, and I didn't realize that the fact that I was graduating with extraordinary good grades and this computer science courses, that I wasn't going to be someone that would be very attractive to these companies to hire. Then I got to Bell Labs and I got in there, and then after a little bit of time you become aware from mostly dating guys there that you weren't making as much money as they were.

Misa: Oh really.

Miller: Yes, probably about 30 percent less. They were making \$12,000 and I was making \$8,000 or \$9,000. I always rationalized that they had probably gone to a better

school than I had gone to or that they had done something exceptional that I hadn't done. I'd just gone to a state university and even though I had very good grades, I hadn't gone to M.I.T. or these other schools. So I convinced myself that the reason I was getting less was that I hadn't gone to a 'good' school. Until one day I ran into a classmate from the University of Kentucky and found out what he was making. [Laughs.] I had been his classmate so I knew what he was capable of, and I knew I was as good as he was. Then I thought there's something going on here. The other thing, too, was the women were — this doesn't even seem possible but it's true — we were hired on a program called the Courtship Program, and we were essentially on probation our first year there. And if we didn't get married, I guess if we married the job instead, we were then considered for promotion. But we were hired in at a lower job category — we were called Senior Technical Aids. And the men that came in with the same degrees were Members of the Technical Staff, they were a level above. So there was discrimination from the get-go, at the hiring point. [Later, I was transferred to Bell Labs in the Chicago area.] And then this group of women that [I] just plugged into, a group of women from the Chicago laboratories, we got together and figured out an awful lot of what was happening, and challenged it in various ways. It was easy to convince yourself that maybe you just weren't as good as somebody else. But it was harder when you had a cup of coffee with Mary or Beth and you heard them talk about, well they didn't feel like they were as good as somebody else in the workplace, *and you knew they were*. You could see their lack of confidence, but you knew they were good, then that would make you think well maybe I should rethink, you know, myself with respect to what I'm capable of, and what I'm doing; what I'm sitting here doing on the job.

Misa: It sounds like those three women, as well as this group of women at Bell Labs were really important to help you understand what your own talents were and how the company might not have been adequately recognizing it.

Miller: They were extremely important. [I recently had a reunion] with the 12 women from Chicago. We got together for three or four days in August, so it's been about 40 years and we still get together every five years and share where we are, where we've been, and we're together five minutes, it's like we haven't been apart. And we always reflect on experiences we had at Bell Laboratories.

Misa: You were hired into Whippany. Can you say a little about working conditions? Were you working mostly with a set of women programmers or what kind of programming team or work group were you involved with?

Miller: Okay, there were several women hired in at that time. We were math majors from various schools, but we were assigned to men who had been there a year or two, and so we were their programmers. The women shared offices. There'd be three or four of us in an office space. We were not allowed to share an office with a man. They said they didn't want the men to have trouble with their wives if they came home, and there were women's hairs on their coat or something, because they'd shared a locker or something.
[Laughs.]

Misa: Protecting the men.

Miller: Protecting the men, right, from us. [Laughs.]

Misa: Got it.

Miller: Our offices, there were glass panes in the top half of the door, you know? And [the glass] was not frosted so everyone could see in. The mens' panes were frosted. I remember that because I thought oh, they're always going to keep their eye on what the women were doing. [Laughs.] We had in-house classes in programming and they were fabulous. A lot of the faculty at Bell Labs were the leading computer scientists of the day. They were teaching, they were adjunct faculty at nearby universities. I attended Stevens Institute of Technology, so I received my master's there. I said we were all assigned to a man to be his programmer. The one I was assigned to was this guy, Larry Crume. Larry took me to Stevens Tech and said, 'Get your master's, Bell Labs will pay for it, they'll reimburse you.' If you were a man, you got time off work and if you went to that university, you were given much more support. If you were a woman and you were an STA, a Senior Technical Aid, it was tuition reimbursement. I took a course and then they reimbursed me. So you were treated differently. But after I'd been there a couple of years, they pulled me in and asked me if I'd rather be promoted to a Member of the Technical staff or an Associate Member of the Technical Staff. My boss strongly recommended that I go the Associate Member of Technical Staff, because that was 'better for women.' And the guy I was dating at the time said that's complete bull, you go

back in there and tell him you want the MTS, and so I did. And that was the right thing to do. [Laughs.]

Misa: MTS defines who is important at Bell Labs, is my understanding.

Miller: Yes, [being an MTS] was very important.

Misa: That promotion to MTS, do you recall about when that occurred? Was that close to when you started at Bell?

Miller: I think it was probably in 1970. You know, I think something was going on at the time — we were all one big company, it was Ma Bell, and some of what were called operating companies, like Bell South and Illinois Bell, they were under the gun for discrimination, I think, primarily against blacks and there were lawsuits. Things were getting stirred up there, and so I think I was probably benefitting a little bit from Bell Labs saying hey, maybe we better look a little bit closer at the way we're doing things because over at these other companies such as Bell South —the company is getting scrutinized. But I don't know that for a fact.

Misa: No, I think you're exactly right. You can see different companies responding to that pressure for greater visibility, and greater equity or accommodation toward women and also African American employees, and it pivots right around 1970. So that wasn't

something unique at all to Bell, but that was Bell responding to a shift in laws. I think that's the key thing there.

Miller: Yes.

Misa: During these years, Carol, were you still working as a programmer? Or did you have different terms because sometimes people worked as analysts, or there were different terms to describe what we would just generically refer to as programming?

Miller: I was doing programming, but in my mind I was doing a different type of programming than might be generally thought of. I was doing systems programming, low level operating systems. I did that, and that's what I did the whole time. The department I was in on the East Coast was building a prototype computer that was cache memory, a special kind of memory. It was going to be used for tracking missiles as part of an anti-ballistic missile defense system. Part of the department contained groups of men who designed the hardware and built a prototype. And the other part had women and we built the operating system for the computer, and the applications that sat on top to demonstrate that this type of computer, this parallel computer would do the job they wanted it to do.

Misa: So the systems programmers sounded like a cluster where there were a number of women in that area?

Miller: Yes, there were probably six or eight out of 30 people were women.

Misa: Six or eight, so that's a good proportion, then.

Miller: Yes.

Misa: A back-up question to that — I studied Bell's military computing and it seemed to me there were distant connections between its military computing and the computers they built for the phone system. They didn't call it computers, exactly, but Electronic Switching System was a stored program computer and that was being quite actively developed also in the 1960s and the 1970s as well. Did you have much contact with the ESS people, or was it strictly the military side?

Miller: Okay, so I was in Whippany, NJ, and [that was military research]. Then Bell decided to get out of military research for the government, so my entire department was transferred to Indian Hill, to the Chicago Laboratory, and that was ESS [Electronic Switching System]. The department that I was in still did system software: linkers, loaders, compilers. So, yes, I did shift over, but the work that was already going on, was in parallel to the East Coast. There wasn't much interaction between the East Coast and the Chicago Lab. But yes, [the Chicago lab work] was called electronic switching systems because Ma Bell was a monopoly and couldn't be in the computer business. So they didn't want an electronic switching system to be considered a computer or they would lose all the privileges of being a monopoly. But, yes, it's a complete computer, that's all it was. [Laughs.]

Misa: I talked with Joe Wosk — who may have hired Joyce Malleck, and he's the first one who clued me into this. You can read thousands of pages of Bell's own history and you have no clue that the ESS is a stored program computer. So I asked Joe point blank, 'This sounds a lot like a stored program computer.' And he said, 'Oh yes.' [Laughs.]

Miller: Oh yes. [Laughs.] No question.

Misa: Even the things that Bell has published about its own history, they were trying to keep those two quite separate. So this transfer then, when Whippany was shut down, you ended up having your whole department moved to Chicago, physically moved.

Miller: That's true, yes.

Misa: Sometimes when people get a transfer, it's interesting to reflect on the culture that might've been different between Whippany and Chicago. But you probably had continuities in working relationships, and in company culture.

Miller: Yes, although we weren't kept together as a department in Chicago.

Misa: Oh, okay, so you were actually distributed then.

Miller: Right. Small groups, three or four, were distributed to different departments.

Misa: So you may have had a chance to see some differences in how the work was organized or how the company culture was experienced. Did you notice anything that was striking?

Miller: I felt like it was quite different.

Misa: Quite different.

Miller: The environment on the East Coast was much more research, and the way we approached software design was different. We would review the literature. We would consult with people in other departments who were leading edge, doing a lot of this work. When I got to Chicago lab, they had already done #1 ESS, they were actually working on #4, and it was a development environment. Lots of pressure to get code written and get it out the door.

Misa: So did you think that time pressure was more acute then in Chicago?

Miller: I think so. I think another pressure might've been — I think everybody was sensing that divestiture was down the road, that we were going to be split up as a corporation. And I think there was a hesitation to begin research and develop new products. There was [a sense of] just keep the game plan going, of getting these ESS machines out the door with maybe new features, but let's not talk about another

generation of computer until we see what's going to happen, and what's going to happen to Bell Labs in the process. The ESS machines were all developed [and built] by Western Electric, and at the Chicago lab there were groups of people that were Western Electric and people that were Bell Labs all mixed in together.

Misa: By mixed in, would you actually have a working group that would have both Bell Labs and Western Electric?

Miller: Yes.

Misa: So you'd be working side-by-side on a daily basis?

Miller: Yes.

Misa: But technically you'd still be working for a different division of the company?

Miller: That's true. [Bell Labs and Western Electric] were what they called wholly owned subsidiaries. Bell Labs was a wholly owned subsidiary company of AT&T Corporation, and so was Western Electric. Then there was something called Long Lines, too, the long distance telephony. And then there were 10-20 operating companies that were the companies that actually delivered phone service.

Misa: Right. But when you had these mixed groups, would you also have some supervisor then that would somehow straddle the groups? I'm curious how that worked.

Miller: You know, I can't answer that question because I just don't remember. My department didn't have any Western Electric people in it. We did system software. But I had many close friends, including some of these women friends, like Beth Eddy was there, and she was a Western Electric employee. She was the first woman promoted into management, in the whole building [of 5,000 workers]. I can remember the day that happened. [Laughs.] We "confiscated" all the copier machines that were in private spaces and we Xeroxed a million copies of Beth's promotion and went around and just stuck them up everywhere.

Misa: Oh great. [Laughs.] Did you notice any notable differences in how women were treated, or what the environment was between Whippany and Chicago years?

Miller: I think the women in Chicago had their act together, but that may have just been an evolutionary thing, you know, a few years later. I guess I was in Whippany three or four years so by the time I got to Chicago, the women who were coming into the workplace had a different mindset and it was a better place for women to develop. We also had some wonderful men who supported and mentored, so it wasn't all a negative thing. And I think many of the men in management were just not aware, as some of the women were not aware of some of the prejudices at work.

Misa: You mentioned earlier that 1970 seemed to be a change. And of course, the 1970s, that's the decade when the women's movement in the United States becomes strong and a pretty big cultural force. Do you recall your thoughts or experience with the wider women's movement?

Miller: Yes. In Chicago, about a dozen women at Bell Labs and Western Electric got together and created a little group. We called ourselves a Rap Group, isn't that an interesting term?

Misa: Yes.

Miller: And we met — I can't think how often — maybe twice a month or something. And we rotated meeting in our various apartments, and we had rules, such as you couldn't clean up your apartment, you couldn't cook, you couldn't do any of the things that women typically do when they're entertaining.

Misa: Right, okay.

Miller: So what we'd do is we'd order pizza and we'd have a jug of wine, and sit on the floor, and one of the women had gotten a list of questions — kind of like you've got the questions today — and she would read out the question, and then we would go around the group and answer the question, and you were not allowed to interrupt. You could pass, but we'd go all the way around the room, we'd deal with one question, and we'd maybe

have some discussion then because we'd be so surprised at what we heard our colleagues saying. And so we did that for gosh, a couple of years. And we even got some other groups started. So we might've been — was it called sensitivity training, or something back then.

Misa: Yes, something like that.

Miller: So we became a close group of women friends. Some of those women were the ones I met with in August, back in Chicago, so we stuck together all this time. And again, it made you very aware when you would just hear the responses coming from your friends and you'd get up enough courage to share how big your raise was, and then you would find out we all got crappy raises. And some of them were married and their husbands got better raises, you know, so you would learn a lot about what was going on.

Misa: Probably the supervisors didn't quite intend it that way.

Miller: Right. [Laughs.] But there was not a single woman in management when I got there in, I guess, 1972. And there were 5,000 employees in that building.

Misa: Wow.

Miller: Didn't have a single woman even at first supervisory level.

Misa: And you said it was Beth Eddy who was the first?

Miller: Yes, Beth was at Western Electric, and I'm still super friends with her. I'll share an e-mail with you and you can talk with Beth.

Misa: Oh, that would be great.

Miller: One of the women I saw on your list is Mary Holt.

Misa: Yes.

Miller: Have you talked to Mary yet?

Misa: Not yet.

Miller: Mary was a big leader and she hosted our group back in August. So she has a long list of contacts that you might be interested in, in that group.

Misa: That's splendid. You said there were 12 women meeting this August, was that about a similar size back in those days in the 1970s in Chicago? A dozen women, or 20, or . . . ?

Miller: That [discussion] group was, yes, about a dozen women in that group. But there was more than one group of us. We got ourselves organized. One of the things that Bell did which was just great — I'm sure they were forced into it — but we spent one day a year on affirmative action meetings, an all-day meeting. And this is kind of amusing because they decreed that you had to do this, but they didn't give any guidelines on what you did, or anything else. In my department, the boss called in a couple women and a couple blacks in the department, and he told us to plan the meeting. I think this may have been Mary Holt's idea, even though she was in a different department but she was involved in planning hers. We got a group of women together and the blacks got together, and we wrote a description that was a composite of our experience being there in that department. I can still remember the blacks saying that they never got invited to dinner, that their day ended at five o'clock and they didn't get included in anything after that, you know. they didn't get invited to parties or anything after work. I can remember one of the things that we women said was that when we would give an opinion, a technical opinion, the man that we were talking to would turn to somebody else and say, is that right? They would have to have a confirmation that our technical opinion was valid.

[Laughs.]

Misa: Oh dear.

Miller: I remember including that in our group testimonial. So it was a composite and after we read it, and we said that everything that we talked about in here is really what it's like for us in this environment, many of the men were amazed. They just were totally

unaware and when they were doing things like saying 'is that right?' Or when the supervisors were never appointing the women as group leaders for projects, which were then going to be the positions that lead to the promotions to supervisor. They were never aware they were never picking a woman. So they started making some changes.

Misa: When do you think there were visible signs of change? I know these things go really, really slow sometimes, but you said Beth Eddy's promotion was one of those events that was quite memorable. Were there other things that you'd point to as visible signs of change, even if it were slow?

Miller: I think there was enough discussion going on that the management felt some pressure, particularly to get some women into management. The first woman on the Bell Labs side they brought in from another location. She'd been promoted in Greensboro, North Carolina, and they transferred her in at the same level; so she'd already been promoted. Her name was Karen Boozer, and I still have contact information for Karen. And then a few other women got promoted. Mary Holt, we've talked about her, she got promoted. So it started to happen. It was probably 1972-76 where there's just a little bit of promotion being seen. But some others, I got a group project. I was not promoted there. I left in 1976 and went to work for General Electric, and worked there for six of seven years. And then I became a college lecturer at NC State for 25 years. So I ended my career teaching.

Misa: And when you went to General Electric, was that still in the Chicago area or was that involved with —

Miller: That was in North Carolina.

Misa: Oh, you moved then to North Carolina.

Miller: Right. You know we're talking about having Western Electric and Bell Labs mixed in, there were also a few operating company people mixed in. And there was this guy from Southern Bell, named David Smith, and he was on a rotation, on assignment in Chicago, and I ended up marrying him. So he rotated back to North Carolina; I came with him and he was transferred to Wilmington, North Carolina, and there was a nuclear fuel manufacturing plant there in Wilmington. Want to know how I got my job there?

Misa: Sure.

Miller: Okay. It wasn't a very big town and I hadn't really foreseen that the stuff that I'd been working on wasn't really needed in a town of 35,000 people. [Laughs.] They didn't need computer programmers.

Misa: You were doing this operating system work, which was extremely valuable to the right people, but okay, smaller place.

Miller: But not valuable in this town. And so I was having trouble finding a job. Back then, you just looked at newspapers and that kind of stuff. I was going a little crazy with not working — I'd never not worked — and so I dived in and I started doing volunteer work. It was the era of Equal Rights Amendment and so I joined a chapter of NOW and of ACLU, and just anything I could find. I found that I was very welcomed, especially if I said I'll do the fundraising.

Misa: Oh, that's the tough job, right.

Miller: So I went to organize all sorts of things, and I met all sorts of wonderful people. I'd read this book called *What Color is Your Parachute?* It was a book back then about how to get jobs in a nontraditional way. So I had copies of my resume and I would just give them to anybody I met, so I became good friends with this woman and we were working very hard on, I guess it was NOW, and she called me one night and she said I have got a problem. She said, I'm on a date with this manager at General Electric and all he wants to do is complain about he can't find computer people to do the kind of work he wants. And she said, I had your resume and I pulled it out, and so I want you to talk to him so we can get back to our date. And I did talk to him. [I] ended up going in at six o'clock on a Monday morning and interviewing with him. He said you're just exactly what I want. I don't have an opening, you go down to Manpower and I'll hire you on my expense budget and bring you in here. So that's how I got in the door.

Misa: And that was at General Electric? Wow.

Miller: General Electric, a senior digital engineer there. [I] did real time systems for inspecting nuclear fuel parts. So probably the most exciting technical work I did my entire career.

Misa: Can you say a little bit about that?

Miller: We manufactured — the plant is still there — we made low enrichment of uranium pellets, and the tubing that they went in for nuclear reactors. I was in a department that designed and built quality inspection equipment for the plant. It was multi-disciplinary work. It was a lot of engineers: ceramic engineers, mechanical engineers, nuclear physicists. They would throw us a problem like we need to be able to inspect these pellets and find if there's any chips or cracks in the exterior, and get them sorted out of the assembly line. So we would tackle that problem. So the work at General Electric was in an age of minicomputers. We had Digital Equipment, and Data General computers, Intel was coming out with microprocessors. And we just took some of those boards and built the computer controls for the inspection, different inspections of nuclear equipment.

Misa: So you were building computer systems . . .

Miller: Oh yes.

Misa: . . . for the specific purpose of doing quality inspection, and control. I mean, that's a very demanding job and of course the idea of doing inspection any kind of uranium plant would be uppermost on your mind.

Miller: Yes, it was very challenging and wonderful. We were building the entire system. Move the product along, and do the inspections, and sorting, and various things like that.

Misa: One of the key puzzles that you might have some opinions on or some insight about is a shift in the computing industry in the 1980s. I think I mentioned before our recording that in the 1960s and 1970s, and through about 1985, the computing industry as a whole was unusually welcoming to women as compared to, say, engineering or some of the physical sciences, and that seems to have been reversed in the mid-1980s. So 1985 until now, the proportion of women getting computer science degrees actually has dropped from the mid-1980s. And similarly even in the IT white collar workforce, the numbers are down. Do you have any sense from your own experience, or did you recall anything about the cultural climate or the work climate in the 1980s that might in any way bear on that puzzle?

Miller: Well, I actually went to work at NC State University in Raleigh in 1985, so I would see women in computer science classes. When I got there I probably had 20-25 percent of my class was women. I saw that decline and I think one of the things that was happening there was when I came the department of computer science, the department was in the physical and mathematical sciences college. It moved to the college of

engineering. When it moved to engineering, the women students didn't move with it. There were fewer women seeing engineering as the career they wanted and so the numbers dropped tremendously when it became an engineering discipline than a general science discipline.

Misa: Do you think that the courses changed in some way, or was it a question more of women's perceptions may have changed? Just because you changed from teaching whatever it was, a compiler course in one college, you could be teaching a compiler course in a different college but your course wouldn't necessarily change. But the major and the other students might've changed.

Miller: Okay, the introductory courses did change.

Misa: They did change. Can you explain that?

Miller: When [the department moved] into college of engineering, first of all, the administrators decided that *everybody* in engineering would take a programming course their freshman year, along with calculus and physics. So that was a general requirement for all engineering majors. So what happened? We had these colossal classrooms, so I had 200 students I'm lecturing to, and then they'd break down into labs later on. What do you think happens to those girls in those great big classes? They feel like total imposters and they won't speak up when they have a question, they're feeling much more out of place. I think they tend to not consider engineering anymore, not consider computer

science as something to stick with. So it's a very different environment for that freshman woman.

Misa: And earlier you said that the engineering intro classes were about 200. Could you compare the size to when it was back in the science-oriented college? The intro programming would be less than that.

Miller: It would be about 30.

Misa: Okay 30, so that's the better part of 10 times bigger.

Miller: Yes.

Misa: That's a real change.

Miller: And as a teacher, the way the classroom is run. You know, when I've got 30 kids, somebody can ask a question. When I've got 200, it becomes a one-way communication. I'm putting slides up on a big projector — they're PowerPoints — I'm not going to be developing code in response to a question, on a chalkboard, because people in the back can't see it. So it's a very different format as a class.

Misa: Nobody intended that to be something that would make computer science less welcoming to women, but you think that had the effect of just that?

Miller: Absolutely.

Misa: Were there changes also in other upper division classes, maybe in programming or other computer science topics that were similar?

Miller: The curriculum for the computer science major didn't change that much, in the two colleges; the theory classes, and the numerical analysis, and whatever. And the classes got to be a reasonable size. It was the freshman and sophomore classes that were huge classes. And also, because it was all of the engineers, the ones that succeeded were the boys that had computers to play with in their basements before they came to college. [Laughs.] They had enough going for them that they didn't have to ask questions; they could just pick it up and go. It made all the difference. Even though we had labs a few days a week, the groups were still too large. You sit and you listen to the lecture, and then two days later you go and you're in a lab and you're trying to apply something you heard about two days before, it's just not a good way to get started.

Misa: Yes. Some people have made the observation — and again, this is more or less unintended consequences, I suppose — but people point at the 1980s as a decade when a lot of schools and even some homes ended up getting microcomputers, personal computers. I don't know why, but seemingly that was dominated by boys. Maybe gaming, maybe male culture or something like that, so that boys gained high school experience or home experience with computers, but girls didn't and that had a big

differential impact when the boys and girls went to college then, they had different experiences. Did you see anything like that?

Miller: I saw it in my home, but I had boys. [Laughs.] We had a Mac Classic and they were expected to mess around with it. I didn't have any girls, but yes, I do think there was a different home culture for girls and boys. The boys just came in with not being intimidated by the machines, and using a computer back then, it was pretty easy to be intimidated. So yes, well, when I left — I've been retired now about six or seven years — we've still probably only maybe got, my guess would be about 15 percent women, maybe 10-15 percent women. Do you know what it is for women in computer science?

Misa: It depends on exactly who is making the measurement, but that sounds about right. I think the numbers that most people say are about 15 percent. There's this Taulbee Survey of the top computer science departments so it's not necessarily a representative sample, and might be a little bit higher because puzzlingly enough, it's been the case within computer science that the higher ranked departments are even less welcoming to women. Again, I'm just saying what the data is. It's really quite puzzling to try to understand.

Miller: Right.

Misa: I think it's stuck right around 15-25 percent, and it had been at the peak 37 percent. Those are national figures. In 1984-85 it was 37 percent of the undergrad

computer science degrees were collected by women and it's half that now. And the workforce numbers are down too, that's got people really worried because that's not just a question about academic computer science, you can get into computing in lots of different ways, of course, but computer science is one direct way to get into computing.

Miller: Yes. I know at NC State they are concerned, and we went back [and] we changed the format of the first class. But the best thing that happened was the other engineering majors decided they didn't need to put all of their students in that freshman course.

Misa: Ah.

Miller: And so that cut down just on the demand for the classes. [Laughs.] But we were able to go back to a class where it's integrated lecture/lab. I taught in that environment. I went from seeing sometimes as high as 30-40 percent of my class having a D or an F in the course, to become less than 10 percent. The success rate was when we changed the format and the number of students in the class.

Misa: Those failure rates are really pretty high; it's great to see that come down.

Miller: I still see those students [from large classes], and I will apologize to them.

[Laughs.] I just felt so bad that that was the way we were introducing them to computer science. But I was talking to the ones that survived. [Laughs.]

Misa: Yes. Well, Carol, this has been such a marvelous conversation. One question I like to ask of everybody, is to make sure if there's an additional question or topic that you'd like to make part of this conversation?

Miller: I can't think of anything. You just did a tremendous job of taking me back and thinking about all those years. I'm so glad that you're doing this work; I think it will be very important going forward.

Misa: It's very interesting too. There's all these amazing people, women and men, who've had really important, and valuable, and satisfying careers in computing. Hope we can do better in the future so that's one of the things we're trying to work on.

Miller: Thank you for your work.

Misa: Carol, again, really appreciate your time today. [I] really enjoyed our conversation. Thanks so much for it.

Miller: Thank you.